UNIVERSITY OF
BIRMINGHAM

AN APPROACH FOR MONETISATION OF SOCIAL IMPACTS ACCRUING FROM RURAL ROADS

By

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A thesis submitted to the University of Birmingham for the degree of

DOCTOR OF PHILOSOPHY

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August 2023

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ABSTRACT

This PhD thesis is about finding the best methodology to be used in attaching value to social benefits accruing from rural roads through Monetisation of social benefits and costs. This PhD thesis specifically discusses the valuation of social benefits in monetary terms. The monetization of social benefits may be used in prioritizing maintenance of rural roads in low-income countries a process currently not taken care of by many available valuation methodologies. The closest of these is the Road Economic Decision Model (RED), a World Bank methodology which considers low volume roads but not rural roads with traffic volumes less than 50 vehicles per day. The thesis consists of literature review on the methodology techniques, proposed methodology for carrying out the research, the case study to assess the implementation of the proposed methodology and a discussion on the findings as well as the recommendations for further research. The available literature indicates that Sub-Saharan Africa has approximately 700,000 kilometres of rural roads, with half of them in poor condition. These rural roads however are characterized by poor maintenance regimes, low funding and in many instances limited management. Despite inadequate maintenance, rural roads contribute significantly to the economic and social development of the areas they traverse as well as provision of access to markets and amenities such as schools, health centres, religious centres, tourism centres and farmlands. Despite rural roads being drivers of development in the communities they serve, decision makers are reluctant to allocate adequate funding for the improvement and maintenance.

The literature also shows that there is no dedicated monetizing methodology for social benefits accruing from rural roads, however there are a number of techniques in use for other sectors such as environment, water and agriculture. In lieu of this, there is need to develop a methodology which can be used to monetize the social benefit from rural roads. Based on the theory of change process, the outcomes are assessed, and the associated impacts as well as the social return on investments (SROI) ratio are calculated. The SROI ration measures the value of the benefits or costs in line with the investment in monetary terms. To demonstrate the effectiveness of SROI technique, a case study in Kamuli district in Uganda was adopted, field work carried out using survey tools and the respective data collected and collated for analysis.

Results for all ten roads surveyed indicated positive correlation in the figures obtained through SROI calculations. The results provided proof that SROI can be used to monetise social benefits accruing from rural roads. It's however, important to note that monetization based on SROI is not void of limitations. There is need to validate the data inputs, analysis and modelling. Valuation of social benefits should be considered as an ongoing process other than an event. Therefore, Monetisation of social benefit for a given community be carried out regularly.

ACKNOWLEDGEMENTS

I would like to wholeheartedly acknowledge the University of Birmingham (UoB) for the full bursary they extended to me for this PhD course and Dr. Michael P.N. Burrow who coordinated the payments. In the same way I wish to acknowledge again Dr. Michael P.N. Burrow, together with Dr. Gurmel Ghataora and Dr Mehran Eskandari Torbaghan for their the inputs, mentoring, and encouragement without whom I would not have managed to accomplish this milestone. They know how far we have come.

I also wish to acknowledge with gratitude the patience and support exhibited by my wife Patricia Kabahinya Kakiiza, my children Ray Muhumuza Daniel Kakiiza and Ryan Mwesigwa Amani Kakiiza and posthumously my parents Mr. Alisen Kiiza (RIP) and Mrs. Regina Kiiza (RIP) who passed on in 2013 and 2018 respectively.

In the same vine I give gratitude to all my brothers who provided the much-needed support in the UK and my niece Vivian Kahunde for her backstopping support. Last but not least to the entire management of the department of Civil Engineering at the University of Birmingham (UoB).

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List of abbreviations

ADB	African Development Bank
AFCAP	Africa Community Access Partnership
AM	Asset Management
ASCAP	Asia Community Access Partnership
CBA	Cost Benefit Analysis
CS	Consumer surveys
DFID	Department for Further International Development
GEM	Economic Growth through Effective Road Asset Management
HDM4	Highway Design and Maintenance (Model)
IAMM	Infrastructure Asset Management Manual
IRF	International Road Federation
IRI	International Roughness Index
LVR	Low Volume Road
MoWT	Ministry of Works and Transport, Uganda
PIARC	Permanent International Association of Road Congresses
PO-RALG	President's Office – Regional and Local Government
RAI	Rural Access Index
RAMMI	Road Asset Management Maturity Index
RAPI	Road Asset Preservation Index
ReCAP	Research for Community Access Partnership
RED	Roads Economic Decision (Model)
SA	Social accounting
SCBA	Social Cost Benefit analysis
SDG	Sustainable Development Goal
SLRA	Sierra Leone Roads Authority
SROI	Social Return on Investment
SSA	Sub-Saharan Africa (SSA)
SSATP	Sub-Saharan Africa Transport Program
TCM	Travel cost method
UBOS	Uganda bureau of statistics
UGX	Uganda Shillings
UK	United Kingdom (of Great Britain and Northern Ireland)
UKAid	United Kingdom Aid (Department for International Development, UK)
UNRA	Uganda National Roads Authority
UoB	University of Birmingham
WB	World Bank
WTP	Willingness to pay

1 CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter makes a case for the prioritisation for maintenance or rural roads based on Monetisation of social benefit. It introduces the concept of Monetisation of social benefits, the available techniques currently in use, the theory of change and its impacts to social benefits among others. This thesis will significantly make it easy for the road managers to voucher for maintenance funds for rural roads based on the monetary value of the accrued social benefits.

The PhD thesis involves literature review, assessment of the appropriate methodology, data campaign based on a case study for rural roads in Uganda proceeded by analysis of the collection data. Primary data for this thesis will be collected from the case study. The outcome of this thesis is expected to inform the provision of funds for maintenance of rural roads best on the robust methodology for prioritisation of rural road maintenance. To find an appropriate method to monetise social benefits accruing from rural roads, the researcher collected and modelled the data based on a case study. The details of the process adopted in selection of the case study site are discussed in chapter seven.

Understand this thesis, Kamuli district in Uganda was among others considered due to a large rural road network, availability of data on rural roads collected under GEM project (Washington et al., 2010) and other projects and the researcher's knowledge of the country and language spoken being his country of origin. Ten rural roads were selected for this thesis in line with the agreed criteria. Surveys and study focus group discussions were conducted.

1.2 Problem statement

More than 40% of rural regions in Sub Saharan Africa are agrarian and so their economic outlook relies on farm products reaching markets on time, undamaged and with economical vehicle operating costs. Further, human resources and products which support agriculture also need good access to amenities, low travel costs, minimal travel time and reduced accidents. Poor transport infrastructure and associated high transport costs from poor route conditions, or intermittent seasonal access, adversely impact social-economic activities emanating from the rural roads network. Further, rural communities with inadequate access are also often restricted from social interactions, schools, health facilities and basic needs (Luiu et al., 2018). World Bank in its policy research working paper 7729 on Roads and Rural Development in Sub-Saharan Africa asserts that there is relationship between roads network, markets, farm land and development. Also notes that improved road network produced a modest but significant positive relationship between increased market accessibility and expansion of local farm land which contributed to the wellbeing of the community measured through gross domestic product (GDP) (Washington et al., 2010).

To alleviate poverty and or improve economic and social development, Sub-Saharan Africa requires improved access to social and economic facilities among other parameters. Improving access hinges on better transport infrastructure, which includes roads, tracks, footpaths, and footbridges. Rural roads form the bulk of the roads in Sub-Saharan African countries. They also form a major link between the communities and their environs making them important drivers of the economic and social development of rural communities. The 1990 World Bank report, prepared under the Rural Travel and Transport Project of the Sub-Saharan Africa Transport Program (SSATP) estimated rural roads at 700,000 kilometres out of a total of over 1.02 million kilometres of road in Sub-Saharan Africa (SSA), The highest concentration found in west African countries notably Nigeria, Cameroon and Côte d'Ivoire. It is noted that Sub-Saharan Africa has a sparse road network much less dense than the developed countries. The road network is subdivided into classes namely; primary, secondary and unclassified such as tracks (Gwilliam et al., 2008), the unclassified road sections is the bulk of the road networks although they are the least funded. In their current setting, rural roads are considered as public infrastructure and are managed by the lowest tire of Government or road administration. Like other public infrastructure, rural roads are very susceptible to effects of climate change, tear and ware and other distresses. They are further affected by poor funding from the road administrations, central government and financing agencies. Despite rural roads being very important drivers of the economic and social development, they are least thought after in terms of funding for maintenance, and management. Policymakers and transport professionals in governments and donor agencies have paid little attention to

maintenance of rural roads as compared to new paved roads (Gwilliam et al., 2008). This disinterest is caused by among others;

1. Limited visibility exhibited by rural roads in comparisons to new motor ways and paved or asphalt concrete. Thus, less appealing to politicians and donor agencies,
2. Lack of a well-defined institutional framework for rural transport infrastructure. They belong to the lowest tier of group of roads. This tire is the least funded,
3. Lack of appropriate methodology used by roads administrators, policy makers and professionals for maintenance prioritisation for rural roads

Rural road network generates a formidable amount of economic value contributing greatly to the region's gross domestic product (GDP). The bulk of goods transported on these rural roads come from agriculture and natural resources of which about 40 percent contributes to export revenues while the rest is utilized domestically and by urban populations. Further to economic importance of roads, the majority of rural population in Africa mainly women and children walk to work, to collect implements, to cultivate their gardens, fetch water for domestic use, and to access services such as health, education, recreation and social amenities.

For this thesis, Item (c) of the mentioned problems indicating lack of appropriate methodology to voucher for maintenance funds is the basis for this thesis. Items (a) and (b) will not be discussed but mentioned for completeness of the thesis. In trying to solve this problem of finding an appropriate methodology for maintenance prioritisation of rural roads. A number of methodologies have been advanced though none is linked to rural road maintenance.

1.3 Statement of purpose:

The core of this thesis was to find an appropriate method to assign value to the social benefits accruing from the maintenance of rural roads. The monetised value of the social benefits is expected to be used for maintenance prioritisation of rural roads. The total value of the rural road (Replacement value and social benefit value) is a good indicator that can be adopted to secure funding for rural road maintenance. This thesis considers the value of the social benefits, the replacement cost is beyond the scope of this thesis. Monetised social benefits accruing from rural roads is a good indicator of the impact of the investment. Literature review indicates that investments in rural road assets spur significant increase in social-economic benefits across the communities they serve. The game changer is development of the user friendly but robust indicator to prioritise rural road maintenance. Such intervention will ease the work for the road managers and or technical people to easily voucher for funding. The methodology adopted should be simple and easy to populate and analyse the data collected from the field.

As noted in section 1.2 and in literature review as detailed in chapter 2.0, there have been a number of interventions in prioritising in the road sector, however, it was established that none of them gives a clear and acceptable methodology for prioritising maintenance for rural roads. This creates a need to formulate an appropriate methodology to close the gap.

1.4 Aim of the Study

From the problem statement and the statement of purpose, the aim of this thesis is to develop a technique that can monetise social benefits accruing from maintenance of rural roads in low-income countries for use in prioritisation of maintenance of rural road infrastructure.

1.5 Study objectives

To meet the aim of this thesis, the following objectives were considered;

4. to establish the effect of rural road maintenance on social changes and their drivers in the served communities,
5. to assess the available techniques for monetisation of social benefits,
6. to develop a framework for monetisation of social benefits and costs accruing from rural roads,
7. to demonstrate the effectiveness of the methodology and modelling technique through a case study, and
8. to develop a user friendly but robust tool to prioritise maintenance of rural roads.

1.6 Scope of this research

This research aims at developing a technique that may be used to monetize social benefits accruing from rural roads. This technique should be adopted for use universally by all managers advocating for maintenance of rural roads. This research considers literature on maintenance of rural roads, the involved social changes and how they are valued through a monetization technique. This research tests the adopted methodology using Uganda, Kamuli District as a case study, reference is also made to World Bank report on Findings and Conclusions from Village-Level Travel and Transport Surveys and Related Case Studies.

1.7 Overview of methodology:

This study is based on gaps established from literature review and industrial practice. The study involves literature review, analysis of the gaps, analysis and comparisons of the available monetisation techniques, data collection in line with the most viable technique from the selected case study. Eventual testing of the selected technique based on the data collection and sensitivity analysis. This study recognises the fact that, monetisation of social benefits base on known criterion is a well-documented and widely accepted process in many sectors other than rural road infrastructure. The use of return on investment (ROI) is also one of the common methods in sectors like health, environment and social sector but has not history in the rural road sub-sector. The nature of data required calls for a combination of data collection techniques. For this study, conventional data collection using questionnaires was adopted and the participatory rural appraisal (PRA) system based on user community participation. The analysis was made based on tools in excel software. Tools such as linear regression tools, data analysis tools.

1.8 Rationale and significance:

Given the inconsistencies in arguing for funding for maintenance of rural roads and given the lack of appropriate methodology, it's imperative that a study be carried out to find a practical solution.

The output of this study is expected to be used by road maintenance stakeholders; road administrators, policy makers, and technocrats among others in prioritising or arguing a case for maintenance of rural roads. The study provides the following benefits:

a) A methodology to monetize social benefits accruing from rural roads,

b) Provision of a user friendly but robust methodology to prioritise rural road maintenance based on the value of the social benefits accruing from rural roads, and

c) Method to argue for funding maintenance for rural roads by road administrators, technocrats and policy makers.

1.9 Thesis outline

This thesis is structured as a step-by-step flow. It comprises of ten chapters excluding references and attachments. The chapters are;

Chapter One (Introduction): provided the overview of the research, the problem statement, and the aim and research objectives. It also considers the research problem, and statement of purpose. It provides an overview to the methodology as well as the rationale and significance. This chapter closes out by summarising the scope of the research and creating outline.

Chapter Two (Literature review): provides insight into the available methods currently used for monetisation of social benefits. The literature review process was aimed at finding any leads that are in use or directly related to monetisation of social benefits accruing from rural roads. Based on systematic review process, most of the techniques used to monetise social benefits were identified. However, there was need for further literature review on the selected methods to refine the search for the most appropriate method. Prior to zeroing on an appropriate technique, there was background literatures reviews on road asset management concept and general road maintenance processes. The reviews were aimed at helping the researcher get a holistic approach to the monetisation problem.

Chapter Three (Methodology): discusses the methodology followed in this research. It looks at the research methodology, data campaign methodology, data processing, modelling and analysis. It also provides methods of results and sensitivity analysis. It is these methods that are adopted in the research.

Chapter Four (Social benefits accruing from rural roads): this chapter provides insight on what brings about social change and what techniques are available to measure the changes. It underscores the social benefits accruing from maintenance of rural roads, how they are measured and the measurement techniques. Data requirements are also considered in this chapter.

Chapter Five (Comparative study of monetisation techniques): This chapter looks at different available techniques compares them against each other with the purpose of finding the most responsive one to measure social benefits accruing from rural roads. In doing so, common parameters in the use of available techniques such as; cost, data availability, time efficiency and clarity in the processes are used for comparison. A review and analysis of advantages and disadvantages of the different monetisation techniques and eventual selection of the most appropriate techniques are considered. Lastly Linkert scale methodology was adopted to rank the techniques.

Chapter Six (Proposed monetisation Framework for Rural roads): This chapter proposes a methodology that may be used by road managers and road sector stakeholders to voucher for the allocation of money for maintenance of rural roads. It provides for the processes that should be considered. It brings on board the concept of the theory of change and the eventual monetisation of social benefits based on social return on investment methodology. Limitations to the proposed model are also included for completeness of the chapter.

Chapter Seven (Case study – Kamuli district, UGANDA). For ground truthing of the proposed model and for ease of testing the findings from literature review, a case study was carried out. This chapter provides details about the case study, the data collection in the field, challenges and any actual findings in this research. Calculations of SROI ratio, sensitivity analysis and limitations are all discussed in this chapter.

Chapter Eight (Summary and Discussion). This chapter summarises the study and discusses the findings from the data collected, analysis.

Chapter Nine (Conclusions and recommendations). This provides general conclusion on the work accomplished by the study, findings and general discussions. It also provides recommendation that may be considered for improvement of the methodology and any other future research needs.

2 CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The aim of this research was to develop a technique that can monetise social benefits accruing from rural roads in low-income countries for use in prioritisation of maintenance of rural road infrastructure. The study is based on the literature review process of the available information through; desk studies, internet, books, journals and papers. To facilitate this study, this chapter reviews recent studies in line with the set objectives. It also reviews literature on; rural road development components, road asset management concept, rural road maintenance regimes and its effect on social changes in the served communities, social impacts and their drivers, and monetisation techniques of social impacts. Available prioritisation methods for funding of maintenance activities on rural roads are also reviewed.

2.2 The elements of rural development

It was established through literature review, that rural roads are one of the major components of rural development, they act as links to communities that facilitated social-economic activities. The components that contribute to rural development include; infrastructure, social-economic and the productive sectors (Starkey, 2005) figure 1 indicates the components that make up rural development.

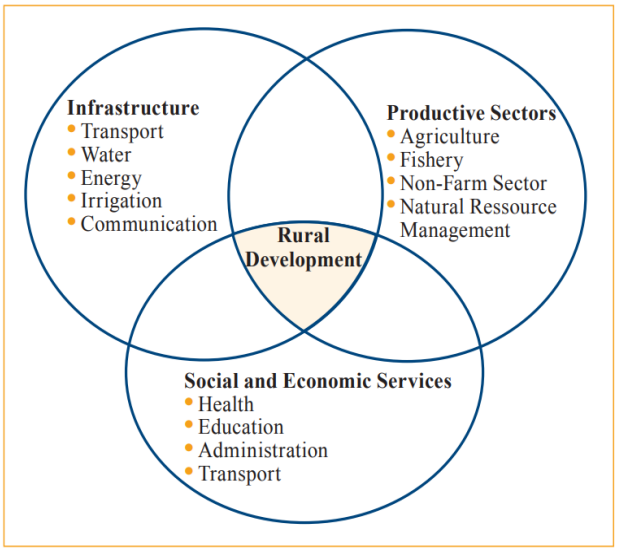

Figure 1: Elements of rural development (Starkey, 2005)

Improvement in the infrastructure (transport, water supply, energy, communication, irrigation and others) impacts the productive sectors and the social economic services sectors as indicated in figure 1. This study traces the impacts caused by road infrastructure maintenance on the two components (productive sectors and the social economic services sectors).

Roads in general are considered to be very crucial to social and economic development. Rural roads form part of the strategic infrastructure component of rural development which is fundament in the provision of access to rural areas they serve (Hine et al., 2014). However, such access has to be sustainable for the user communities to benefit otherwise the reverse will lead to loses.

2.3 The Road networks

It’s established from literature that a road is a way or route on land between two places prepared to permit travel by appropriate type of transportation modes for freight and passenger movement. However, Roads networks are considered to be crucial to economic and social development as noted in the previous sections. It is however surprising that there is limited data on rural roads in the sub-Saharan Africa region. Data on the highways or national roads is relatively available in abundancy compared to rural roads making it difficult to find available and reliable statistics for rural roads. It has been established that rural roads make acritical mass of the road network and depend on the other higher order of the road network to serve their purpose.

2.4 Classification of Roads

Road classification varies from region to region depending on how they are perceived and described either by location and function, type materials, traffic volume and traffic type, economy, width, rigidity and topography. Based on Location and Function, roads are further classified as national highways, state highways, district roads and rural roads or village roads. Village roads connect villages, a nearby town or trading centre or to district roads. Rural roads are usually low-quality roads due to low or none existent traffic. Several reviewed prepared by world bank defines rural roads as all publicly owned roads that provides access to and from the rural villages or communities. Rural roads play a key role in the provision of community access to economic and social services. Based on Materials roads are classified as; Earthen roads, Gravel roads, Marram roads, Bituminous roads and Concrete roads. Earthen roads being the weakest and Concrete roads being the strongest. Concrete roads are very popular and costlier than all other types of roads. They are not flexible and require less maintenance than other types. based on materials roads can also be classified on the strength and rigidity of the pavement, such classification includes; Flexible roads consisting of flexible layers and rigid roads with non-flexible pavements. All types of roads fall under flexible roads except rigid roads. Roads are further classified based on traffic volume, such classification include; Light traffic roads carrying 400 vehicles daily on an average, medium traffic roads carrying 400 to1000 vehicles per day and high traffic roads carrying is more than 1000 vehicles per day. Other classifications are based on topography that is sub-divided as Plain area road and Hilly area roads. Road classification provides a basis for funding, maintenance and rehabilitation. Different types of roads require different interventions. Road asset

management provides insight on the required intervention at all levels be it external or operations.

2.5 Road asset management concept

Road asset management serves as key tool in management and maintenance of road infrastructure assets which are very expensive to construct and more expensive to maintain to meet public expectation Rural roads are key components in the development of a community, they provide the much-needed access to amenities, such as markets, hospitals, schools, homesteads, farms among others.

Over the years, there has been a deliberate effort to maintain, upgrade and or open new access road to bolster development, World bank has been at the forefront to provide the required resources.(Washington et al., 2010). The Economic Growth through Effective Road Asset Management project noted that effective management of a country's road network is vital to the development of the community they serve and the environment the habitants live in. It was indicated that rural roads are veins of the economy and play a very crucial role in the served community attaining economic growth. To achieve maximum benefits from rural roads, there is need for a holistic approach to road asset management that include efficient design, construction and maintenance of the rural roads without compromising on quality, standards and the level of service expected by the stakeholders in the road sector.

A frame work for road asset management is based on a road maintenance pyramid used by PIARC in 2016 in its drive to preserve roads. The road preservation pyramid involves seven building blocks that includes; external/political, institutional building, financial, planning and management, technical, operation and finally sustainable road preservation or maintenance (Washington et al., 2010), in essence, road maintenance is supported by six building blocks that play a vital role in the road preservation.

The preservation pyramid looks at optimizing the level and allocation of road maintenance funding to improving medium to long-term road conditions and reduction in road user costs The road preservation pyramid as discussed in the Economic Growth through Effective Road Asset Management project Geddes et al.,2018). The maintenance requirement is multi-dimensional in nature and influenced by a number of inter-related factors that may be logically viewed as a vertical pyramid. Government policy and political goodwill, political The Government policy and political goodwill provide the necessary foundation of the hierarchical pyramid as indicated in figure 2;

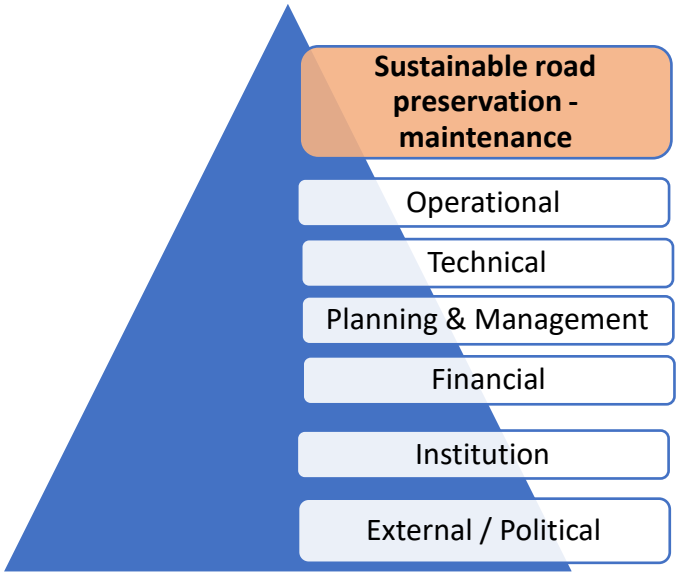

Figure 2: The Road Preservation Pyramid

The building blocks clearly indicates that at the bottom of everything, the key decision makers are the external influencers and or the politicians followed by the institutional actors that govern the road administration.

The external and or political block is very key and should be well managed since all other blocks build from this block. It is the block that asses the availability of a road asset management policy which is supported by senior decision makers and adopted at the highest level in government and road administration such as the ministry in charge of road infrastructure. It questions whether the agencies do research and carry out informed decisions and communicates the findings to the road users and stakeholders. It helps in providing relevant information and managing stakeholders' expectations. Literature indicates that's governments are more interested in construction or rehabilitation of roads rather than maintenance. Table 1 indicates the disparities between roads constructed or rehabilitated and roads maintained in Sub-Saharan Africa.

Table 1: Rural roads project achievements in sub-Saharan Africa (J. Riverson, Gaviria, & Thriscutt, n.d.-a)

Period	**Roads Constructed or Rehabilitated**		**Roads Maintained**	
	Target Km	**Actual %**	**Target Km**	**Actual %**
Before 1980	49,999	81	28,978	42
After 1980	39,112	72	46,193	49
Total	89,111	79	75,171	43

Institutional block looks generally at the effectiveness of the institutions involved in the management of road maintenance portfolio. It checks the level of involvement of different actors in particular stakeholders. This block provides for stakeholder needs and expectations, training provisions, their renumeration as compared to other private entities and ensures the organisation struct is aligned to the asset management policy. From literation, it was established that few sub-Saharan countries have acceptable road maintenance institutions.

The financial block looks at the stability, adequacy and sustainability of funding for roads through an annual valuation of the infrastructural assets. It calls for prudent budgeting, robust financial accounting and auditing and involvement of all stake holders. Road maintenance financing is usually influenced by policy shaped by political decisions. Maintenance in nature is considered as capital project that requires high amount of money. This disadvantages maintenance of roads and thus state budget is not a viable option in the long run. Due to low visibility, many funders are reluctant to finance maintenance activities.

Planning and Management block is key in assessing the agencies or road maintenance administration of the implementation of road asset management system and the status of the data base in designing maintenance plans in the short, middle and long-term periods.

Technical block provides for technical inputs into the maintenance process such as design standards for roads, local conditions, terrain and the needs of road users, affordability of the users and sustainability issues. It may also consider the technical aspects of road asset management, road referencing systems, road deterioration models, roughness index as well as gravel loss or tear and ware of the road pavement. This process is usually carried out by the technical staff such as engineers, technicians among others.

The operational building block in this pyramid represents the vital aspects of road asset management that is in daily contact with the road users. The operational block provides insight on the balance between force account operations and the private contracted maintenance works. It discusses the annual procurement plans or scheduling of maintenance works as well as looking at availability of independent technical auditing of works and services. The form of contract used in carrying out maintenance works are also discussed.

Sustainable road preservation. while the top most part of the pyramid provides for the road maintenance or commonly referred to as sustainable road preservation pyramid, it is supported my all the other six blocks. For sustainable management to occur all the six road preservation blocks that support sustainable road asset preservation must be addressed in time. Timely maintenance of roads and regular monitoring of the road asset is key to prolonged life of the road structure and to spurring social-economic development (Washington et al., 2010).

A review of Institutional Arrangements for Road Asset Management by the World Bank provides appropriate lessons for the developing world and in particular sub-Saharan Africa on the approaches to the road asset management. It's noted that the type of institutional arrangement for managing roads depends on the objectives and performance set by the country's road network management authorities and policies**.** (Washington et al.,2010). World bank provide a guide to selected tools for road infrastructure management, that explains to politicians and high-level decision makers in road authorities and road agencies how to carry out road management.

Although asset management seem to have solutions to decaying roads, it is limited in its approach mainly because the vital data required for analysis both at network level and project levels is not readily available in road agencies and is not easy to collect for rural roads. Equally challenging is the analysis of the collected data. Lack of appropriate data on rural roads is majorly due to relegation of rural roads by many governments to the lowest tyre of road administration with very low funding and limited requisite resources. This arrangement leads to deficient institutional and managerial arrangements that also leads to poor planning at appraisal or during execution of the rural road maintenance. The resultant lack of funds to carry out data collection and storage, lack of appropriate skills, tools and equipment to collect the requisite data leads to inappropriate design standards or technology use since they have no data to depend on.

2.5.1 Rural road asset management

The importance of road maintenance is often underscored by local authorities resulting in constrained budgets for maintenance activities. The constrained budgets have hampered the collection of requisite data for improvement of rural roads. It's been established that road asset management approach has not been introduced to the local decision makers to generate more political and local support for rural road maintenance activities (Geddes et al., 2018.).

2.5.2 Rural Road Maintenance

As indicated in road asset management section 2.5, Road maintenance is contained in the most top part of the Road Preservation Pyramid. It is a vital component of the road asset management component. It is noted that rural roads are characterized by poor maintenance regimes, low funding and in many instances limited management inputs. Despite inadequate maintenance, rural roads contribute significantly to the economic and social development of the areas they traverse Most rural regions in SSA are agrarian and so their economic outlook relies on farm products reaching markets on time, undamaged and with economic vehicle operating costs. Further, human resources and products which support agriculture also need good access, poor transport infrastructure and associated high costs of transport services from poor route conditions, or intermittent seasonal access, necessarily adversely impact agricultural costs. This assessment is supported by the user guide to road management tools, Sub-Saharan Africa Transport Policy Program as provided for by the World Bank. Further, rural communities with inadequate access are also often restricted from social interaction, from schools, health facilities and basic needs (Ngezahayo et al., 2019).

It was established from literature that most of Sub-Saharan Africa is sparsely populated and characterised with low agricultural productivity despite the fact that it is predominantly agrarian (Sieber & Allen, 2016) , (J. D. N. Riverson & Carapetis, 1991), (Gwilliam et al., 2008) this means, the burden of construction and maintaining adequate rural road network is carried by the communities served instead of being carried by the productivity of the masses in heavily populated and highly productive communities. The table 2 adopted from Rural Travel and Transport Project of the Sub-Saharan Africa Transport Program (SSATP), provide an insight in the distribution of the rural road network in sub-Saharan Africa.

Table 2: Rural roads network in Sub-Saharan Africa (Gwilliam et al., 2008)

Region	All Roads	Rural roads	Density m/km2
Western Africa	430,937	286,425	32
Eastern and southern Africa	589,943	398,972	36
Total	1,020,880	685,397	34

Despite rural roads being drivers of development in the communities they serve, decision makers are reluctant to maintain maintenance of rural road networks as compared to construction of new national roads or rehabilitation from gravel to bitumen standard roads due to the greater visibility they exhibit to the voters and donors (Trl et al., 2002.). Reviewed World Bank report indicated maintenance achievements were substantially below planned targets. Taking south Africa as an example it has about 90% of main roads in good condition and about 30% of rural roads in good condition while Rwanda has less than 25% of main roads in good condition and no rural road in good condition. All Rwanda's rural roads are in poor condition. Figure 3, derived from Africa infrastructure country diagnostic Roads in Sub-Saharan Africa, (Gwilliam et al., 2008) provides the details.

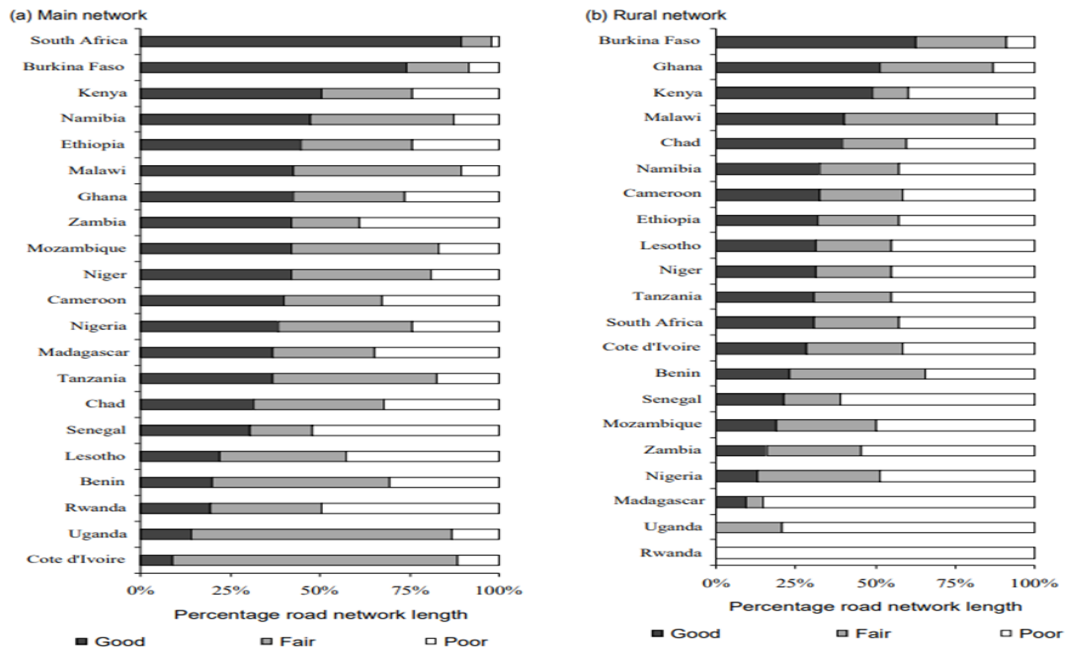

Figure 3: comparison of African countries status of main network and rural road network (Gwilliam et al., 2008)

The major causes of low maintenance levels were established and categorised in four main areas as;

a) Poor planning at appraisal or during execution;
b) Inappropriate design standards or technology;
c) Difficulties with mobilization of financial and other resources; and
d) Deficient institutional and managerial arrangements.

A review of the causes through several World Bank literature established that deficient institutional and managerial arrangements as the most common factors affecting 35% of the total number of projects. Difficulties with mobilization of financial and other resources ranked the second with 27% while technical problems in the same study ranked the lowest at13 per cent. The details are indicated in table 3.

Table 3: Percentage of causes for failure of rural road projects (Gwilliam et al., 2008)

Types of problems	**Total (percentage)**
Inadequate planning	26
Resource Constraints	27
Institutional	37
Technical	13
Another minor	20
None- Identified	8
Total number of projects	**122**

It was established that policy framework and institutional arrangements in most sub-Saharan Africa are still lacking and will need immense support in building and maintaining of rural roads.

2.5.3 Functionality of rural roads

Research has attempted to link the improved performance in road asset management to improved economic and social benefits for local communities in rural areas (Donnges et al., 2007) . As discussed in the previous sections, the benefits from rural road maintenance cannot be underscored. The main benefits being accessibility to the villages, trading centres and to service centres. However, lack of maintenance commonly hampers accessibility which creates a lot of complications ranging from reluctancy by the famers to produce more crops for the market due to high freight charges of lack of transport for full closure of the road to ow school enrolment due to absenteeism among the teachers as well as the children, reduction in health standards due to accessibility challenges for health workers and patients as well, loss of production due to women spending a lot of time fetching water and other fuel resources. This also affects the social interactions of the communities serviced by the road and may increase criminality in the village. The actual functionality of the road can be measured in terms of the value they add to the community they serve. In addition to the social and economic benefits they provide, rural roads can also be valued in terms of the physical assets which they contain (e.g., carriageway, drainage, utilities).

2.5.4 Rural Road Maintenance regimes

Road maintenance refers to work activities that aims at keeping the road motorable through preservation of the road structure to a level as normal and as practicable as possible. Rural road maintenance brings both immediate and long-term benefits through improved road safety, reduced vehicle operation costs, reduced travel time, comfort and reduced environmental impacts such as pollution thus keeping the road serviceable throughout its design life (Mwangi et al., 2024). Maintenance of rural roads safeguards previous investments in construction and rehabilitation by keeping the road open to traffic and contributes to more reliable transport services sustaining social economic benefits to the user community. However, lack of maintenance, may lead to; reduced access, loss of investment and social economic benefits that accrue from all-weather rural roads (A. K. & Kongolo, 2014).

Road maintenance are commonly categorised into 2 groups notably: off-carriageway and on-carriageway for road surface. The off-carriageway includes works such as maintaining drainage works and road components outside the road surface. The on carriageway includes works that ensure good runoff on the road surface ensuring proper drainage of the surface. The common defects usually worked on during maintenance period include; the repair of potholes, desilting culvert lines, blading the gravel road back to camber, re-gravelling, desilting the blocked culverts, repairing edge breaks, opening the mitre drains (Offshoots) and slashing the grass. There are three types of road maintenance regimes namely: Preventive maintenance, Reactive maintenance, and Emergency maintenance. These are further subdivided into routine, periodic, and emergency maintenance activities, (Donnges et al., 2007).

Routine maintenance is a recurrent activity carried out regularly. Appropriate scheduling of maintenance work inputs strategically at intervals and actual implementation of the activities guarantees good road condition and raiding quality for the users. The prime objective of scheduling maintenance works is to implement the preventive measures at an early stage to limit deterioration and damage. The most common routine work activities are: erosion control on shoulders and slopes, clear drains to allow free passage of water, clear culverts and other waterways. These translate into minor repairs to culverts and retaining structures, repair and replace scour checks, repair, fill and compact potholes and ruts, grass and bush clearing, and repair to the road signs. Labour based work methods are usually suited for routine maintenance of rural roads due to its nature due to its requirement for widely spread but small resource inputs

Periodic maintenance in form of extensive overhaul becomes inevitable after a number of years between 3-7 years. Periodic maintenance involves more comprehensive and expensive activities such as major repairs to structures, reconstruction of cross-drainage structures, reshaping and re-gravelling or re-surfacing, rehabilitation of failing sections sometimes called spot improvement and installation of new culverts where necessary.

Emergency maintenance caters for unforeseen demand for road maintenance during emergency situation. These emergencies are caused by excessive floods, landslides, or other freak conditions. This could be caused by excessive floods or rains, landslides, war, and other freak conditions. By its nature, emergency maintenance caters for unforeseen scenarios and cannot therefore be forecast and or budgeted for in annual work programmes. however, such activities should be catered for under the road authorities' budget as contingency funds to be utilised on assessment of the extent of damage. Besides scheduled maintenance activities, road works agencies need to make provisions for the occurrence of unforeseen damage to the road network. contingency maintenance activities involve; repair or reconstruction of damaged cross-drainage structures. repair or reconstruction of damaged road sections due to wash-outs, erosion, or floods, repair or reconstruction of damages to erosion protection.

2.5.5 Road condition assessment

The actual maintenance treatment to be applied depends on the road condition data collected for the section to be worked on. The data collected varies depending on the pavement type (earthen road, paved road and gravel road etc). For rural roads which are predominately earthen or gravel; the data capture includes checking for surface distress and impassability extent. Common condition data collected include; data on gravel loss, rutting, cracking, potholes, ravelling, patching, and edge break among others. The conditional data required is categorized into two groups; on road and off road where on road includes pavement related data such as gravel loss and off road includes data such as desilting of culverts and drains and re-construction of score checks. Data collection for routine maintenance needs to be continuously updated and or routinely collected. Such a venture is very expensive and requires skilled manpower for both manual and equipment-based data collection, cleaning and analysis. Due to limited funding for rural road maintenance activities, rural road data collection has not been supported by many roads' administrations, (Donnges et al., 2007). For proper reliable data, collection and update should be regular and routine in nature to match the routine maintenance activities. In addition to funding data collection requires skilled labour, appropriate tools and equipment which are not readily available to rural road administrations. The inconsistence in data collection renders the available road condition data unreliable and incomplete.

Road condition data is usually collected either manually or using specialised equipment such as telematics-based technology that allows roads to be monitored on a continuous, real-time basis by extracting data collected from the various on-board devices installed in the field. Similar applications allow data to be collected the smartphone platform (Starkey et al., 2020). Other equipment and tools used include; standard forms, GPS, tape measures and other hand tools. A sample for road condition assessment form that is used in manual data collection process is indicated in figure 4 derived from documents for Ministry of Works and Transport - Uganda.

Road condition visual assesment	**Region**					**Section**				
	District					**Name**				
	Road name					**Surface**				
	Terrain					**Date**				
	SURFACE DISTRESS					**IMPASSABILITY**				
CHAINAGE (KM)	1	2	3	4	5	1	2	3	4	5
Km 0.0 -12.5										
Km 12.5 - 18.5										
Km 18.5 - 23.3										
Severity	*None =1*		*V. Slight =2*		*Slight = 3*		*Significant = 4*		*Severe = 5*	

Figure 4: Data collection form for road condition assessment for rural road

2.5.6 Funding road maintenance

Although road maintenance is extremely important for the development of a community and country, inadequate funding has always been a trend in many countries including developed countries. Funding has a ripple effect in meeting budgets and work plans of the user communities of local governments. There are a number of funding provisions for sub–Saharan Africa namely: loans from development banks, multilateral and bilateral donations, grants, central government, regional governments and locally generated funds. It's established that with few exceptions, rural roads are not planned and are not systematically considered for national resource allocations as they are largely confined to evaluating their benefits and costs to the users or central government prior to funding their development and or maintenance.

External funding accounts for a large fraction of the total funding for construction and rehabilitation of rural road surpassing the inputs for maintenance of rural roads. As its well-known maintenance should start as soon as the construction is complete, frontloading rehabilitation carries the risk of overloading the local managerial capacity. On the other hand, over funding by the donors creates resentment in the other parts of the ministry without funding for road maintenance, (Donnges et al., 2007).

There is a preference for opening new earth or gravel roads, new construction of paved roads and upgrading gravel roads to paved or bitumen standards due to the greater visibility they exhibit to the voters and donors.

It was established from several world bank documents and in particular World Bank technical paper number 141 on Africa technical department series that there are no firm guidelines available for apportioning road expenditures between maintenance, construction and rehabilitation activities as compared to main or national roads. However, (Washington et al., 2010) on road deterioration in Sub-Saharan Africa suggested fractions of 20 percent for construction, 65 percent for maintenance and 15 percent for rehabilitation. Because of low funding, rural road agencies or administrations have a lot of challenges in terms of human resource, equipment and construction materials to carry out maintenance activities in time and to expected standard (Gwilliam et al., 2008). Due to many years of no maintenance and neglect, the majority of the rural road network in Sub-Saharan Africa is old and in distress (Donnges et al., 2007). Extracts from (Donnges et al., 2007) showing expenditure are indicated in table 4.

Table 4: Expenditure between main road and rural road (source:(Donnges et al., 2007)

Country	Length % of Total	Vehicle-km % of Total	Expenditure as percentage total of the road		Expenditure as percentage total national budget	
			Main Road	Rural Road	Main road	Rural road
Malawi	53	NA	85	15	5.0	1.0
Kenya	52	13	69	31	3.4	2.4
Tanzania	32	NA	88	12	5.0	1.0
Nigeria	58	12	78	22	3,2	1.0
Cameroon	35	10	90	10	8.7	0.9
Senegal	39	10	93	7	2.9	0.4

The solution to this funding gap from economic point of view is to treat rural roads as commercial proposition and provide separate budget lines with dedicated funding for maintenance of rural roads. Road asset management approach should be incorporated in rural road administration for ease of rural roads policy formulation and review. Given that rural roads are spread over a wide area, it's advisable to use labour-based methods for maintenance of these roads. This process however, requires the relevant institutions to build labour-based capacity and provide appropriate training.

2.6 Social – economic Impacts associated with roads

The effect on communities and its people caused by an activity, program or project, action or inaction is referred to as social-economic impact. social-economic impacts may be positive or negative usually referred to as benefits and cost respectively. social-economic impacts are key to our way of life and are becoming more and more important day by day. It is therefore very important to understudy their management, compliance, promotion and resistance (Robinson,1999). In order for us to understand the impact of rural road maintenance on the social set up of the community they serve and how it impacts on different social groups at the village level, this research employed works of (Gao & Tong, 2023), and (Kah & Akenroye, 2020).

2.6.1 Impacts associated with rural roads maintenance activities

According to (Khanani et al., 2021), the impacts associated with road infrastructure that impact different social groups are clustered in three categories notably; social impacts, spatial impacts and economic impacts. It is however noted that the difference between the impacts is very thin and sometimes intertwined. figure 5 indicates the impacts associated with roads as considered by this research.

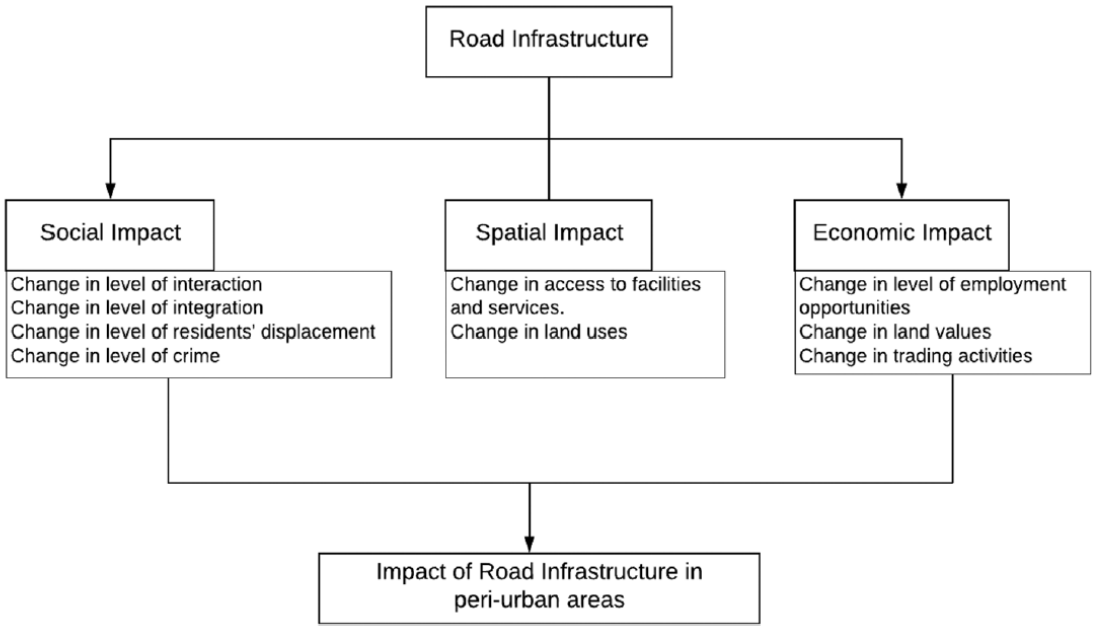

Figure 5: Impacts associated with road infrastructure (Khanani et al., 2021)

In line with the works of (Sieber & Allen, 2016) , (Campanion Guidance, 2017) the theories of social change are well grounded. The impact of constructing a road or maintaining a rural road in good motorable condition have been observed in many rural communities in the sub-Saharan Africa in particular Uganda. The impacts may be positive of negative. The social changes noted include; social integration or disintegration, social interactions, level of resident's migration and changes in crime rate. The spatial changes include; changes in land use, changes in access to facilities and services like health, education, markets, farms and recreation areas. Environment includes: changes in natural environs, changes in pollution levels, changes in tranquillity. Road infrastructure parameters: changes in road quality, changes in number of closure times, changes travel time, changes accident and fatality rate, while the economic changes include: changes in trading activities, changes in employment levels, changes in land use values. Social-spatial integration comprises of four dimensions, namely relational, functional, physical and symbolic. Accordingly, in this study none market goods that are not usually presented in monetary values such as social and spatial aspects were considered. Economic aspects of development have not been considered in this thesis but are mentioned for completeness due to the limited scope of this thesis and time constraint. The values of the economic impacts can easily be calculated based on the available models such as cost-benefit analysis (CBA) among others methods. None market goods are not directly valued by the available economic methods.

2.6.2 Social impacts accruing from Rural roads

Unlike economic impacts, social impacts refer to those intangible impacts that are not monetised. Social impacts may be positive or negative usually referred to as benefits and costs respectively. Social impacts are key to our way of life and are becoming more and more important day by day. It is therefore very important to understudy their management, compliance, promotion and resistance (Arvidson et al., 2010a; Arvidson & Lyon, 2014) and the best technique to monetise them. In order to understand the social impact of rural road maintenance on the social set up of the community they serve and how it impacts different social groups at the community level, this research employed works of (Khanani et al., 2021).

In similar ways (Ruiz-Tagle, 2013) and (Sieber & Allen, 2016) echoed these changes caused by road infrastructure. However, these changes are intangible in nature and cannot be measured with the ordinary economic methods, there is need to find the best way to measure the intangible goods (Diefenbach, 2006) and (Alexandra & Liliana Mihaela, 2013). These spatial changes, social changes and economic changes are usually outcomes observed in increase in residential development, change in land use and land cover for spatial impacts, while social changes are likely to emerge from social disintegration and integration. Economic changes are seen by changes from subsistence farming to agriculture-based economic activities to those of higher productivity and infrastructures like roads, with the possibility of employment opportunities.

Although the changes impacted on the road user community are not entirely due to the influence of the road, the nature and quality of the road accounts for a substantial percentage of that change. Improved road surface attracts new modes plying the routes that are well maintained, new modes may include buses, private cars, vans, trucks, omni-buses, and freight transport and motorcycles. It's noted that a well-maintained road will encourage private car owners to use their vehicles due to low vehicle operation costs, and savings in travel time. However, buses are used as the primary vehicle for public transportation by many rural communities in sub-Saharan Africa plying fixed routes on a regular schedule,(Mattson et al., 2021).

The common changes accruing from the rural road are categorized in three categories: social impacts, spatial impact, and economic impacts (Khanani et al., 2021). It should also be noted that, there is a thin line between economic and social impacts which makes it complicated to segregate. Through literature review, social changes have been identified and documented in table 5;

Table 5: Social impacts due to rural road maintenance

Social Impacts indicators	Description of Impact (s)	Supporting literature
Change in level of integration	Perception about social networks	(Noland, 2002; Pereira, 2024)
Change in levels of resident's displacement	Residents forced to move into hinterland due to; Lack of tranquillity Increased insecurity	(Verme & Schuettler, 2021) (Schwinn, 2022) (Allen et al., 2003) (Ruiz-Tagle, 2013)
Change in Crime rate	Reduction in the rate of theft of property and goods in the area. Reduction in insecurity in the area	(Lusher & Robins, 2010) (Lusher et al., 2010)
Change in health levels	Number of people visiting the nearby health centre or Clinic	(Campanion Guidance, 2017)
Change in road accidents reported to health facilities in the community	Reduction in number of accidents	(Khanani et al., 2021) (Krupnick et al., 2002; Luiu et al., 2018; Reed et al., 1997a; Tan et al., 2017)
Changes in Maternal birth reported at the facility	Increase in numbers of women giving birth at the health facilities	(Pereira, 2024)

Changes in agricultural production output	Increase in number of farm staff or laborers due to easy access Increased number of trips by freight transport	
Change in Education levels	Improved children and staff daily attendance in school due to easy access	
Change in land uses	Reduction in agricultural farm land to new land forms in such as housing	
Changes in air / dust pollution levels	Reduced death rate due to pollution related illness	
Change in travel time	Reduction in travel time due to improved road surface. Saving time for other social activities	
Introduction of new modes of transport	Availability of new modes due to improved road surface (Modes that did not ply these routes before. Such as buses and freight transport.	
Changes in traffic volumes	Increase in traffic volumes due to improved surfaces and low vehicle operating cost.	

2.6.3 Economic impacts

Economic impacts are those impacts that have pre-determined monetary values. These changes are visible through change of monetary values and rate of turnover. These changes though mentioned and discussed are beyond the scope of this thesis. They are mentioned for completeness of the PhD thesis.

2.7 Social-Economic value and valuation methods

2.7.1 Social-Economic value

Social-economic value of a good or service entails both economic and social values which is the amount of money one is willing to pay for goods and services. The market model concept as described by Varian before demand and supply is the base for valuation of goods and services (Varian, 2010). This model is indicated in the figure 6.

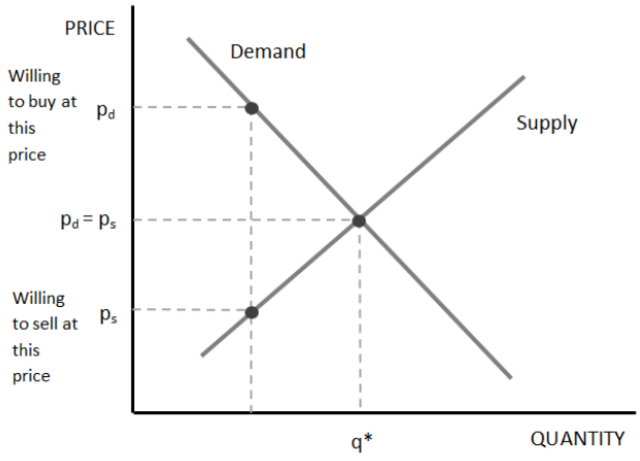

Figure 6: Market equilibrium,*(Varian 2010)*

The interaction between demand and supply determines the market price. Figure 6 provides equilibrium at point with quantity q* at a point where demand equals supply (Pd=Ps). The difference between what a consumer is willing to pay and the actual price is considered as consumer surplus. All goods and services have a value attached to them. Goods and services are broadly divided into two categories; market goods and none-market goods. The market goods are valued using the available economic models such as cost benefit analysis CBA while none-market goods such as environment, social actions maybe estimated based on proxies and or surveys based on concepts that convert human perception, need and willingness into monetary values (Breidert et al., 2006). The willingness to pay concept is key in estimating the actual value of the service or good.

2.7.2 Valuation methods

As alluded to in the previous chapters the goods and services are divided in two categories namely; marketed goods and services and non-marketed goods and services. marketed goods are those goods whose value is easily determined by economic models such as cost benefit analysis (CBA). The value of these goods combines both the physical value sometimes called the use value and the non-use value called the intangible value. On the other hand, None-market goods include the category of goods and services whose value may not be determined by the economic models but by other means such as willingness to pay, social return on investment, transport cost methods among others. The process of valuation of such goods and services commonly considers social benefits and or social costs and is sometimes referred to as monetisation of social benefits and or costs.

2.7.2.1 Valuation method and data collection

Valuation method and data collection are dependent on the availability of data which are grouped in 2 categories: stated preferences and revealed preferences. Stated preferences are dependent on asking direct questions which indicate respondent's attitudes, opinions, intentions and desires. These questions are asked during surveys, interviews and focus group discussion. Revealed preferences brings on board respondents' actual choices and behaviours revealing their real options and constraints when confronted with real challenges.

2.7.2.2 Monetising of social benefits – Conceptual approach

Monetising of social benefits is the process of assigning monetary value to the social changes created by the investment, projects and policy among others. There are many ways of monetising social impacts (Benefits and loses) as noted in the guide to measuring impact (Scotland, 2012) , (Epstein & Yuthas, 2014) and (Rawhouser et al., 2019) . In order understand how rural road maintenance processes impacts the social fabric of the rural communities they serve in sub-Saharan Africa; the study employed a conceptual approach based on social benefits accruing from maintenance of rural roads (Figure 9).

This concept builds on the social integration theories by (Ruiz-Tagle, 2013), (Sieber & Allen, 2016) and related literature. On the social scene, there has been changes in social integration, displacement and disintegration. Other changes include change in crime rate, health levels, accident rate, maternal birth, agricultural production changes, education and land use changes among others.

Based on the findings from the literature, a conceptual framework was adopted depicting dimensions relevant to our thesis.

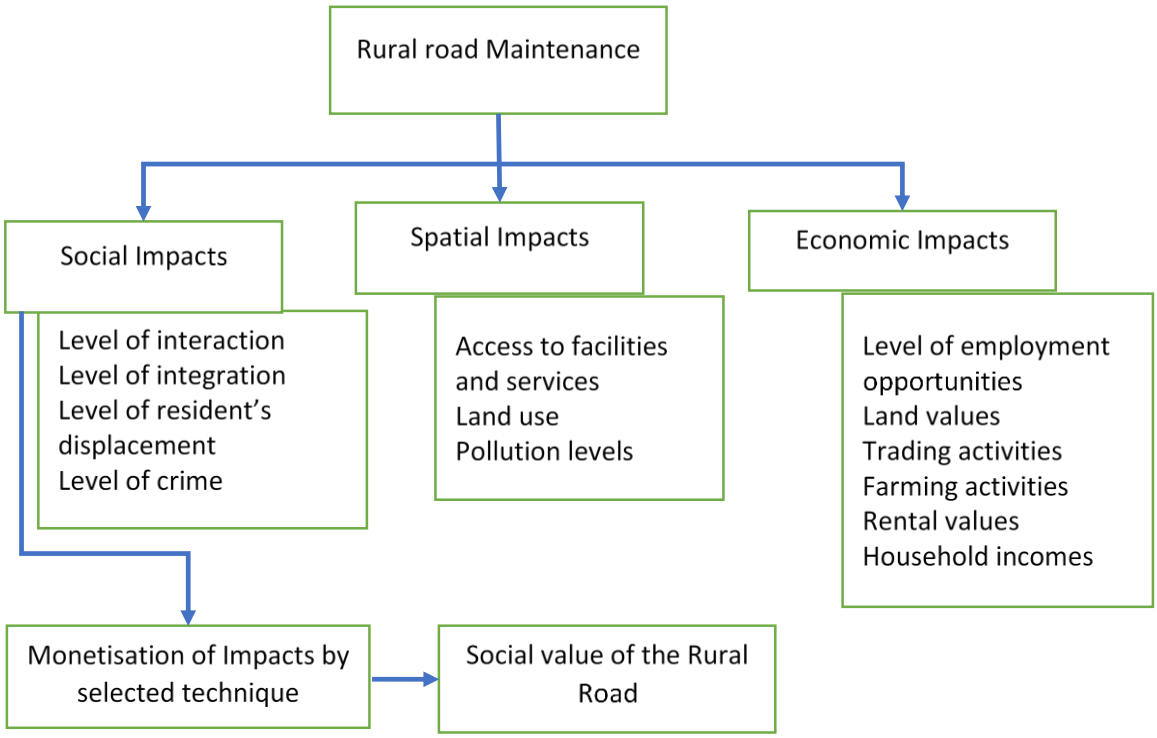

Figure 7: Conceptual Approach- Monetisation of social benefits,

2.7.3 Sectors embracing monetisation of social Impacts

It was established that; the most common sectors embracing monetisation of social benefits were; Environment, Tourism, health, agriculture and housing usually associated with none market goods returned high frequencies. However, no single research was found to be related to monetisation of social benefits accruing from rural roads sector. Figure 8, shows the frequency of the searches and their corresponding sectors that have adopted the use of monetisation of social benefits in their valuation processes.

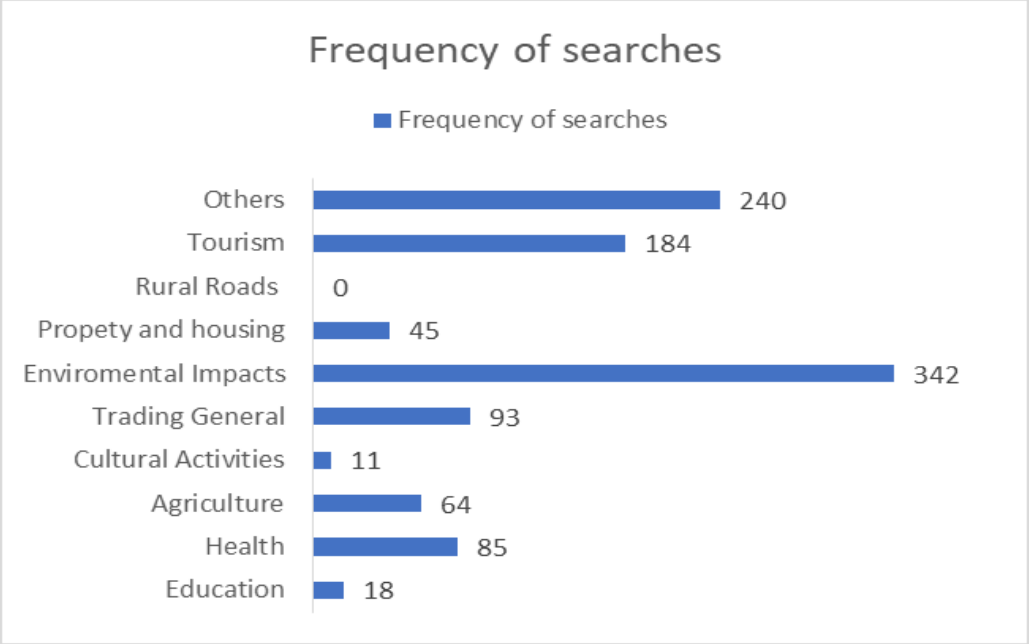

Figure 8: frequency of searches on monetisation of social benefits

2.8 Monetisation techniques for social Impacts

Through literature review process, it was evident that not all sectors have embraced monetisation of social benefits as a means of assigning value to none market goods. After a comprehensive literature review, a total of 1978 searches were reviewed and documented using the excel spreadsheet process. Out of the 1978 studies reviewed in this thesis, 77% (1519 searches) had included monetisation as a concept in their study while only 23% (459 searches) had no mention of monetisation of non-market goods. By tabulating the number of searches that adopted monetization as a means of valuation for none market goods using excel spread sheet, the common techniques were identified and ranked based on number of searches as indicated in table 6.

Table 6: common techniques for monetisation of social benefits

No.	Valuation methods	Number of Searches	Ranking	Authors
1.	Social Cost Benefit analysis (SCBA)	35	9	W Van Erp · 2023 MJ Broeks · 2020 S Louali · 2022 C Tisdell · 1985
2.	Social return on investment (SROI)	249	2	Arvidson, et al, 2010 (Vachal, 2006) Brian T. Yatesa, and Mita Marrab, 2016 Stevenson et al. 2010 W. van Vuuren a and P. Roy, 1992 Ross Millar, 2013 Juha Klemelä, (2016) Varinder K Gambhir1 et. al. 2017
3.	Cost Benefit Analysis (CBA)	178	5	J Ananthapavan · 2021 Manning · 2016 RJ Brent · 2023 W Jiang · 2021
4.	Consumer surveys	208	4	S.O. Olsen, A. Kole, 2008 M Gold · 1995 P Suchánek · 2018 Westbrook R. A. et, al. (2010) Graham Kenny, (2019)
5.	Willingness to pay (WTP)	261	1	Econ. Lab., 2002 Breidert, C., Hahsler, M. and Reutterer, T., 2006 Hanemann, W.M., 1991 Breidert, C., 2007 Bohm, P., 1979 Bala, M.V., Mauskopf, J.A. and Wood, L.L., 1999
6.	Travel cost method (TCM)	220	3	Khisty and Lall, 2002 Sohngen et al.,1999
7.	Social accounting	73	8	Jose Luis Retolaza1 and Leire San-Jose, 92021) Rob Gray 2021 C.A. Adams *et al.1998* G.J. Benston, (1982)

8.	HDM4	174	6	Kerali, H.R., (2000) Odoki, J.B. and H.R. Kerali, (2000) Robinson et al, 1988
9.	RED	121	7	Ruiz, A. and Guevara, J., (2020) Archondo-Callao, R.S., (2001) Odeck, J., (2010) Worm, J.M. and Van Harten, A., (1996)
10.	Others	459	Not ranked	Several authors and references
	Total searches	**1978**		

It was established that most of the available valuation methods were based on available economic models such as cost benefit analysis (CBA). The techniques used for monetisation of social benefits were limited since this is a new approach to many sectors including roads sector. The commonly employed techniques for monetization of social benefits as reviewed in literature were:

9. Cost Benefit analysis (CBA),
10. Social return on investment (SROI),
11. Cost Benefit Analysis (CBA),
12. Consumer surveys,
13. Willingness to pay (WTP),
14. Travel cost method (TCM),
15. Social accounting, HDM4 and RED.

2.8.1 Selection of the appropriate methodology

Literature did not establish a stand-alone methodology that was in use for monetisation of social benefits accruing from rural roads but rather a number of methodologies that are adopted by other sectors. However, in the review of these methodologies, crosscutting parameters were noted and assessed with intension of finding the most responsive methodology. Table 7, summarizes the crosscutting parameters adopted for further assessment of the methodologies and table 8 summarises the responsiveness of the methodologies to the selected parameters.

Table 7: Summary of the crosscutting parameters

No.	Parameter	Details of parameters usefulness
1.	Monetisation of social impacts - General	A review whether the methodology was used to measure valuation or Monetisation of social benefits.
2.	Monetisation of social Benefits for rural roads	Check whether the technique monetizes social benefits accruing from rural roads.
3.	Cost efficiency	The cost of managing the process valuation including data collection, analysis and reporting. Costs of tools and labour are all considered
4.	Data collection	Data collection methods, tools and human resource form an important role in this area.
5.	Validity of results	Validity or quality of the results or estimates are key given the need to have accurate results
6.	Time efficiency	The total time required to complete the valuation exercise including data collection period
7.	Clarity in processes/ flexibility of methodology	How easy it is to work with the methodology is considered

Table 8: comparison of valuation techniques

No.	Parameter	Methodology								
		SROI	**SCBA**	**CBA**	**CS**	**WTP (CA)**	**TCM**	**SA**	**HDM4**	**RED**
1.	Monetisation of social impacts - General	++	+	--	+	+	+	n	n	+
2.	Monetisation of social Benefits for rural roads	n	n	n	n	n	n	n	n	n
3.	Cost efficiency	++	+	+	++	+	++	-	--	--
4.	Data collection	+	++	-	++	+	++	+	-	-
5.	Validity of results	++	--	--	++	++	+	-	--	--
6.	Time efficiency	+	+	++	--	++	+	++	++	++
7.	Clarity in processes/ flexibility of methodology	++	+	++	++	++	+	+	++	++
++ strongly responsive, + responsive, n Neutral, - not responsive, -- Strongly not responsive										
Social Cost Benefit analysis (SCBA), Social return on investment (SROI), Cost Benefit Analysis (CBA), Consumer surveys (CS), Willingness to pay (WTP), Travel cost method (TCM), Social accounting (SA), Highway Design and Maintenance (Model) (HDM4), Roads Economic Decision (Model) (RED)										

Tabulation of responsiveness of the nine methodologies revealed the need for more review of the most responsive methodologies with the aim of selecting one for adoption in the monetisation of rural road social benefits. The four most responsive techniques selected from the nine are;

a) Social return on investment (SROI)

b) Consumer Surveys (CS)

c) Travel Cost Method (TCM)

d) Willingness to pay (WTP)

2.8.2 Social Return on Investment Methodology

2.8.2.1 Introduction

SROI is considered as a framework for measuring and accounting for the broader concept of value. SROI is about value, rather than money. SROI is thus about assigning monetary values to change being created by the activities of an organization (whether environmental, or social). SROI is an outcomes-based measurement tool that helps policymakers, decision-makers managers in organisations or Governments to understand and quantify the social, environmental, and economic value they are creating.

It is a form of evaluation that uses mechanisms such as Pay for Success (PFS) and Social Impact Bonds (SIBs) to answer questions related to evaluation design, intent, and utilization (Arvidson et al., 2010c) summarises, SROI process as a process involving:

a) Discussing with stakeholders to identify the amount of the monetary social value and what it means to them,
b) Identification channels of value creation through a set of activities,
c) Identifying appropriate ways or indicators of knowing' that change has taken place given specific inputs,
d) Allocating financial proxies to the indicators that may not be monetised directly,
e) Comparison of the financial value of the social change created to the financial cost of producing these changes.

SROI attempts to solve problems associated with impact caused by government or private program or policies by use of carefully sourced information on resources input, activities enacted, processes inspired, and outcomes. SROI is one of the most used methodologies to stimulate funding by the private sector as well as public entities of innovation in assessing the social impacts of projects to society in order to avert human suffering and community's fulfil their human potential. Mangers and policymakers are increasingly drawn to the Social Return on Investment (SROI) method to evaluate the social impact of programs, organizations, or organization networks. While many claims about the benefits of SROI have been expressed, various points of criticism have also been raised.

On the basis of reviewed literature available globally, research reveals that this methodology is structured along two dimensions: the observer's paradigmatic perspective, on the one hand, and positive or negative valuation. Among common approaches that have been developed for measuring social impact, SROI analysis is one of the most widespread (Rawhouser et al., 2019). It is a mixed method approach to assess the social, economic, and environmental impact of interventions. Its most prominent feature is the SROI ratio. This ratio is both the biggest attraction of SROI analysis as well as its danger. The advantages with this tool are that it can provide legitimacy to managers or their funders, and it can assist in allocating resources efficiently and effectively.

Social Return on Investment (SROI) is calculated by assigning the SROI Ratio a monetary value to inputs and outcomes (Banke-Thomas et al., 2015). If that SROI Ratio is 3:1, it means that every pound allocated has generated or will generate social value worth three pounds, (Durie et al., 2012). According to Social Value UK, 2012 there are two types of SROI namely: Evaluative and forecast. Evaluative is conducted based on actual outcomes that have already taken place hence conducted retrospectively, whereas, Forecast, predicts how much social value will be created if the activities meet their intended outcomes. This study followed the forecast social return on investment in a six-stage format. The adopted six stages are indicated in figure 9 by (Tulla et al., 2020);

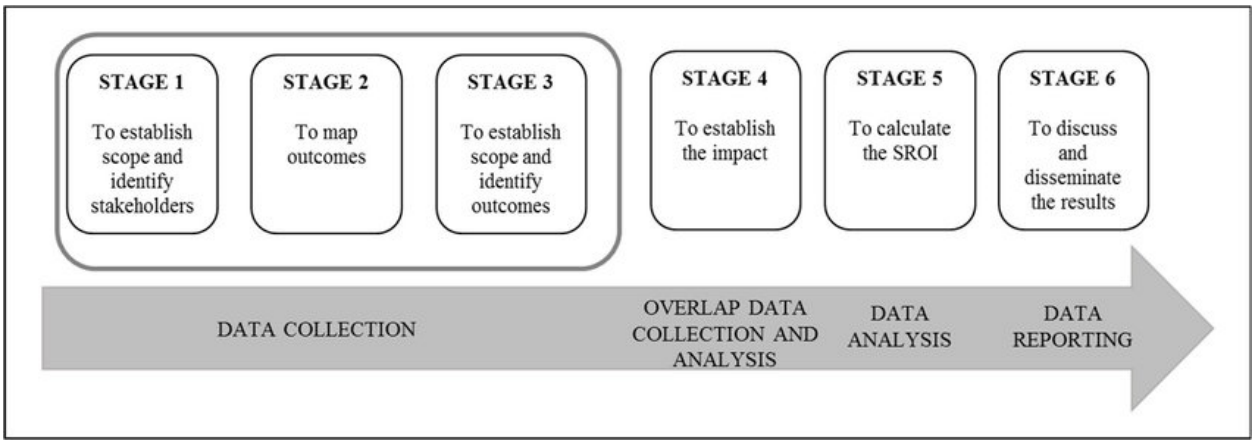

Figure 9: Social return on investment (SROI) stages. (Tulla et al., 2020).

2.8.2.2 The theory of change

One of the most important frameworks adopted by SROI is the theory of Change.(Connell & Kubisch, n.d.-a) defines a theory of change as a systematic and cumulative study of the linkages between activities, outcomes, and impact.

It directly or indirectly relates to the involvement of stakeholders to the project as well as their perception and belief of how and why their lives have changed or will change in future. It maps out the relationship between inputs, activities, outputs, outcomes and impact. It enhances collective ownership and encourages learning from and about different perspectives and realities. The theory of change brings on board new approaches to evaluating community initiatives through inputs such as funding, time, manpower into different activities, their outputs, outcomes and impacts and the avenues through which they will be achieved, (Connell & Kubisch, n.d.-a). Figure 10, indicates the process of the theory of change as established from the researcher's perspective of the literature review.

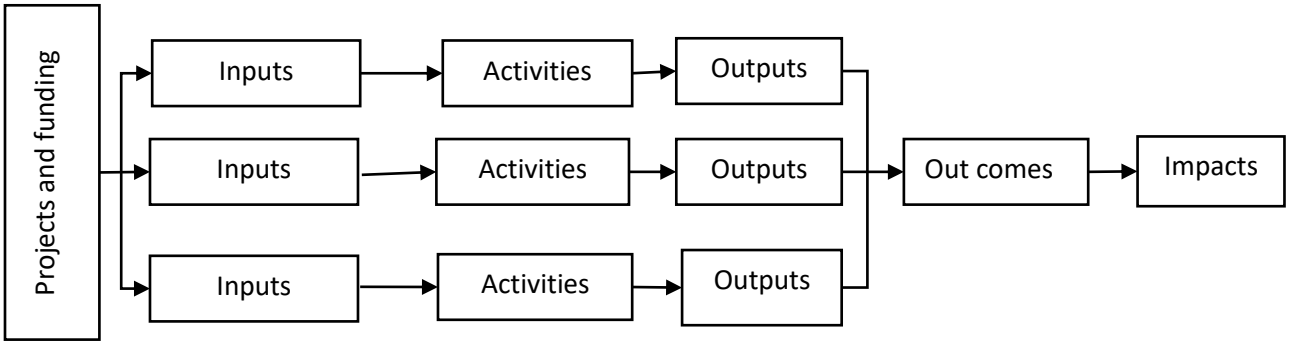

Figure 10; Theory of change process

The theory of change is backed up by deduction methods of deadweight, displacement, attribution and drop off. Social Value UK, 2012 defines dead weight as the estimation of the value that would have been created in the absence of the program intervention, displacement as a percentage by which social value displaced other outcomes while attribution represents the percentage of other activities that contributed to the change and drop-off considers the fact that there will be an annual reduction of the outcome achieved or the impact of the intervention would decrease every passing year.

It has been reviewed that the theory of change is very key in providing a working model against which hypothesis and assumptions can be tested to bring out the intended outcomes. It therefore creates an honest opinion of what is required to achieve the intended goal as envisaged by the stakeholders. This process also provides an opportunity for stakeholders to assess their capacity to dictate the requisite impact that can be achieve in the time frame with the available funds. This process is key in identifying measurable indicators which may be used for monitoring and evaluation. The theory of change is also used to document lessons learned for funding, policy and other purposes,(Campanion Guidance, 2017).

2.8.2.3 Social return ratio calculations

SROI Ratio is calculated by adding up all the benefits, subtracting any negatives, and comparing them to the investment. This calculation entails a comparison of the inputs (investments) and the outputs and the resultant is a ratio of investments to outputs. Total impact if defined as total return (number of affected populations multiplied by value of the return or financial approximation) minus adjusted factors (deadweight, attribution, displacement and drop-off). Investment is estimated from total resources need to implement the proposal multiplied by cost associated with each resource to be invested.

2.8.2.4 Advantages of the SROI

a) SROI analysis has a number of beneficial aspects that may be summarised as enabling legitimation and more efficient and effective resource allocation. The most widely acknowledged advantage of SROI is its effectiveness as a communication tool.

b) The most important application of SROI is found in Decision-Making. SROI has been adopted by the funders, investors, and project managers to make informed decisions and choices about proposed investments. It thus allows a formal dialogue with stakeholders that enables organizations understand the extent to which the intended outcomes were achieved or to which the investment will affect the stakeholders.

c) The data collected from the SROI framework may be used for strategic discussions and management and evaluation of the most suitable strategy to generate social benefits.

d) SROI helps stakeholders track and observe the real impact of their work, as well as improvements in people's wellbeing.

e) SROI provides a comprehensive and holistic view of the value created by the stakeholders for none market goods. It goes beyond the traditional financial methods and considers the social and environmental outcomes that affects the community.

f) SROI is useful in identification and quantification of both the positive and negative effects accruing from the activities undertaken.

g) By using a common currency of value, SROI can be used to communicate and compare the impact across different sectors and contexts. SROI may help show potential customers that they can develop new dependable ways to define what they want out of contracts, by taking account of social and environmental impacts.

2.8.2.5 Limitation of SROI methodology

Although the tool has become popular, it's not devoid of limitations. Through research the limitations could be identified from three perspectives: From an interpretative-sociological perspective, criticism of commensuration and utilitarianism which calls the method into question as a whole. Some of the limitations established are;

a) The very nature of SROI analysis is a controversial issue. Some see it as a tool for social accounting and performance measurement which belongs to the same family of management tools as balanced scorecards. while others see it as method of evaluation research (Corvo et al., 2022).

b) interpretation issues between ideal and practice, creating room for shortcomings regarding the interpretation and use of the SROI ratio (Arvidson & Lyon, 2014). Also, there is limited literature on fundamental criticism of SROI analysis. b) Some limitations of SROI are inherent in the method but become problematic only if not properly considered when conducting or interpreting analyses.

c) SROI is not a standalone tool, it should work hand in hand with other tools, in the same way that ROI is not used as a sole indicator of financial performance. SROI ratios need to be interpreted against the background of the methodology used and complemented with additional information.

d) Many SROI analyses to date rely on manual data entry and one-off calculations. It has been suggested that SROI analysis could be standardized so that organisations would be able to enter their data into a mask and then receive ‘‘their’’ SROI figure. Attempts into this direction so far futile. Undoubtedly, however, customised SROI analyses are easier to manage if organisations have impact-oriented routine information systems. Reliability and validity are not fully appropriate for judging the quality of SROI analyses. Due to the method’s low standardization and universal need for researchers to make discretionary decisions. (Ariza-Montes et al., 2021)

2.8.3 Consumer Surveys Methodology

Consumer Surveys method is one of the most direct and common methods of data collection and forecasting of demand in the short term. In this method, the organisation conducts surveys with consumers in the interest if forecasting demand based on the current demand of the existing products and or services. The three common methods of consumer surveys include; complete enumeration survey, sample survey and market testing method and end use method.

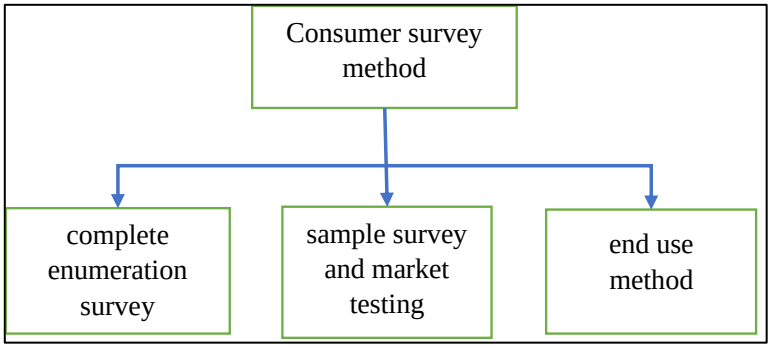

Figure 11: Consumer survey methods

During data collection, the consumers are asked directly for information about their satisfaction levels with existing products and their opinions and expectations regarding new products and services. Satisfaction levels of the consumers can be measured by asking the right questions, whose answers are analysed to create strategies for improvement. There are four consumer survey data collection methods, namely: written surveys, telephone surveys, online surveys and focus group surveys. These data collection methods are. Like other surveys, this survey has seven components, namely; Identifying the Project Focus, sampling, designing the questionnaire, data collection, data population, interpreting the data, and finally communicating the results.

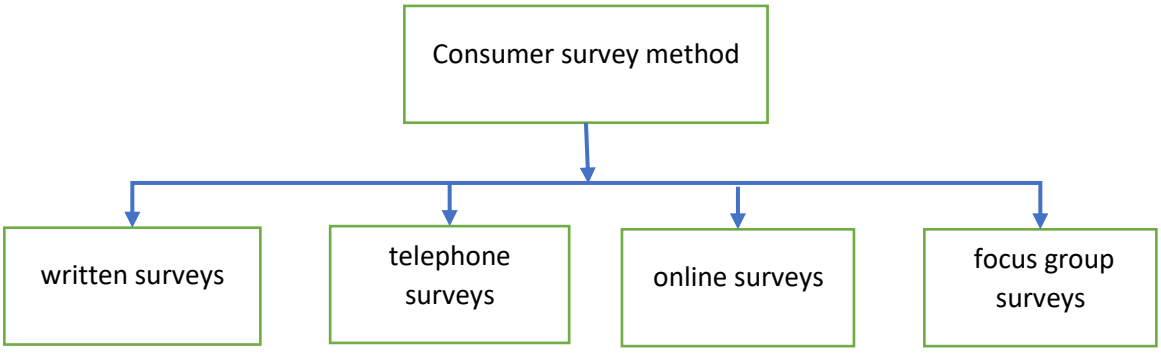

Figure 12: consumer survey data collection methods

Consumer survey for this study is hinged on transportation and use of transport infrastructure specifically rural roads as the key interest of this research. In transport terms, demand for transport is not a straight forward process but a unique one in terms of time and space, technological differences among different modes and economies of scale, governmental interventionist policies and regulations in transportation. Literature indicates that transportation economics specifically addresses; transportation services demand, supply of transportation services, price mechanisms, elasticities of demand and supply, and transportation cost analysis.

2.8.3.1 Advantages of consumer surveys

a) Consumer surveys methodology is the most common, easy, quick and simple methodology in data collection and analysis compared to many other monetisation methods.
b) Carrying out a consumer survey provides confidence to the consumers of an intended or planned improvement of a given service or product.
c) Consumer surveys allow accurate determinisation of areas for improvement.
d) Consumer surveys are easy, quick, and simple for data collection
e) Doing a consumer survey gives chance to show to consumers that there is an intention to improve the product/services.
f) By asking the right customer satisfaction survey questions, deep customer insights are obtained much more rapidly which gives a clear understanding of the consumers.
g) Well-written and thoughtful consumer surveys proves to consumers that their opinions matter and this enables the investor/researcher/business personnel to optimize consumer experience hence creating a good relationship with the consumers.

h) No matter how great the products or services you offer are, no matter how competitive your prices, no matter how fast you're shipping and how responsive your customer service is, you will occasionally get unhappy customers. A good customer survey gives you the chance to turn bad word of mouth around before it hits the streets.
i) Consumer survey research can provide insightful information about consumer demographics such as age, gender, income etc.

2.8.3.2 Limitation of consumer survey method

Much as this survey method has a number of merits on its side, it's not devoid of limitations. The common limitations include;

a) Respondents do not usually feel free to provide accurate, and honest responses,
b) Respondents may not be comfortable in providing responses that controversial questions,
c) Respondents may not be knowledgeable on the subject which may provide incorrect answer,
d) The process in not void of sampling errors that may exclude valuable Customers from participating,
e) There are high chances of customer dissatisfaction with the survey
f) There concerns about customer privacy
g) There is a probability of Survey Fatigue.
h) The survey process may be affected by Technical and non-Technical Glitches. ...
i) This process may be affected by survey biases
j) One of the common limitations is asking the wrong question in the survey, there might be no time to correct it

k) Survey data varies in customer interpretation of their experiences, challenges, variability of results, validity of survey results and reliability of survey results.

l) Reliability measures, reproducible and validity of the survey data is limited.

2.8.4 Travel Cost Method (TCM)

2.8.4.1 Introduction

The travel-cost method (TCM) is commonly used for estimating economic values of non-market goods such as recreational sites and beaches among others. Unlike other valuation methods, TCM can only estimate use value of a non- market good or service. It has been mostly applied to determine economic values of sites that are used for recreation such as national parks. It can also be used to estimate part or whole of economic benefits of non-market goods such as, beaches or wetlands stemming from their use for recreational activities such as diving and swimming and sunbathing and bird watching. It can also serve for evaluating how an increased entrance fee a nature park would affect the number of visitors and total park revenues from the fee.

However, it cannot estimate benefits not directly associated with a specific site. TCM assumes that travel costs represent the price of access to a recreational site. Peoples' willingness to pay for visiting a site is thus estimated based on the number of trips that they make at different travel costs.

2.8.4.2 Field data campaign for TCM

Field data is collected by conducting a survey among the visitors of a site being valued. The survey usually includes questions on the number of visits made to the site over a specified period (usually during the last 12 months), distance travelled from visitor's home to the site, mode of travel (car, plane, bus, train, etc.), time spent travelling to the site, respondents' income, and other socio-economic characteristics (gender, age, degree of education, etc). The researcher uses the information on distance and mode of travel to calculate travel costs. Alternatively, visitors can be asked directly in a survey to state their travel costs, although this information tends to be somewhat less reliable. Time spent travelling is considered as part of the travel costs, because this time has an opportunity cost. It could have been used for doing other activities (e.g., working, spending time with friends or enjoying a sport). The value of time is determined based on the income of each respondent. Time spent at the site is for the same reason also considered as part of travel costs. For example, if respondents visit three different sites in 10 days and spend only 1 day at the site being valued, then only fraction of their travel costs should be assigned to this site (e.g., 1/10). Depending on the fraction used, the final benefit estimates can differ considerably.

Two approaches of TCM are distinguished – individual and zonal. Individual TCM calculates travel costs separately for each individual and requires a more detailed survey of visitors. In zonal TCM, the area surrounding the site is divided into zones, which can be either concentric circles or administrative districts. In this case, the number of visits from each zone is counted. This information is sometimes available (e.g. the site management), which makes data collection from the visitors simpler and less expensive.

The relationship between travel costs and number of trips (the higher the travel costs, the fewer trips' visitors will take) shows us the demand function for the average visitor to the site, from which one can derive the average visitor's willingness to pay. This average value is then multiplied by the total relevant population in order to estimate the total economic value of a recreational resource. TCM is based on the behaviour of people who actually use an environmental good and therefore cannot measure non-use values. This method is thus inappropriate for sites with unique characteristics which have a large non-use economic value component (because many people would be willing to pay for its preservation just to know that it exists, although they do not plan to visit the site in the future). The travel-cost method might also be combined with contingent valuation to estimate an economic value of a change (either enhancement or deterioration) in environmental quality of the NP by asking the same tourists how many trips they would make in the case of a certain quality change.

This information could help in estimating the effects that a particular policy causing an environmental quality change would have on the number of visitors and on the economic use value of the NP.

2.8.4.3 Travel cost calculations

The travel cost method involves collecting data on the costs incurred by each individual in travelling to the recreational site or amenity or area of interest (Parsons, 2003). This 'price' paid by visitors or facility users is unique to each individual visitor or user, and is calculated by summing the travel costs from each individual's original location to the amenity. By aggregating the observed travel costs associated with a number of individuals accessing the amenity a demand curve can be estimated, and as such a price can be obtained for the non-price amenity.

Some amenities may be complex to calculate the associate costs to travel destinations or amenities. Some amenities do not have a direct cost associated with them. For example, some recreational sites may be free to enter and or travel to such areas may be offered free.

In order to apply a value to these types of amenities a value is often derived from a good or service which is complementary to the consumption of the free amenity. One method of estimating a value is therefore to collect data on the travel costs associated with accessing the amenity or recreational site. This is commonly referred to as the travel cost method of estimating the value of an amenity. This method can be illustrated using figure 14 based on observed or revealed preferences

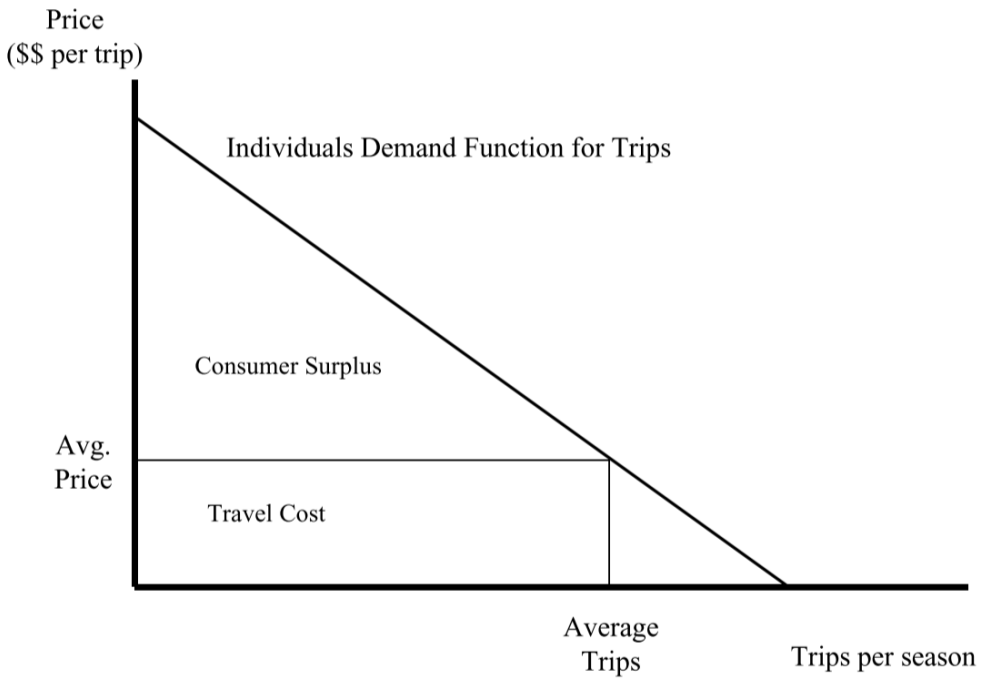

Figure 13: Generalised demand function showing consumer surplus and travel costs

(Sohngen et al., 2006.)

2.8.4.4 Zonal Travel Cost Method Vs individual visitors

Zonal Travel cost method is considered more feasible than the individual visitors. Using the zonal travel cost method, a researcher can estimate the value of an asset by exploring the actual visitors or users of a site or asset, rather than potential visitors or users. The level of analysis focuses on the zones in which people live compared to the location of the asset. The estimator is required to specify the zones from which the site users travel to the asset. In this research, markets, health centres, schools are considered the sites and people are zoned accordingly (Kheyri et al., 2020).

To calculate the value of the asset (V) for a single visit, the researcher uses the simple equation as follows:

V = ((T x w) + (D x v) + Ca) x Va ……1

Where; V = Value of asset

T=travel time (in hours)

w =average wage rate(£/hour)

D = distance (in km)

v = marginal vehicle operating costs

Ca = cost of Admission to asset

Va = average number of visits per year

It is however very important to note that, the estimator must provide an accurate measure for the average hourly wage rate and the marginal vehicle operating costs. A common value for the operating costs can be accessed through firms and organisations and national bureau of statistics (for Uganda). The operating costs vary from place to place.

2.8.4.5 Advantages of the TCM

There are many advantages associated with TCM. The common one's included:

a) Relates to conventional economic techniques that utilizes market prices to estimate economic values commonly used by economists,
b) The method is based on actual consumer behaviour and provides actual or realistic consumer related results
c) Data collection from the visitors is simpler and less expensive.

d) Provides an opportunity for a big sample size.

e) The results can be easily analysed using simple tools like excel

2.8.4.6 Limitations of the TCM

There are several limitations associated with the travel cost method of value estimation. These include among others;

a) The method assumes that perception and response to changes in travel costs would be the same for admission price

b) The method is not well suited for multi-purpose trips, it is modelled around a single purpose and destination trip to a specific recreation site. If the site is multi-purpose, there is a possibility of overestimation of the value of the site. For example, Prior to visiting the final destination, an Individuals may visit other amenity or recreational sites. The travel endured to access the amenity includes the travel of visiting other amenities. In this case the cost incurred in travelling to the amenity does not represent the value the individuals place on the amenity but the aggregated value of all the amenities visited in that same journey.

c) It is quite difficult to measure the cost of accessing a site or amenity and or assessing the value of benefits accruing from the road maintenance activities. This is because mainly of the opportunity cost associated with the travel time. For uniformity, the opportunity cost of all individuals needs to be the same for the estimated price to be accurate. If, however, the opportunity cost of individuals accessing the site varies, which is most likely, then the measure will be inaccurate.

d) TCM only provides a price or value relating to the cost of accessing the amenity or recreational site, it does so for the entire site. If, however we intend to value part of the site of, it becomes difficult to delineate the part of the site in question. In relation to benefits accruing from the roads, segregation of a amenities in the wider community benefiting from the maintenance of the road.

e) Sometimes the journey itself has a value to the individual and if this is true then some of the cost incurred in travelling to the amenity should not actually be applied to the individual accessing the amenity, and as such should be removed from the estimation of the amenities value. Example include the cost of entertainment, feeding and any related expenses.

f) The travel cost method does not account for the costs involved in purchasing complementary goods which may be required in order to enjoy accessing the amenity. estimation.

g) The model does not count for people purposefully leaving very near the site to reduce travel cost but maximise the value of the site. This affects the estimation of the demand function which requires enough difference between origin and destination to effect travel costs and eventually affect the number of trips made.

h) The TCM method assumes that individuals respond to changes in price regardless of its composition. For example, Conclusion.

2.8.5 Willingness to pay (WTP),

2.8.5.1 Introduction

Willingness to pay (WTP) as a concept of monetization of social impacts was reviewed in this research. This concept has become very popular over the last twenty years in economic assessment studies in the health field,(Hahsler & Reutterer, n.d.; Reed et al., 1997b; Vachal, 2006). The adequacy of the concept within rural road evaluations was also considered. A considerable number of researches in the literature pointed out a number of methodological issues on the use of WTP methodology. According, willingness-to-pay is defined as “the amount an individual is willing to pay to acquire some good or service. This may be elicited from stated or revealed preference approaches. Willingness to pay is closely related to the demand curve. The demand curve for most products and services illustrates lower levels of demand as prices rise. This means as the price increases, more consumers leave the market for the product or service in question because they are not willing to pay the higher price. Conversely, as the price of a good declines, more buyers enter the market because they are willing to pay the lower prices. In line with this definition, willingness-to-pay maybe measured through revealed preference or stated preference methods. Revealed preference data is either observed or reported actual behaviour while stated preference data is observed or expressed in response to hypothetical scenarios, (Nieboer et al., 2010). Classification framework for methods to measure willingness-to-pay is indicated in figure 14:

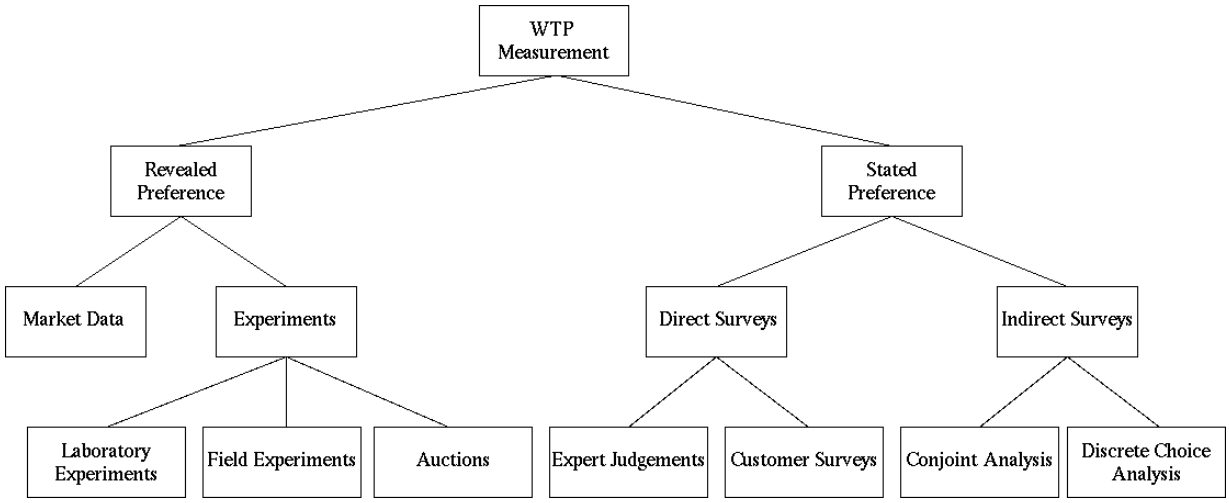

Figure 14: Classification framework for methods to measure willingness-to-pay (Breidert et al., 2006)

It's application in cost benefit assessments and in decision-making processes in other economic assessment models have made it one of the tools demanded most in many sectors but specifically in the area of health economics. However, its use is still questionable where some authors base their concern on the way in which information is presented in the questionnaires (in terms of its order and characteristics), which have proved to be decisive to establish the results of subsequent WTP estimations. However, the accuracy of the resultant estimates creates doubt in its application. On the other hand, not only could this type of methodological problem skew the WTP estimate, but the direct and indirect experience of those surveyed sector being analysed is also a source of significantly inaccurate estimates. If individuals do not have appropriate and sufficient information, it is difficult for them to place a reasonable monetary value on something complex, so this is one of the sources of errors (Breidert et al., 2006) .

2.8.5.2 Advantages of WTP Concept

Willingness to pay is a common tool used in the valuation of social impacts in many sectors such as health, agriculture and environment among others. It provides a value for none-market goods and services through willingness to pay surveys.

16. Willingness to pay (WTP) indicates the market demand of a product or service. In general, the higher the demand for a good or service, the more people will be willing to pay for it. Thus, willingness to pay may be considered as a proxy for market demand for a product or service.
17. It is simple to apply and easy to collect and analyse the relevant data from the field.
18. WTP covers a wide range of activities. It may be adopted for both the revealed and stated preferences. However, revealed requires existing data while stated preference depends on both the direct and indirect surveys.
19. WTP provides clues on which products or features a producer or supplier should focus his time on. Through market demand, WTP provides clues to understand which products and features to be focused on.

2.8.5.3 Limitations in The WTP Concept

Much as the WTP concept is applied in many fields, there are a number of theoretical and methodological limitations mentioned by various authors that may lead to questioning about the use of this tool. These limitations include;

a) WTP is a variable indicator that depends on the economic and social stratum of the community in which the survey is carried out. Evidently, this has a strong impact when decision-making is based on a WTP measurement. If only a high socioeconomic stratum is considered, its most likely that a large number of cost-effectiveness studies that evaluate benefits with different interventions are accepted as cost-effective if the decision variable is precisely willingness to pay. If the same studies only consider low socioeconomic strata, the results might have exactly the opposite results to the first study indicating that the large number was not cost effective. This problem may lead to the fact that certain alternatives, which are proven to be efficient and effective, may be reserved for people according to their capacity to pay (a moral problem). This limitation of WTP indicates that this instrument is clearly discriminatory for economic and not health reasons. From this point of view, this fact might lead to suppose that in certain societies the concept of WTP should not be recommended for decision-making if no care is taken when estimating it.

b) It is impossible to extrapolate individual preferences within a social function. On this point, economics literature has had an extensive debate and the aggregation of individual preferences are generally accepted when the convexity assumption and interpersonal comparison of such preferences is imposed.

c) WTP estimation calculations might be overestimated from the social point of view in those studies where the instruments are applied to only recipients and not to society as a whole. This last fact would tend to raise WTP estimates for a particular society and accept some interventions as cost-effective when, in reality, they are not.

d) Additionally, it is possible that WTP estimates are underestimated since willingness to pay may be insufficient to cover a predetermined optimal service from the sectors. In other words, the WTP concept only takes into consideration the individual willingness to pay of a society and excludes, in the vast majority of cases, the collective capacity.

e) WTP estimations might show that there are methodological problems of the representativeness of the sample considered for estimates (problems of external validity, size of the sample, with over and under-represented groups, in accordance with socioeconomic, age and gender strata) or some other type of bias, in which questions are prepared in such a way as to induce a certain type of response. valid and internally consistent.

f) Finally, the psychological and technical aspects of WTP studies should be added. The first deals with the difficulty of solving the problem associated with questionnaires that are used to collect the information that generate a low response rate. The second has to do with the robustness of the statistical analysis of these studies. The problem comes from WTP questionnaires that present a very small number of discrete selection responses relative to the number of scenarios generated. This evidently complicates the resulting statistical analysis when this technique is used.

g) WTP does not always suggest the advantage for a society to adopt one treatment rather than another, since some market costs are distorted by non-competitive factors (for example, the monopolistic price of drugs in some cases). WTP studies for various countries or regions are not comparable since preferences are different. Generally speaking, preferences derive from the individual's own circumstances, which include education, culture, income, health, environment, among others.

h) WTP is only useful for some perspectives of the investigation, for example, from the patient's point of view. However, from other perspectives its use is highly debatable, as is the case with the public health service provider, where the provision of service is beyond the insureds' capacity to pay. Whether the beneficiaries of the public health service have high or low incomes, the services required must be provided regardless of the wishes or the capacity to pay of families. On the other hand, even when the beneficiaries of a particular health system wish to earmark more of their income for the treatment of an illness (greater WTP) given the current taxation model, this would be extremely complicated over the short term since tax collection for the health field is unique and indivisible (unless this increased expenditure is used for medications or other medical interventions in the private sector).

i) Despite what has been said, the controversy as to whether WTP really represents the ability to pay and the level of well-being of families, and if these terms are equivalent or not, still persists. Other studies mention that redistribution of funds within the home when there is spending on health, a redefinition of the family's spending priorities (such as spending on leisure, housing, education and food; in some cases, health spending is postponed, sometimes definitively) and the true levels of vulnerability of the home are factors not observed in WTP estimates.

2.8.6 Social cost benefit analysis (SCBA)

2.8.6.1 Introduction

The Social Cost Benefit Analysis (SCBA) is a decision support tool like many other economic tools that measures and weighs various impacts of a project or policy. It compares project costs (capital and operating expenses) with a range of social impacts, such as travel time savings, travel costs, impacts on other modes, climate, safety, and the environment. It may also measure impacts on property values and economic impacts can also be assessed. Social Cost Benefit Analysis (SCBA) is predominantly used for evaluating public investments and has since received increased emphasis in recent years due to the increasing importance of public projects especially in developing countries where government play significant role in economic development. SCBA is also relevant in major private investments, which require governmental approval due to bearing on national considerations (Coady, 2000; Pienaar, 2018; Van Erp & Schuitemaker, 2022).

2.8.6.2 Aspects of Social Cost-Benefit Analysis

SCBA hinges on the Cost benefit analysis (CBA) that has been in use for many years to calculate economic impacts. Decision makers, planners and economists have been using and improving Social Cost Benefit Analysis (SCBA) tool for many years. The tool supports decision makers in various policy areas like transport economics for all transport modes, health, energy, spatial development, water management and tourism among others. It's noted that output of the SCBA tool compares benefits against costs of projects and may allow for comparison of different measures. Outputs indicate which measure has the highest 'social yield', to what extent goals are reached, which side effects occur and to which parties' costs and benefits accrue. Positive impacts sometimes called Social Benefit and negative impacts termed as Social Cost are the two components that are involved in project evaluation in line with economy (Van Erp & Schuitemaker, 2022) . This in general is termed as Social Cost Benefit Analysis (SCBA) sometimes referred to as Economic Analysis. Therefore, social cost-benefit analysis evaluates the benefit and costs of a decision for the public projects. Cost-Benefit Analysis is a procedure for evaluating the desirability of a project by. cases where the project has a broad impact across society.

The costs in SCBA include;

i. Indirect costs include utilities, rent, overhead costs and electricity
ii. Direct costs include manufacturing expenses, raw materials, direct labour associated with manufacturing and inventory
iii. Cost of potential risks include competition, regulatory risks, and environmental impacts
iv. Opportunity cost includes purchasing a manufacturing plant instead of building it and alternative investments

v. Intangible costs include employee impact, delay in delivering of a product, construction of manufacturing plant and a new business strategy

2.8.6.3 Advantages

i. Competitive advantage due to the outcome of a decision
ii. Intangible benefits because of customer satisfaction and improved safety of employees
iii. Revenues and sales because of a new product or increased production

2.8.6.4 Limitation of social cost-benefit analysis (SCBA)

Like any other economic tool, social cost-benefit analysis has its fundamental and methodological limitations. Most limitations identified by researchers include;

a) SCBA like many economic tools such as the cost-benefit analysis is guided by consequences of the respective decisions. Its notable that SCBA assume a basic rationale that things are worth investing in if the positive effects outweigh the negative ones which imposes an evaluation of costs and benefits with a focus on the consequences of the outcome decisions. However, this guidance by consequences violates the fundamental civil rights.

b) Its common knowledge that, the used techniques are an estimate rather than a precise measurement although economic analysis tends to assume “completeness of knowledge” of all the effects and corresponding weights. This assumption of completeness poses a risk in daily practice that in search of completeness the economic analysis results in judgements that are without justification that results in ignoring “the less exactly measured consequences or less clearly agreed values, even though they may be extremely important.

c) It is common practice for social cost-benefit analysis to place a monetary value on human life, for example, when assessing safety measures against road safety. The question is, however, if it is possible to adequately value a human life based on a market valuation system.

d) Economic effects are principally valued according to the market mechanism. However, for a lot of public goods and the environment, among others and specific type of external effects there exist no markets.

e) In theory, economic science does not presuppose a policy preference and the outcomes of a cost-benefit analysis or economic impact study is not the decisive step in the decision-making process. In practice, however, both economists and the public decision makers have to be very careful not to regard the economic analysis as the final/normative step in the decision-making process, and to reduce the multidimensional realm of reality to a financial and market value-based model of reality.

2.8.7 Highway Development and Management Model (HDM4)

2.8.7.1 Introduction

The Highway Development and Management Model (HDM-4) is a life cycle computer software application developed by World Bank aimed at helping road administrations in the planning, analysis, management and appraisal of road maintenance, and or improvements, and investment decisions (Ashington & Archondo-Callao, 2008), (Anand et al., 2021), and (Watanatada et al., 1987), HDM-4 is an improved version of an earlier software HDM-III developed by the same institution. It supports high level decisions such as technical and economic appraisals of road investment projects, standards and strategies. This model supports the determination of the most economic and efficient maintenance and improvement strategy for a road network.(Anand et al., 2021) , (Yogesh et al., 2016),(Čutura et al., 2016) Although this software is currently deployed to support many road administrations, it's not devoid of limitations. World Bank notes that, it will be improved in the near future for both the software and its content. There is other related software developed over time but like HDM4, they do not prioritize rural roads.

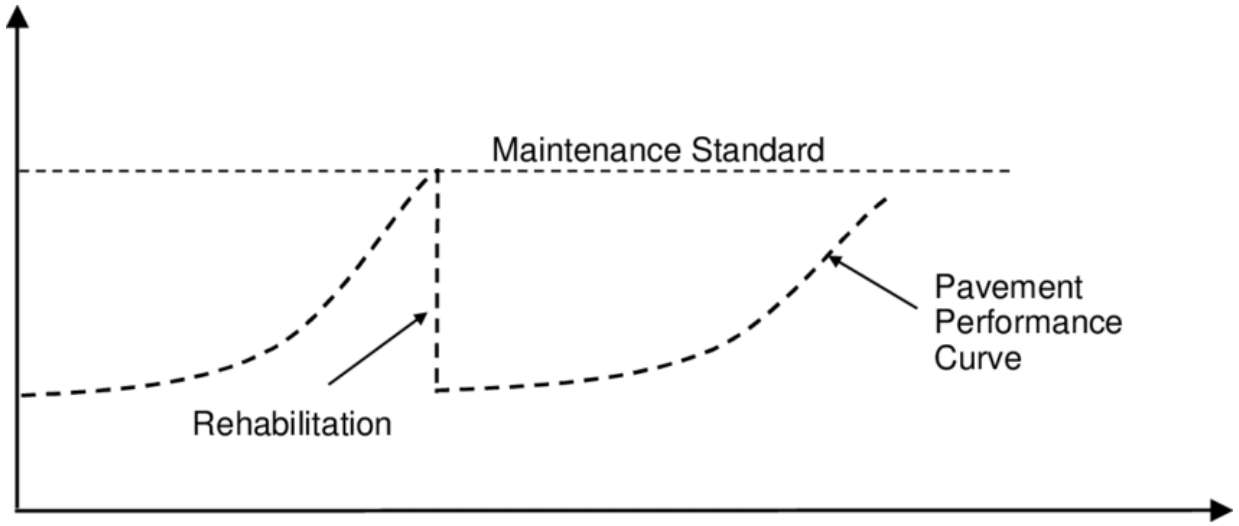

Figure 15: Analysis in HDM-4 (Ashington & Archondo-Callao, 2008)

2.8.7.2 Advantages of HDM4

HDM-4 is a decision-making tool which is used for checking the engineering and economic viability of the investments in road projects (Watanatada et al., 1987),

The Highway Development and Management Model is used for analysis, planning, management and appraisal of road maintenance, improvements, and investment decisions as a primary tool for road administrations (Čutura et al., 2016),

HDM-4 supports business-level decisions in road investment projects through technical and economic appraisals, setting standards, and strategies. It is also helpful in the most economically efficient maintenance and improvement strategy for a road network (Yogesh et al., 2016).

2.8.7.3 Limitations of HDM4

d) This model is suited for highways and or high-volume roads, under its unpaved roads deterioration model, it is not particularly customised for low volume roads and rural roads with AADT lower than 300 common in the developing countries (Čutura et al., 2016).
e) In its processes, HDM4 does not monetise social benefits and in particular those accruing from rural roads.

2.8.8 Roads Economic Decision Model (RED)

2.8.8.1 Introduction

Roads Economic Decision Model (RED) was developed by World bank for Economic Evaluation of Low Volume Roads (R. S. Archondo-Callao, 1999) . The main objectives of this method were to;

a) Simplify the economic evaluation of low volume roads
b) Better capture the economic benefits of a project
c) Characterize the wet and dry seasons separately
d) Include in the analysis the high level of uncertainty related to low volume roads (risk analysis)
e) Produce proper sensitivity, switching values, user impacts, and distribution of benefits analyses
f) Perform budget constraint optimization
g) Compute CO2 emissions

It was noted that RED was developed to cater for low volume roads not catered for by HDM4. It makes use of Consumer Surplus Approach unlike HDM4 and other methods which makes use of Producer Surplus Approach. World Bank considers low volume roads as roads with AADT between 50 to 300. HDM-4 Considers roads with more than 300 AADT (Ashington & Archondo-Callao, 2008). It uses a customised excel model developed by world bank. However, this is better than HDM4 which uses unpaved roads deterioration model, which is not particularly customized for developing countries due to the lack of drainage. Comparisons for constant average level of service for HDM4 and RED as noted by World Bank is indicated in figure 16;

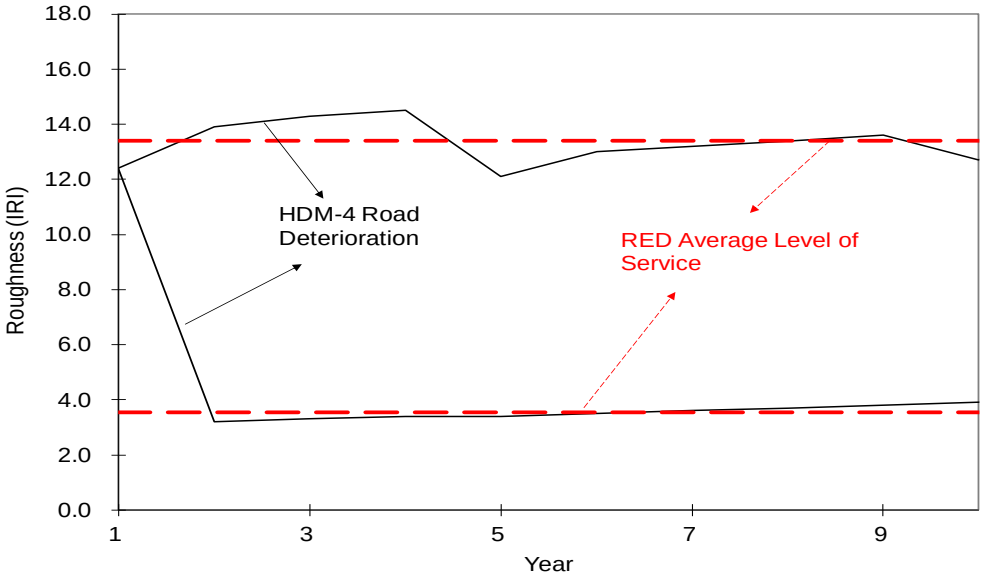

Figure 16: Comparisons for constant average level of service for HDM4 and RED (Source: (R. Archondo-Callao, 2004))

2.8.8.2 Advantages of RED

a) RED computes benefit for normal, generated, induced, and diverted traffic, and considers changes in road length, condition, geometry, type, accidents, and days per year when the passage of vehicles is further disrupted by a highly deteriorated road condition (wet season).

b) Roads Economic Decision Model (RED) performs economic evaluation of road investments, and maintenance options, customized to the characteristics of low-volume roads, such as: high uncertainty of the assessment of traffic, road condition, and future maintenance of unpaved roads; periods with pass disruptions; levels of service, and corresponding road user costs defined not only through roughness; high potential to influence economic development; and, beneficiaries, other than motorized road users.

c) The model computes benefits accruing to normal, generated, and diverted traffic, as a function of a reduction in vehicle operating, and time costs, and, adopts the consumer surplus approach, which measures the benefits of road users, and consumers of reduced transport costs.

d) RED addresses, among others, the following additional concerns: reduce input requirements for low-volume roads; consider the higher uncertainty, related to input requirements; compute internally the traffic generated due to decreased transport costs, based on a defined price elasticity of demand; and, quantify the economic costs, associated with the days per year when the passage of vehicles is further disrupted by a highly deteriorated road condition. Particularly, the model highlights all input assumptions, and comprehensively integrates them with sensitivity, switching values, and stochastic risk analysis.

2.8.8.3 Limitations of RED

a) RED Version 4.00 Excel Workbooks incorporates HDM-4 Vehicle Operating Costs as one of its inputs. This makes it reliant on the HDM4 model which is not suitable for monetisation of social benefits.

b) RED was developed for low volume roads (50-300AADT), it is not useful for unpaved rural roads that have lower than 50 AADT.

c) Does not calculate values for social benefits

2.9 Summary

Rural roads contribute significantly in the development of the communities they serve. Accessibility is one of the key components rural roads contribute to the social-economic development of the area. It has been established through literature review that the bulk of the roads in sub-Saharan Africa are categorised as rural roads. For the roads to be effective, it is imperative that they are kept in good motorable condition and open to traffic all year round by purposeful maintenance. Maintenance regimes should be well planned to cater for rainy seasons and other harsh conditions and should be implemented using the right materials.

It's also been established that there is no dedicated methodology in use for valuation and or monetisation of social benefits accruing from rural roads. However, monetisation of social benefits is common in other sectors such as environment, health and tourism among others. Some of the monetising methodology reviewed reveal potential for adoption in the monetisation of social benefits accruing from maintenance of rural roads.

Literature review indicates that well maintained roads lead to social-economic changes in the communities they ply and in turn these social changes (impact) results into social benefits leading to the development of the area. The common social changes accruing from maintenance of rural roads include; changes in level of interaction, level of integration, level of resident's displacement and change in crime rate in the area. If these changes are well tracked through the theory of change process, their value can be calculated based on monetisation methods commonly used for none market goods such as environment. It is however important to note that there is a thin line between social benefits and economic benefits which makes it difficult to separate the two.

it is possible to adopt similar techniques in monetising social benefits accruing from rural roads. It was established that there is no any technique currently used to monetise social benefits accruing from rural roads. However, there are many methodologies employed to monetise social benefits accruing from other sectors. The common techniques include SROI, WTP, TCM, among others. The techniques have been studied in details with an interest of adopting one of them or a combination to monetise social benefits from rural roads.

Having reviewed in detail the common methodologies of monetizing social benefits accruing from other sectors like health, education and environment. It was clear that none of the reviewed methodologies provide requisite solutions for monetization of benefits accruing from rural roads although it is possible. An analysis of the selected common methodologies indicates common parameters such as; Variability, Comparability, Standardisation, Accuracy of results, and Availability of dependable data as some of the common limitations. It is important to find a new methodology that will take into consideration impacts accruing from rural roads and reduce on the limitations. A comparison of the 3 selected methods indicates that SROI is the closest to monetization of social impacts and its modification could yield fair results for rural roads adoption.

3 CHAPTER 3: METHODOLOGY

3.1 Introduction

Literature review process indicated that there is limited information on the monetization of social benefits accruing from the maintenance of rural roads, and limited methods of valuing the intangible benefits of maintained roads, and their environs. This revealed limited research on the prioritization of maintenance for rural roads based on the true value that encompasses the monetized value of social benefits or costs. To address this challenge, it was imperative that a comparative study of different monetisation techniques be undertaken. Having consulted professionals in the road sector, appropriate parameter on which formed the basis for analysis for the most responsive technique were agreed upon. Based on Linkert scale the most appropriate techniques was adopted. The adopted techniques were reviewed further to zero on the most appropriate technique if possible. After further interrogation of literature social return on investment was considered the most responsive technique having fulfilled most of the parameters agreed on earlier. Given the selection of this method, the nature of data to be collected and the methods to be utilised required a unique but very robust survey technique. This would ensure the collection of requisite data from the case study location and easy design of the questionnaires and interviews.

3.2 Conceptual approach

This research has been designed to provide insight into the existing methodologies and their capacity to be adopted for application in the monetization of social benefits accruing from rural roads. Available social-economic models and concepts were reviewed, assessed, and analysed for adoption in monetising social benefits. The study is based on monetization of social benefits, which are none market goods, hence excluding all economic models from this study. This study is therefore designed to cover both qualitative and quantitative data collected based on the designed questionnaires as primary data, secondary data collection using the web and focus groups. The adopted approach to conduct the study is summarized in Figure 17, which gives a general overview of this research.

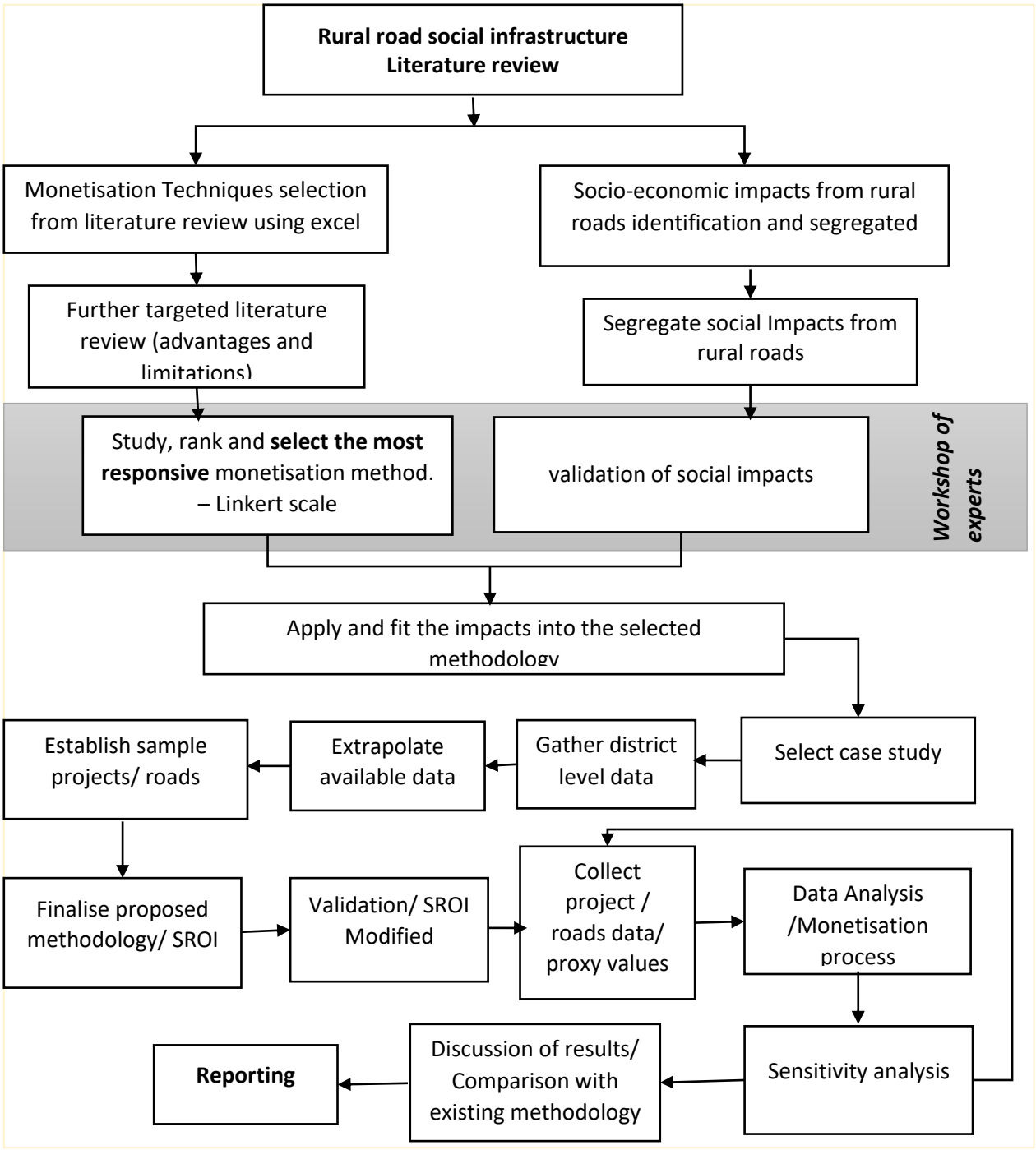

Figure 17: Conceptual approach

3.3 Research Methodology

3.3.1 Literature review

This research is based on finding the most appropriate method of monetizing social benefits accruing from rural roads. The monetization process brings into consideration of the value of social benefits or costs accruing from the maintenance of rural roads. This research process is informed by the results of a literature review carried out to find the possible gaps in the monetization of social benefits or costs accruing from rural road maintenance regimes. The research process also involves the identification of techniques to measure the social benefits of rural roads and assessment of the appropriate social changes. A comparison of the available techniques was conducted from which the most viable of them are considered for further assessment with the interest of adopting the most appropriate for modelling of social costs and or benefits emanating from the maintenance of rural roads. The selection for the most viable methodology carried out through a workshop of experts involving economists, engineers, road managers, and social workers. Linkert scale was adopted for ranking and selection of the most responsive methodology. Details on the workshop and Linkert scale process are discussed in the proceeding sections.

3.3.2 Socio-economic impacts from rural roads

In line with the literature review, social economic impacts from rural roads are not any different from impacts from roads in general. What makes it unique is the nature of the communities they serve.

The common impacts associated with rural roads are clustered as social and economic impacts in line with, spatial and environmental impacts fused with both social and economic impacts. It should be noted that the difference between the economic and social impacts is very thin and sometimes intertwined. The impacts assessed and segregated as established from literature review have been conceptualised as indicated figure 18.

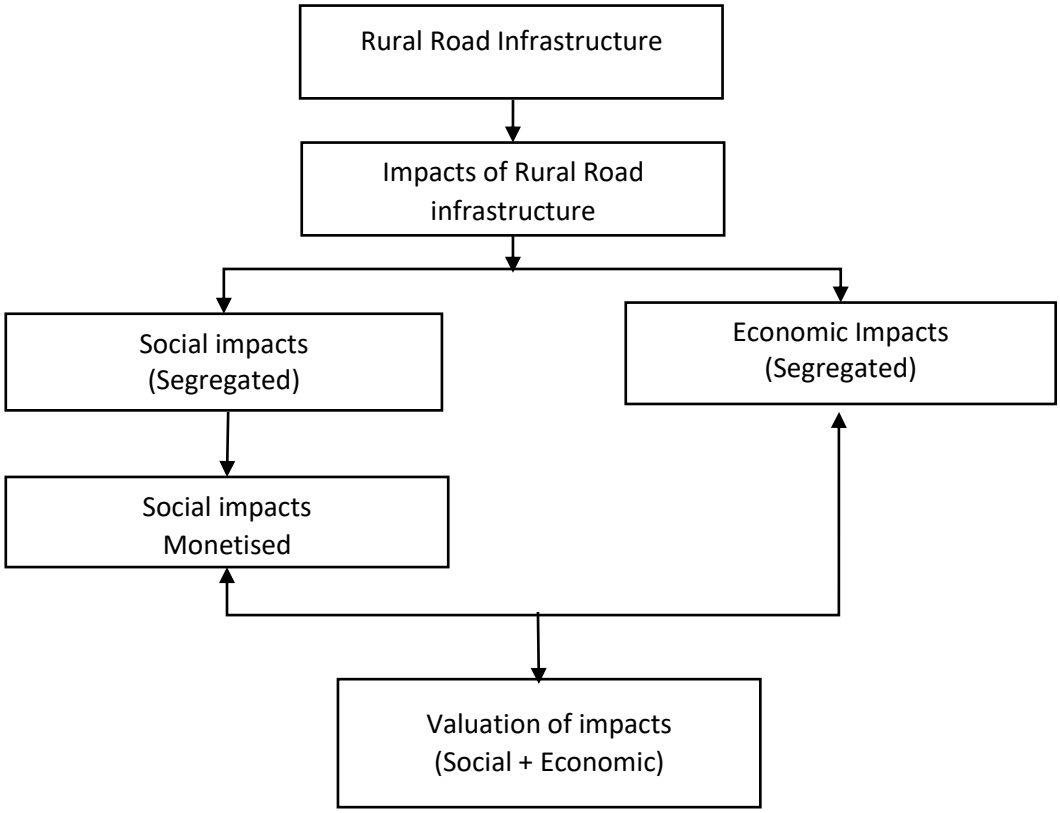

Figure 18: Impacts associated with road infrastructure

3.3.3 Social impacts accruing from Rural roads

Social impacts are driven by change, and if we are to fully discuss social impacts, it's important that we understand causes of social impacts.

As indicated in the literature review, chapter two, impacts accruing from rural roads include; Social change, spatial change, economic change, environmental change, educational change, health related change and agricultural change. Social changes are intangible changes that may be through the theory of change process for calculation of their impact value.

3.3.4 Social-Economic value and valuation methods

None-market goods where social benefits belong are usually monetised based on none conventional means as opposed to market goods valued based on economic methods as described by Kolstad, 2000. This thesis adopts the use of techniques that can monetise social benefits accruing from rural roads. Figure 19 conceptualises the monetisation of non-market goods.

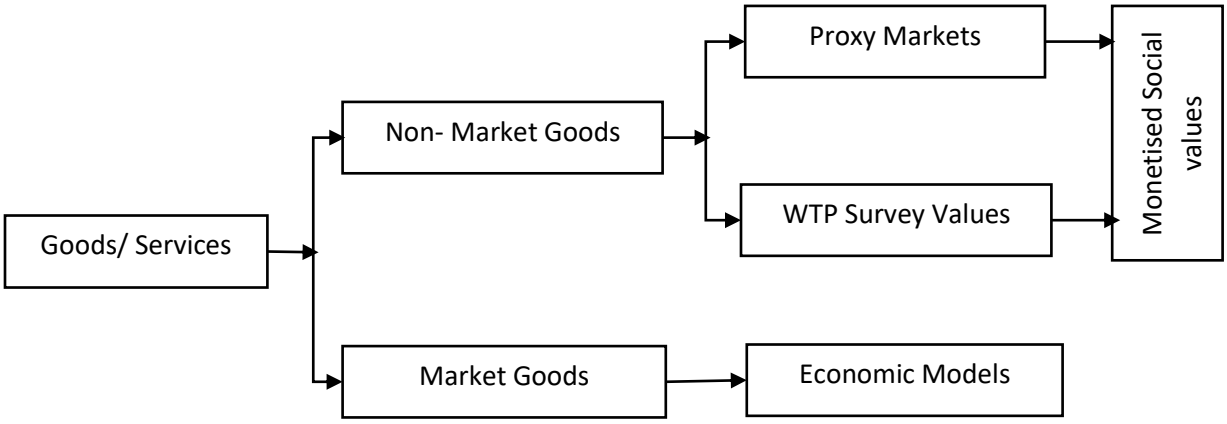

Figure 19: social economic value

3.3.5 Valuation – monetisation of social benefits

Valuation methods are dependent on the availability of data which are grouped in 2 categories: stated preferences and revealed preferences.

Stated preferences are dependent on asking direct questions which indicate respondent's attitudes, opinions, intentions and desires. These questions are asked during surveys, interviews and focus group discussion. Revealed preferences brings on board respondents' actual choices and behaviours revealing their real options and constraints when confronted with real challenges.

willingness to pay, social return on investment, transport cost methods are some of the methods used to monetise social benefits in sectors other than roads sector. An attempt to valuate social benefits by the world bank was made through the adoption and use of the Roads Economic Decision (Model) (RED). However, RED is suited for low cost roads and not rural roads.

3.3.5.1 Monetising of social benefits

Monetising of social benefits is the process of assigning monetary value to the social changes created by the investment, projects and policy among others. There are many ways of monetising social impacts (Benefits and loses) as noted in the guide to measuring impact (Scotland, 2012).

In order understand how rural road maintenance processes impacts the social fabric of the rural communities they serve in sub-Saharan Africa; the study employed a conceptual approach based on social benefits accruing from maintenance of rural roads. This concept builds on the social integration theories by Transport Scotland, (Scotland, 2012) Bodo, Allen and (Ruiz-Tagle, 2013) among others). Scotland, 2012 denotes that, due to changing local economic and employment patterns rising from land values and dynamic land uses, there has been changes noticed in the communities. On the social seen, there has been changes in social integration, displacement and disintegration. Other changes include change in crime rate, health levels, accident rate, maternal birth, agricultural production changes, education and land use changes among others. Based on the findings from the literature,

3.3.5.2 Monetisation Techniques selection from literature review using excel

The selected techniques were further assessed and compared through a comparison matrix for viability in the monetization of social benefits accruing from rural roads. A detailed literature review was carried out outlining the advantages and limitations of the selected most compliant methods to select one most responsive technique. Linkert scale criteria was again utilised to rank the techniques. The requisite data, was collected based on the requirements of the selected technique, and or formulas reviewed. This data was collected as input for the most responsive techniques. The mode of data collection was through questionnaires based on Linkert scale. For ease of data collection, KoboCollect statistical methods were used.

The processed data was used for the calculation of the value of social benefits. This research requires sensitivity analysis to check the consistency of the data. The selected techniques are outlined in the proceeding sections. The techniques bring on board proven models previously used for the monetization of none market goods (Intangibles).
Through literature review, parameters that were key to the assessment of the viability of a technique to be responsive were identified.

These were further discussed and agreed upon in a workshop of eminent road managers and economists, the majority coming from Uganda national roads Authority (UNRA), the Uganda Road Fund (URF), and the National Planning Authority of Uganda (NPA). The parameters considered for use were;

a) Monetisation of social impacts
b) Cost effectiveness
c) Time efficient
d) flexibility of the methodology
e) Validity of estimates or results
f) Ease of Data collection and analysis

There are a number of approaches that may be utilised to select suitable techniques for monetization of social benefits and the appropriate sectors through ranking. The common approaches are Linkert scale (Jamieson, 2004) and multi-criteria analysis (MCA) based on the Analytical Hierarchy Process HP designed by (Saaty, 1987). Through research on the approaches, Linkert scale was adopted for use in ranking the techniques. As described in chapter 2, Linkert scale using the responses *Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree was adopted.* The narrative alternates between odd numbers and even numbers were adopted as indicated in table 9.

Table 9: Linkert scale (Jamieson, 2004)

Narrative (Even numbers)	**Scoring**
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

An expert workshop was organized to analyse the results of the literature review and advise on which techniques are best suited for adoption in the monetization of social benefits accruing from rural roads. Through Linkert scale process, the 3 most appropriate techniques were selected.

3.3.5.3 Further targeted literature review

Further literature review on the 3 most appropriate techniques selected was conducted with the view of selecting the most appropriate technique. To aid the selection, advantages and disadvantages were reviewed. Also, common parameters were identified in most of the reviewed techniques. These parameters were vital for assessment of the viability of the methodologies. The identified parameters are; Cost efficiency, Data and data collection, Validity of results, Time efficiency, and Clarity in processes. These common parameters were used for comparison purposes.

3.3.6 Comparison of monetisation techniques

Upon conducting further study of the three most responsive techniques, advantages and disadvantages for all techniques reviewed were identified and common parameters identified and tabulated. With the help of experts derived from a wide range of specialisation and based on the Linkert scale, the most responsive technique was identified through ranking. The Linkert scale with a five-pointer scale was adopted as: Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), Strongly Agree (5). The ranking was analysed based on Linkert calculations as indicated in table 10.

Table 10: Linkert scoring

Statement	**Scores**	**Range (calculated)**	**Interpretation**
Strongly Disagree	1	1.00-1.80	Strongly non-responsive (SNR)
Disagree	2	1.81-2.60	None responsive (NR)
Neutral	3	2.61-3.40	Neutral (N_e)
Agree	4	3.41-4.20	Responsive
Strongly Agree	5	4.21-5.00	Strongly responsive (SR)

3.3.6.1 validation of selected technique

The selected technique was validated through presentations in a workshop comprising of eminent persons with the knowledge of the subject. Social changes that accrue from maintenance of rural roads as derived from the theory of change were also agreed on and fitted them into the agreed methodology. From the discussion it was established that social return on investment (SROI) was more responsive compared to other techniques reviewed.

3.3.7 Case study

A case study approach was considered for this study given its many benefits. According to (Priya, 2014), a case study method is useful when considering a multi-faceted understanding of a complex issue in its natural real-life context. The case study makes use of real client problems and also provides real solutions of the problem at hand. The case study is expected to follow the same methodology as the main study. The common steps established include; selecting the case(s), collecting and analysing the data, interpreting data, and reporting the findings. Through literature review on data requirements for this thesis, specific parameters or data centres were established as indicated in table 11.

Table 11: Selection of case study

No.	Parameter for case study suitability	Attributes to selection of case study
1.	Location	Actual location of the sites to be surveyed and analysed. Should be well suited to encompasses all the required details
2.	Accessibility and or Proximity from the location of the researcher	The site should be accessible easily and from the location of the researcher
3.	Population served (Millions)	Details on demography's or population are important
4.	Area covered (Thousands sq. km)	Area covered by the research project may be important
5.	Administrative institutions	Well-structured administration may be key to the research
6.	Availability of a good road network	Availability of a good road network is desirable
7.	Knowledge of the language used for communication	The researcher's knowledge of the local language is important on the collection of data and focus group meetings with the communities.
8.	Availability of data	Available data is important for trend analysis, or importation to support the collected data
9.	Cost of data collection	The cost of data collection is very key. Low-cost value data collection is desirable.

The period of study is limited to 3 years stretching from December 2017 to December 2020. In this period, baseline surveys were made and recorded in 2017, and follow-up surveys were made in 2018, 2019, and 2020 after regular maintenance regimes. It should be noted that roads selected under this study received funding for maintenance.

3.3.8 Data collection tools and processes

There are many ways of data collection. The methods many times depend on the type of data and the level of quality to be collected. For this research, three types of data were collected as indicated in the table 12.

Table 12: type and data collection method

No	Type of data	Data collection method/ tools
1.	Primary data	Field surveys based on questionnaires collected via KoboCollect software using smart phones, tablets and other electronic gadgets. Hard copy forms used in the absence of software tools. Collection of road condition data and road structures assessment using standard data collection forms. Trained enumerators are required for this survey
2.	Secondary data	Desk/internet surveys
3.	PRA based data	Community participation. Data is collected through focus group discussion and physical visits to the affected area. Trained enumerators are required for this survey

3.3.8.1 Primary data collection

Primary data is collected using questionnaires customised for use in the proposed SROI model. The data collected should answer the data needs of the model. Primary data is collected through manual questionnaires or questionnaires collected via KoboCollect software using smart phones, tablets and other electronic gadgets. This thesis adopts data collection based on KoboCollect software collected using smart phones. However, Manual survey forms may be used in the absence of software tools.

3.3.8.1.1 Manual questionnaires

Manual semi- structured questionnaires prepared in line of this thesis will be used as back up in case of KoboCollect tool becomes malfunctional. However similar questionnaires were uploaded into Kobo Toolbox on smart android phones and tablets of the enumerators and data was collected directly to the phones. Two sets of questionnaires were prepared and administered; one for a small group of people used to test the viability of the main questionnaire and among others estimate the pay range. The second one for general use. Care is taken to collect data to be used to populate the models commonly used in the selected technique. Care is also taken to ensure that the data collected is of high quality and relevance. The questionnaires were prepared using KoboCollect software, a free source web-based software. KoboCollect tool makes it easy to collect and store data in digital form. A bigger component of this survey was the collection of transport data such as travel fares, vehicle operating cost data, freight fares, number of routes made per vehicle, vehicle modes on the roads. And also, the parameters of the road for example, number of times the road is closed to traffic, accidents on road among others. The same questionnaire encompasses questions on house hold income, health, education, housing, agriculture, crime rate among others.

3.3.8.1.2 KoboCollect software and Kobo Toolbox

According to the works of Dizon 2022 and Nampa 2020 et al, KoboCollect, is an open-source web-based tool used to formulate and collect the survey data electronically through Kobo Toolbox (Nampa et al., 2020).

The Kobo Toolbox is an intuitive software used to collect, analyse, and manage data for surveys, monitoring, evaluation, and research. Kobo Toolbox is handy for mobile data collection through mobile devices such as mobile phones or tablets may be used in the field to collect data. paper or computers may also be used (Dizon et al., 2022). The software is also useful in importation of data into excel or SPSS software for analysis. KoboCollect is easy to manage and does not require any previous technical knowledge. The kobo toolbox free down load can be found on https://kf.kobotoolbox.org/. The data from kobo toolbox may be downloaded in XLS, CSV, ZIP and/or KML formats. Enumerators handling the use of KoboCollect can easily be trained. KoboCollect software is handy in rural areas since it works both online and offline.

Collecting data digitally has many advantages and benefits, among them high accuracy, better efficiency in data collection, easy storage and retrieval processes, more accurate data tracking and the ease of sharing information across multiple platforms. The major limitation for KoboCollect is the capping of data at 5GB, exceeding this limit will lead to your account -being frozen.

3.3.8.1.3 Enumerators

Enumerators are the primary agents of data collection from field for surveys, verification of the data, analyses and presentation of quantitative and qualitative data through this thesis. They play an important role in ensuring that data collected is as detailed and relevant as possible.

Enumerators should be trained for at least 2 days to acquire the needed skills in navigation for efficient travel, customer service for effective communication and interviewing, technology use for data collection and analysis and where possible a foreign language proficiency to communicate with diverse communities.

The enumerators are expected to polite, patient and respectful throughout the data collection exercise and they should pay attention to detail. In this survey, a total of 20 enumerators were selected and trained from the local communities served by the 10 selected roads. The 20 enumerators were well conversant with the language, community norms and the area under research. They were arranged in groups of two enumerators per road selected and 2 overall supervisors and the researcher also working as a supervisor making a total of 23 participants.

3.3.8.1.4 Advantages of primary data surveys

Primary data collection and use has many advantages, notably;

a) Because it comes from direct sources collected in real time, it is more accurate, has higher data quality and reliability compared to other types of data.
b) Due to its direct collection in real time, it is faster and easier to collect than secondary data, which may take more time.
c) Primary data is collected directly from the field in real time, which makes it very useful for monitoring processes and tracking events as they happen.
d) Primary data is more detailed and specific in nature, original and unique to the intended research

3.3.8.1.5 Limitations of primary data surveys

Although primary data has many advantages it is not devoid of limitations, the common limitations include:

a) It can be expensive to collect primary data given the enumerators and other personnel will have to be moved to the field for data collection raising logistical challenges
b) Because data is collected in real time in the field, this is time-consuming, and may take long time to complete. This is mainly so if it involves face-to-face contact with customers
c) When manual questionnaires are conducted, there is a risk of less data collected, low quality data due to data inputting issues, fatigue of the enumerators as well as the risk of data loss.

3.3.8.2 Secondary data from the web

Relevant secondary data is accessed from the internet, books, journals, and documentaries including data used for trends analysis, the population of the communities from the Uganda Bureau of Statistics (UBOS), the Kamuli District local Government (KDLG) reports, the Uganda road fund (URF) Databases, and reports, and the Uganda's Ministry of Works and Transport (MoW&T) reports.

References for secondary datasets are attached at the end of this thesis. It's however not possible to guarantee the accuracy of the data sets but all efforts should be made to use secure scholar and government-owned sites.

3.3.8.2.1 Advantages of secondary data surveys

a) Secondary data provides a time-efficient data collection process. It is quicker to collect secondary data than primary data thus allowing more time for analysis.
b) It is easy to obtain the source of information by saving the time and cost required for conducting the research yourself through leveraging on other researchers' data.
c) Secondary data collection is less costly to acquire but not accurate. It may be used to provide a place to start but not for accurate analysis.
d) Through use of existing data bases, more data that would otherwise not be possible for you to collect would be collected.
e) The main advantage of secondary research data is that it is more easily accessible and more cost-effective.
f) Secondary research is nonreactive thus, it doesn't include direct contact with respondents and thus will not alter or influence behaviours of the respondents

3.3.8.2.2 Limitations of secondary data surveys

While secondary research is vital for gaining insights, it presents some challenges, including information limitations such as outdated, unavailable, or unreliable data, subscription requirements for premium sources, and data discrepancies across sources. These limitations include:

a) The quality of the secondary data sources determines use of the data and its validity.
b) Sometimes, Information may not collaborate or fit the same frame or boundaries as the primary data collection.
c) The data may be limited in addressing issues, criteria or indicators. The data is also Less detailed and may lack specific information

3.3.8.3 PRA based surveys and Data Collection

Participatory Rural Appraisal (PRA) is a learning and assessment approach that emphasises empowering communities to take an active and central role in assessing their own living conditions, problems, development requirements, and potentials in order to change their situation, (Nampa et al., 2020) and

(Chambers, 1994). Given the nature of this research, it was established that "Participatory Rural Appraisal (PRA)" survey technique is appropriate since it encompass all relevant factors. PRA brings on board a number of different survey approaches, methods and behaviours that allow the participants to express and analyse the needs of their community and individual lives. It also enables them to plan for themselves actions to take and monitor and evaluate the results. In this way the beneficiary carries out the survey exercise in a way that suits their own needs.(Chambers, 1994). In this approach, the community were in charge of the survey and the author and team guided the survey. PRA techniques are not common in transport studies but whenever used in rural development, have posted successful results; examples include environmental and sustainability studies, and gender and health care studies among others. PRA methodology is very broad and covers many areas, (Ramesh, 2000.). For maximum utilization of this approach, the following methods were adopted for this study;

Community statistics: Requisite community level statistics were collected through discussion exercises and secondary information provided by the community leaders; the village local council 1 (LC1).

Secondary Information: secondary data was collected at village level, district level and other key organizations such as URF, UNRA, UBOS and Government Ministries. The data to be collected included; community level statistics and issues pertinent to their wellbeing, the population figures, the meteorology data, number of amenities in the community and demographic data among others.

Transect Walks: walks were taken around the survey community with key respondents to assess the condition of the rural road under investigation. This ground truthing provided a first-hand impression of the typical rural road, condition before maintenance and condition after maintenance. Visits to the community coupled with community meetings provided information on the much-needed changes.

Participatory Mapping: Simple village level maps were generated by groups drawn from the beneficiary communities. The maps indicated the sketches of the rural roads, the location of amenities such as schools, health centres, trading centre, religious centres among others. Black sports and problematic areas are also included in the sketch. During the sketching session, this period was used to also discuss problems associated with the road and or benefits accruing from the road maintenance sessions.

Historical Time Trend Analysis - this was very key to the research. It involved discussion with senior members of the community to ascertain changes accruing from maintenance of the road under investigation. The expected changes included; increase in number of permanent houses in the village, construction of amenities such as health centres and schools, construction of the road in question and its maintenance regimes. Changes in the modes of transport and the reasons and the introduction of new modes of transport were also discussed. During this session, based on willingness to pay (WTP), the group members were requested to indicate how much they would be willing to pay to maintain the road on their own should Government opt out of maintenance.

Vehicle Preference Matrix – This is key in establishing the type of vehicle compatible with the study area. In this matrix vehicle modes are matched against vehicle characteristics such as load capacity, speed, transmission (4WD/2WD), purchase price, cost and cost of maintenance and vehicle performance in the field. Vehicles were ranked against each vehicle characteristic in order to ascertain the choice of vehicle mode in rural areas.

Seasonal Diagramming – It's important to accelerating the times when the road is closed due to bad weather. Also, important to map out the demand for transport services based on seasons. This group exercise shows major calendar activities and the respective demand patens. Respondents are asked to draw lines marching the use of the vehicle in a month resulting into vehicle utilization matrix.

3.3.8.3.1 Advantages of Participatory Rural Appraisal (PRA)

Participatory rural appraisal is a community-centred approach, whose goals are to empower local citizens by engaging communities in the processes of problem identification, finding and implementing solutions, and monitoring evaluation. The main advantages of this process include:

a) Participatory Rural Appraisal (PRA) may assist in forming better linkages between communities and the institutions and agencies concerned with rural development. This can benefit communities served by rural roads.
b) Participatory Rural Appraisal (PRA) encourages self-reliant development by local people carrying the core responsibilities of managing and executing development activities. This in itself creates a sense of ownership and enthusiasm among the inhabitants and hence increasing the efficiency to achieve the objective of the project.

3.3.8.3.2 Limitations of Participatory Rural Appraisal (PRA)

PRA survey methodology has gained ground in recent times but like many communities' driven methods, it's not devoid of limitations. The common limitations of this methodology are;

a) PRA survey method still has challenges in data validity, the reliability of the participants responses, and comparability of data collected from different communities. It's also noted that in collection of data, the level, influence and social hierarchy as well as the presence of none residents are not considered. Biggs (1995)
b) There is need to train the survey assistants in data collection, convening focus groups, giving appropriate guidance to participants. success of the PRA technique largely depends in the efficiency of the survey assistants.

c) The process of discussions and participation in focus group discussions is usually bogged down with discussion bias. This bias may arise due to the levels of participants, and sometimes pre-conceived ideas of what the researcher is interested. It is usually very difficult to control the selection of participants as they are usually controlled by the village representatives and who naturally select their friends and relatives. This is made worse when attendance attracts some seating allowances.
d) Given that the survey techniques were participatory and unique by their nature, it is usually difficult to collect comparable and easily reproduced data

3.3.8.4 Stakeholder engagement

Stakeholder engagement and consultations are carried out as part of the data collection. Careful selection of stakeholders is very important as they form part of the critical respondents, their relationships should be carefully assessed so as not to compromise on the quality of the data collection (Kujala et al., 2022) and (Oliveira et al., 2023). in this research households form the basis of research and data will be collected from households. It should be understood that a village setting is commonly composed of house owners carrying out subsistence farming and sometimes owning small grocery shops, pubs, and Agri-processing plant. The respondents who doubled as stakeholders are engaged in a one-to-one structured interview. Similar interviews should also be administered to a control group to gauge a do-nothing impact assessment.

3.3.8.5 Sample size calculation

Sample size refers to the number of participants or observations adopted for the study. This number is dependent on the population understudy, the confidence interval sometimes referred to as the margin of error, the confidence level that refers to the percentage of probability, or certainty that the chosen confidence interval would contain the population parameter which are true when you draw a random sample multiple time.

The other critical measure in the determination of the sample size is the standard deviation. This measures the distribution of a given data set from its mean. In sample size calculations, the standard deviation is helpful in estimating the variation of the responses received from each other and from the mean number. It should also be noted that the standard deviation of a sample may be used to approximate the standard deviation of the whole population. Care should be taken to keep the standard deviation within acceptable limits. The higher the distribution or variability, the greater the standard deviation and the greater the magnitude of the deviation (Fox et al., 1987.). There is however need for members of the research team to engage in realistic and open discussion on the appropriateness of the sample size calculated for the research questionnaire, available data if any, research timeline, and cost. This thesis aims to find an appropriate technique to monetise social benefits accruing from rural roads.

The sample size represented as “n”, usually invokes two statistical parameters; the accuracy of the estimates and the power to draw conclusions, (Adhikari, 2021a). A good sample size should be big enough to reduce errors, it’s usually estimated at 10% of the study population but should not exceed 1000 people. Thus, the lager the study sample size, the smaller the margin of error. lists the common five steps in finding the sample size as;

a) Define population size or number of people in the area of research (If known),
b) determine the confidence interval or margin of error,
c) determine the confidence level and it into a Z-Score,
d) determine the standard deviation or expected variance, and
e) finalize your sample size using the common sample sizes formulae.

3.3.8.5.1 Population size or number of people in the area of research (If known)

A population is considered as the entire group under study while a sample is the specific target group that you want to collect data from. The size of the sample is always estimated at 10% of the population. The population may be known or unknown. In this thesis the population will be considered as unknown given the large numbers and size of the area coverage.

3.3.8.5.2 Confidence interval or margin of error.

A confidence interval is a range that is expected to contain the true value of what we are measuring in a population. In order to find out the precision of our estimate, we apply the margin of error. The margin of error is the degree of uncertainty that the survey results might be having. The larger the margin of error is, the more it is likely to be further away from the "true data or figures collected" for the entire population (Thangjai & Niwitpong, 2024). The general formulae for calculating confidence interval takes the general form as:

$$\textbf{CI = Point estimate} \pm \textbf{Margin of error}$$

$$\textit{Point estimate = Critical value (z)} \times \textit{Standard error of point estimate}$$

In order to calculate confidence interval, we need to calculate the point estimate from sample data. The critical value or z value which depends on the confidence level is derived from the standard normal curve. From the curve, z values are estimated. For this thesis the CI of the mean will be considered as:

i. CI = Sample mean ± z value × Standard error of mean (SEM)
ii. Sample mean ± z value × (Standard deviation/√n)

3.3.8.5.3 Estimation of the z values

An estimated z-value or score is the distance between a data point and the mean calculated using standard deviations, the mean and data of the point. z-values can be positive or negative. The positive sign indicates the observation is above the mean while the negative one indicates the observation is below the mean. z-value of zero equals the mean. The common formulae for finding the z-values is:

$$Z = \frac{\mathrm{X} - \mu}{\sigma} \quad \text{.....2}$$

Where: X = data point of interest, μ (mu) is the mean; and σ (sigma) is the standard deviation for the population from where the sample is drawn. The sample mean and standard deviation are used when the population values are not known. Using confidence levels of the mean, the z values can be estimated. It's noted that the margin of error depends on the size and variability of the sample. The larger the sample size the smaller the error. For this thesis, 95% confidence level was adopted and its corresponding z value at 1.96. The table 13 provides a list of the various confidence levels and their respective z values.

Table 13: Confidence intervals (CI) and corresponding z-values (Hazra, 2017)

Confidence level	Critical (z) value for confidence interval calculation
50%	0.67449
75%	1.15035
90%	1.64485
95%	1.95996
97%	2.17009
99%	2.57583
99.9%	3.29053

3.3.8.5.4 The standard deviation or expected variance.

The dispersion of statistical data is measured by the standard deviation by estimating the deviation of data points. Hence Standard deviation indicates the degree of dispersion relative to its mean. Standard deviation in statistical terms is the square root of its variance. Thus, this is calculated as in equations 5 and 6, derived from ((Hazra, 2017) equation. In general terms, the standard deviation (SD) refers to the population standard deviation (SD).

For Population

$$\sigma = \sqrt{\frac{\sum(X - \mu)^2}{N}} \quad \text{..3}$$

X - The Value in the data distribution
μ - The population Mean
N - Total Number of Observations

For sample calculation

$$s = \sqrt{\frac{\sum(X - \overline{x})^2}{n - 1}} \quad \text{..4}$$

X - The Value in the data distribution
$\overline{x}$ - The Sample Mean
n - Total Number of Observations

For this thesis where a community is involved and considered as large random sample, the sample standard deviation is used as affair estimate of the population standard deviation. Given that the standard deviation is unknown 0.5 is used for calculating sample size for a study as a conservative estimate for the proportion in a binary outcome scenario, the binary outcome considered as pass/fail scenario.(Adhikari, 2021) and (Xu et al., 2022). Adopting the use of 0.5 when the standard deviation is unknown helps to ensure that the sample size is large enough to provide reliable results, regardless of the actual population proportion. This conservative estimate ensures that the sample size is adequate to achieve the desired power of the test. It's also important to note that the value of 0.5 represents the maximum variability in a binary distribution. This also provides the highest variance that ensures that the calculated sample size will be sufficient to detect a significant difference regardless of the actual proportions.

3.3.8.5.5 sample size (n) calculation for unknown population (N)

The sample size (n) for unknown population (N) is calculated based on the common sample size equation 7.

$$Sample\ Size\ (n) = \frac{(Z - Score)^2 x\ StdDev\ x\ (1 - StdDev)}{(Confidence\ interval)\text{^}2} \quad \text{.....5}$$

The required parameters are;

- Population (N) - unknown
- The z-score (extracted from the tables)
- The Standard deviation (Use 0.5 if not sure)
- Confidence interval (Margin of error

3.3.8.6 High level / district level data

Monetisation data vary from country to country and from project to project. Collating quality data each valuation method equally varies. In the UK, Office for National Statistics (ONS) data, and the Greater Manchester Cost Benefit Analysis (GMCA) Unit Cost Database will be handy. In Uganda, National Bureau of Statistics (UBOS), Uganda Road Fund and Uganda National Roads Authority are appropriate for population and demography data and roads data. Table 14 indicates data sources adopted for this thesis.

Table 14: High level data sources

No.	Data requirements	Data Source
1.	Population	Uganda national bureau of Statistics (UBOS) Village local council
2.	Road network	URF, UNRA, District local Government
3.	No of amenities (Schools, Health Centres,)	Village local council District local Government
4.	No. of Shops	District Commercial office's office Uganda revenue Authority local office,
5.	Road maintenance funding data	URF, District local Government
6.	Dead weight	Local community through PRA Surveys
7.	Willingness to pay data	Local community through PRA Surveys and semi-structured questionnaire
8.	Environmental data	National Environmental Management Authority (NEMA)
9.	Health sector data	Ministry of health, Local health centres
10.	Education data	Ministry of Education, Local schools
11.	Employment data	Ministry of Labour, Gender and social development. Local recruitment agencies in the area and labour office at the district
12.	Housing census	UBOS, Ministry of Lands housing and urban planning.

Lack of quality data may lead to wrong results and conclusions. The researcher endeavoured to collect accurate, quality and dependable data.

3.3.9 Sample roads in the study area

A single road or a network of roads would suffice to be used as a case study, however, the more the number of roads the better the results. For this thesis, ten roads on the same network are required were considered. The selected roads should be at different levels of maintenance and should have received varying funding over the years. All the selected road sections will be surveyed and considered for full assessment.

3.3.10 Proposed Monetisation Methodology

Upon consideration of the case study area, collection of high-level data, agreeing on the road section to be investigated and upon collection of road-level and community level data, the proposed model is reviewed and modified. The proposed methodology was validated to match the required outcome. The key validation is the inclusion of the proxy values.

3.3.11 Data requirements

Data required include: road condition and structures data, social economic data, and proxy values data among others.

3.3.11.1 Road condition and structures data

Having selected the ten road sections to consider for this research. Data on road parameters such as road section with gravel eroded by rain, size and extent of silted drains, status of score checks as indicate in the figure 20.

No	Parameter checked	Quality				
		1	2	3	4	5
1.	Gravel loss	x				
2.	Sited drains		x			
3.	Culvert status				x	
4.	Bridge status			x		
5.						

Figure 20: Road condition and structures data collection tool

3.3.11.2 Social economic data

Social economic data collected from the district and the community should answer the research questions and provide for social benefits. Questionnaires in line with the social data required were prepared and approved through ethical review committee of the university of Birmingham.

3.3.11.3 Proxy values data

Proxy data or values are an alternative way of allocating value to an intangible good or service which may not easily be monetised. The researcher must be careful to select a proxy value from an institution or project or activity similar to the one under review or else you get wrong results. Fur this thesis, proxy values were collected from several institutions and or sites close to the case study are or those that are similar in nature. The requisite values adopted are indicated in table 15.

Table 15: proxy sources

No	Cost centre	Proxy source
1.	Labour costs	UBOS
2.	Treatment costs	Health centres in the area
3.	School attendance (Students and teachers)	Private schools in the area)
4.	Travel time	Transport companies in the area
5.	Environmental cost	National parks or game reserves
6.	Crime	Police or prisons

3.3.12 Data processing and Analysis

3.3.12.1 Data Processing

Data processing and modelling were aided by an excel spreadsheet developed based on both primary and secondary data sets. The spreadsheet utilizes inbuilt models such as Pearson correlation analysis, simple linear regression models and discounting methods commonly used in economics to calculate values based on social return on investment technique. Inputs from surveys as recorded in questionnaires are used to assign values to a social change. For those changes that cannot easily be assigned values, proxy values are derived from similar activities or changes in the environs. The growth rate used for discounting are adopted from national Bureau of Statistics. Road fund or boards and the local government provide high level details of the investment funds segregated per road section in the last 3 years under review.

The results of the models are analysed for the roads in the case study area with emphasis on those under full maintenance benefits and the control roads that have not been maintained at all (*Do something vs do nothing*).

3.3.12.2 Calculation of present value and SROI ratio

The model calculates the present value based on the impact value. The present value calculation is based on future present value after the years of consideration in which, change occurred. The research considers three years. The impact value is discounted using discount rates for the period of research derived from UBOS. Present value, the total present value and SROI ratios are calculated using equation 8 . SROI is a ratio.

, as shown in equation 7.

$$\boldsymbol{Impact\ Value} = \frac{\boldsymbol{Fin.v\ x\ (100 - Dw)\ x\ (100 - Disp) x\ (100 - Attr)}}{\boldsymbol{100\ x\ 100\ x\ 100}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{6}$$

- Fin.v = Financial value
- Dw = Deadweight
- Disp = Displacement
- Attr = Attribution

$$\boldsymbol{SROI\ Ratio} = \frac{\boldsymbol{Total\ Impact}}{\boldsymbol{Total\ investment}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathbf{7}$$

3.3.12.3 Results analysis

Results were analysed and presented in form of graphs, charts, and tables extracted from the excel spreadsheets and questionnaires for detailed discussion. The analysis was based on the excel in built processes such as correlation, regression and the researchers modified SROI.

3.3.12.3.1 Correlation coefficient (r)

Using excel software correlation coefficient (r) was calculated. Ordinarily, correlation coefficient sometimes called Pearson's correlation coefficient after its originator is a measure of linear association between two data sets. Correlation coefficient is measured on a scale that varies from + 1 through 0 to -1. Positive correlation denotes an increase in one variable corresponding to an increase in the other, while negative correlation relates to a situation where one variable increase while the corresponding one decreases. In calculating the correlation, scatter diagrams are used to check for a relationship between the two data sets. A line of best fit is constructed. The calculation of the correlation coefficient based on independent variable x and dependent variable y follow the formula below; (Stewart, Ken, 2023)

$$r = \frac{\Sigma(x-\bar{x})(y-\bar{y})}{\sqrt{[\Sigma(x-\bar{x})^2(y-\bar{y})^2]}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

Reduced to

$$r = \frac{\Sigma xy - \bar{n}\bar{x}\bar{y}}{(n-1)SD\,(x)SD(y)} \quad \text{.....9}$$

Where;

SD is standard deviation, x value of independent variable, y value of dependent variable, n number of observations.

This calculation can be all done in excel using in built statistical formulas in excel software denoted as CORREL (array1, array 2). The strength of the association, for absolute values of r, is graded arbitrarily as; however, the context of the results should be considered for these limits to hold.

3.3.12.3.2 Significance test (t-test)

To test the significance of the relationship between the data sets, a t-test is used following the equation11 (Stewart, Ken, 2023)

$$t = \sqrt[r]{\frac{n-2}{1-r^2}} \quad \text{.....10}$$

Where; r = the correlation coefficient (r), and

(n-2) = the degrees of freedom.

In case the scatter plot reveals some outliers, Spearman rank correlation methods may be employed to replace the observations by their ranks in the calculation of the correlation coefficient. Multiple regression involving more than one independent variable may be adopted where conditions dictate.

3.3.12.3.3 Regression analysis

Regression analysis was used to create a regression model that is used in predicting the dependent variables. Excel tools were adopted for this process. For this research a 95% confidence interval was adopted for analysis. The level of significance was also calculated to determine whether the relationship existed or not. P-value was calculated and considered for rejection or acceptance of a null hypothesis.

The hypothesis adopted include;

i. **Null hypothesis:** There is no linear relationship between input values provided for investment and the impact values accruing from the investments if P>0.005
ii. **Alternative hypothesis:** There is a linear relationship between input values provided for investment and the impact values accruing from the investments if P ≤ 0.005.

Simple Linear regression model calculations, a regression model equation of the type indicated in equation 14 is adopted for calculation of the impact value as dependent variable and input as independent variable;

$$\mathbf{Y = mx + b \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 11}$$

Where: *Y= predicted or dependent Y variable*

m = the slope

x = the independent x variable

C = the Y intercept

The significance of this research is checked based on the t-test that provide the p-value. The P-value determines the relationship between the two data sets and follows the hypothesis;

a) The null hypothesis; the intercept or slope is zero (Slope = 0)
b) The alternative hypothesis; the intercept or slope is not zero (Slope ≠0)

It is also important to note that, both values; the intercept or slope should be less than the allowable level of significance value; i.e. 0.05. The regression model calculates a number of residual outputs and plots, in particular Residuals and Standard Residuals. Residuals are the difference between the actual values and the predicted values calculated by the model. However, the standardized residual is the residual divided by its standard deviation. While residual plots are very useful when assessing homogeneity of variance. In the normal calculations, the standardized residuals which are >±3 are considered as outliers and are not worth of further investigations in the regression analysis. Probability output plots is useful in assessing normality of the dependent variable data.

3.3.13 Sensitivity analysis of the modelled results

Although an appropriate model is selected, like other models it's not devoid of imperfections and inaccuracies.

For good acceptable results, sensitivity analysis is carried out. This is done by varying the data collected from the field for the most compatible technique. The most fluctuating figures in the data collected are adjusted and the changes are noted for analysis. The results are refined as necessary as possible until acceptable results are attained.

3.3.14 Discussion of results, conclusions and recommendations

Results are discussed in line with the objectives of this PhD thesis. Both positive and negatives if any were discussed and conclusions and recommendations drawn in line with the discussions. gaps for future research were identified. A PhD thesis is compiled as required by the university following the university guidelines.

4 CHAPTER 4: SOCIAL BENEFITS ACRUING FROM RURAL ROADS

4.1 Introduction

Following rigorous literature review process on the prioritization of rural roads basing on total value of the roads part of which is the monetisation of social impacts accruing from those roads under maintenance, it was clear that in the last decade, possibilities of monetization of social benefits have extended noticeably. What once seemed unimaginable (Frumkin, 2003), on monetizing the value of social advocacy, orchestra performances and family unity today can be monetized with economic methods. for example, willingness to pay, required compensation, revealed preference techniques, travel cost method, or average household spending on certain kinds of goods (Nicholls et al. 2012). It is therefore increasingly necessary to think about normative limits: does monetization provide a valid measurement of the impact in question?

In this chapter, the Author undertakes to understand the drivers of change leading to social benefits. The accrued social benefits are quantified to provide a value for the road maintenance, the valuation process calculates the values proportional to the change caused by an investment, action or inaction to an activity or development.

4.2 Socio-economic Benefits

Socio-economic benefits vary from community to community and from project to project, in general terms they include improvements in overall well-being of the community, health, environment, education, agriculture, and economy among others. For these benefits to occur, there must be a driving force.

The common drivers of change are infrastructure, population growth, farming, extension of utilities such as water and electricity and amenities such as schools, markets and health centres. Through the theory of change concept, the benefits and or costs accruing from inputs such as funding, time, and materials can be tracked.

4.3 Differences between social benefits and economic benefits

There is a very thin line between social benefits and economic benefits. They are different in terms of causes, scopes, and impacts. However, they are interconnected in various ways and can influence each other. Social benefits reflect the broader positive impact on society from an input or economic activity while the negative impacts are referred to as social costs. Social benefits refer to the intangible benefits that cannot be measured by the economic models. They are usually considered as none market goods. Recent studies have used none economic models such as WTP, SROI, SCBA among others to measure social benefits. From rural road construction or maintenance, examples of social benefits include: improved social interactions, improved integration, changes in consumer behaviour of the served community, improved accessibility to amenities such as schools, health centres, recreation areas which has a ripple effect in improving school attendance for both the teachers and the learners for schools, improved maternal and or antenatal attendances for health centres.

Economic benefits refer to those benefits that can be valued and quantified in terms of money generated. Such benefits may include: income and revenues, improved prices of goods, changes in farm gate prices.

Economic benefits can be measured by economic models such as cost benefit analysis CBA. For example, arising from the construction of a new rural road or improved rural road, the economic benefits will include benefits such as time savings for the road users due to improved speeds, lower vehicle operating costs due to lower vehicle repairs, and lower accident costs as a result of fewer accidents, lower transport fairs, increase in transport modes, changes in the employment patterns among others. Table 16 is a tabulation of the difference between social changes and economic changes as derived from literature review;

Table 16: Differences between social change and economic change

No.	Parameter	Social change	Economic change
1.	Definition related	Social change, refers to the changes in the social structure, institutions, and culture of a society caused by different inputs	Economic change refers to the changes in the availability, distribution, and usage of goods and services in an economy
2.	Nature related	Social change is usually driven by factors such as cultural, technology and demography.	Economic change is driven by economically related factors such as changes in technology, market conditions, and government policies.
3.	Scope related	Social change, is concerned with the wider aspects of society such as education, healthcare, and political systems.	Economic change is commonly focused on the economic aspects of society such as employment, income, and wealth creation.
4.	Impact related	Social change, has a broader impacts social fabric of society broadly and affects issues such as human rights, social justice, and equality.	Economic change is established to has a direct impact on the economic well-being of individuals and communities.
5.	Interconnectedness	Economic change and social change are in some instances interdependent on each other and can influence one another other.	

4.3.1 Rural road related socio-economic changes

Socio-economic impacts are driven by change, and if we are to fully discuss social and economic impacts, it's important that we understand causes of these impacts. Social and economic changes accruing from rural roads fall in seven categories, namely; Social change, spatial change, economic change, environmental change, educational change, health related change and agricultural change.

4.3.2 Social impacts

The effect on communities and its people caused by an activity, program or project, action or inaction is referred to as social-economic impact. Unlike economic impacts, social impacts refer to those intangible impacts that are not monetised. Social impacts may be positive or negative usually referred to as benefits and costs respectively. Social impacts are key to our way of life and are becoming more and more important day by day. It is therefore very important to understudy their management, compliance, promotion and resistance (Arvidson, M., & Lyon, F. (2014) and the best technique to monetise them. In order to understand the social impact of rural road maintenance on the social set up of the community they serve and how it impacts different social groups at the community level, this research employed works of Khanani et al, 2019, Sabatin 2006, Sirgy et al., 2006. Blanc 2010, Sabatini and Salcedo 2007, and Khaef & Zebardast 2016.

In similar ways Bodo (2019), Woltjer (2014), Ruiz-Tagle (2013) and Allen (2003) echoed these changes caused by road infrastructure. However, these changes are intangible in nature and cannot be measured with the ordinary economic methods, there is need to find the best way to measure the intangible goods (Bassi, A. (2013), and Franz et al, (2013). These spatial changes, social changes and economic changes are usually outcomes observed in increase in residential development, change in land use and land cover for spatial impacts, while social changes are likely to emerge from social disintegration and integration. Economic changes are seen by changes from subsistence farming to Argo-based economic activities to those of higher productivity and infrastructures like roads, with the possibility of employment opportunities (Allen 2003; Woltjer 2014).

Although the changes impacted on the road user community are not entirely due to the influence of the road, the nature and quality of the road accounts for a substantial percentage of that change. Improved road surface attracts new modes plying the routes that are well maintained, new modes may include buses, private cars, vans, trucks, omni-buses, and freight transport and motorcycles. It's noted that a well-maintained road will encourage private car owners to use their vehicles due to low vehicle operation costs, and savings in travel time. However, buses are used as the primary vehicle for public transportation by many rural communities in sub-Saharan Africa plying fixed routes on a regular schedule, (Mattson, 2016).

The common changes accruing from the rural road are categorized in three categories: social impacts, spatial impact, and economic impacts (Khanani, et al, 2020). Building on Khanani's approach, a conceptual approach has been designed as indicated in figure 7. It should also be noted that, there is a thin line between economic and social impacts which makes it complicated to segregate. Through literature review, social changes have been identified, documented and tabled as table 17.

Table 17: Analysis of Social change

Sector	Description of social change(s)	Supporting literature
Spatial related social benefits	Change in access to facilities and services	(Lusher & Robins, 2010) (Ruiz-Tagle, 2013) (Allen et al., 2003; Sieber & Allen, 2016) (Woltjer, 2014)
	Change in arable land to build-up land	
Environment related social changes	Number of road closures	
	Changes in pollution levels	
	Reduction in noise pollution	
Social changes related to wellbeing of the community	Change in level of integration	
	Change in levels of residents' displacement/migration due to road condition	
	Change in level of Crime	
Health related social changes	Change in health levels	
	Change in the cost of drugs and availability	
	Reduction in road accidents reported to health facilities in the community	
	Changes in Maternal birth reported at the facility	
Agriculture related social changes	Changes in volume of agricultural products	
Education related social changes	Change in Education standards	
	Change in the cost of education for private primary day schools	

Social change in this thesis is defined in terms of changes in basic societal institutions, such as family, education, cultural and religion. The influence of rural road infrastructure on social changes relates to change in level of integration, interaction, residents' displacement and change in level of crime, accessibility to amenities, improved agriculture and improvement in social behaviour such as crime,

4.3.3 Social Integration

in this thesis, social integration refers to the extent to which an individual interacts with other members of the community, how he is connected and involved in various levels of their social interactions that encompasses; community, personal and social networks, and close family or friend's relationships.

4.3.4 Social displacement

refers to the detachment and loss of identity, home, or culture experienced by individuals and groups. It can occur among migrants, as well as in communities where people feel isolated or excluded. For rural road construction or maintenance displacement of homes and families causes social distress such as physical, emotional, and social instabilities, however some displacement may cause compensation that may lead to economic gains.

In conclusion, exploring the social factors that influence crime rates is essential for developing effective strategies to prevent and reduce criminal behaviour. Poverty, education, family structure, peer pressure, neighbourhood characteristics, media, and culture all play significant roles in shaping crime rates. By addressing these factors through targeted interventions, community engagement, and policy changes, we can create safer and more inclusive environments that promote lawfulness and well-being. Cohen and Felson (1979)

4.3.5 Change in level of Crime.

Crime rates are not solely determined by individual choices or actions but deeply intertwined with the social fabric of a community, Lloyd E. Ohlin, (1969) and Edwards, (2024). Common factors that affect crime rate and influence the likelihood of criminal behaviour include: economic conditions such as income, poverty level, and employment, cultural factors, inequality, recreational and religious characteristics, education, speed of industrialization, urbanization, and migration, and social support, Ahmadi, (2005) and (Flanagan, Auty, & Farrington, (2019). Social disorganization, family structure, peer pressure, neighbourhood characteristics, culture and media also play significant roles in shaping crime rates, TD Miethe, (1991)

The main focus of this thesis as far as crime rate is concerned is the role of neighbourhood characteristics. The neighbourhood characteristics, such as its infrastructure, socioeconomic status, and social cohesion, also impacts crime rates. Disadvantaged neighbourhoods with high levels of poverty, unemployment, and dilapidated infrastructure often experience higher crime rates. These areas may lack community resources, such as parks, community centres, and well-maintained public spaces, which can contribute to a sense of neglect and social disorganization. On the other hand, neighbourhoods characterized by strong social cohesion, community engagement, and proactive crime prevention strategies tend to have lower crime rates. Building safer neighbourhoods involves fostering community partnerships, enhancing access to resources, improving infrastructure, and implementing effective crime prevention measures.

By addressing these factors through targeted interventions such as road construction and maintenance, community engagement, and policy changes, we create safer and more inclusive environments that promote lawfulness and well-being thus reducing the crime rate. Cohen and Felson (1979).

4.3.6 Spatial change

It was established that spatial change may lead to social benefits and costs. The spatial parameters considered here include: Change in access to facilities and services and change in arable land to built-up land.

4.3.7 Environmental changes

Social benefits associated with environmental changes include: Number of road closures due to poor weather, Changes in pollution levels and Reduction in noise pollution.

4.3.8 Education related changes

Social benefits in line with education were established to be Change in Education standards which may directly be affected by school attendance by both the learners and the teachers. With a road with no closures due to weather, the learners and the teachers to access school all year around, this has a big contribution to the performance of the learners and the school. Being able to travel to schools more quickly and easily due to good road also contribute to the wider impacts of education such as having a better educated and employable population in the served communities.

4.3.9 Health-related change

Social benefits in line with health-related change include: change in health levels, change in the cost of drugs and availability, Reduction in road accidents reported to health facilities in the community, Changes in Maternal birth reported at the facility and environmental change,

4.3.10 Agricultural related

Agricultural related social benefits include: social changes associated in changes in agricultural products and or quantity. Increase productivity will definitely increase income that may lead to changes on the life style of farmers and their workers. Easy access to markets changes the operations of some people and eliminates middle men as the purchase is able to reach the farm with ease.

4.4 Conclusion

Socio-economic benefits accruing from maintenance of rural roads are similar to social benefits accruing from other infrastructure investments. Social benefits are intertwined with economic benefits and in some instances economic benefits may lead to social benefits. Economic change and social change are in some instances interdependent on each other and can influence one another other. For example, economic changes can lead to social changes, such as changes in the employment patterns, and social changes can have an impact on the economy, such as changes in consumer behaviour. Social benefits are considered as none market goods and may be monetised using none convention means such as SROI.

5 CHAPTER 5: COMPARATIVE STUDY OF THE MONETISATION TECHNIQUES

5.1 Introduction

In this chapter, an analysis and comparisons of the methodologies for monetizing social benefits are compared and analysed with the view of finding the most appropriate one for adoption in the calculation of social benefits accruing from rural road assets. The calculation of the monetized value is aimed at leveraging on the total valuation of the rural road that may be adopted in the prioritization of maintenance of rural roads by fund managers, road administrators and leaders at different levels.

5.2 Common parameters

Having established through literature review that there was a gap in monetization of social benefits accruing from rural roads, it was imperative that further review of the available literature is made to rank those methodologies that closely relate to monetisation of social benefits for purposes of benchmarking them for adoption. Through further literature review, common parameters were identified in most of the reviewed techniques. These parameters were vital for assessment of the viability of the methodologies. The identified parameters are; Cost efficiency, Data and data collection, Validity of results, Time efficiency, and Clarity in processes. These are subdivided into attributes as indicated in table 18. Details of this table are adopted from literature review chapter 2.

Table 18: Parameters for the monetisation techniques

Parameter	Attributes
Monetisation of social impacts - General	Monetisation component in the model
Monetisation of social Benefits for rural roads	Monetisation of social benefits from rural roads components
Cost efficiency	Cost of surveys Fixed costs Labour costs (Skilled and none skilled)
Data collection	Ease of data collection Availability of dependable data Resource and expertise requirements Flexibility to include new data Quality of data
Validity of results	Field data Modelling processes or calculations Interpolation - reproduced Validity of estimates Quality assurance
Time efficiency	Time for data collection Time for analysis Total study time and compilation of reports
Clarity in processes	Listing of benefits and costs Methodology Results and interpretation Variability Comparability Standardization

5.2.1 Monetisation of social impacts

This research is more skewed towards the monetisation of social impacts in general. Many techniques reviewed were found to comply with this parameter. The testing was a good indicator for the monetization of none market goods.

5.2.2 Monetisation of social Benefits for rural roads

This involves the analysis of techniques for monetisation of social benefits accruing from rural roads. All studies reviewed were checked for their compliance to this parameter. It was however noted that none of the reviewed techniques was responsive on this parameter and many members remained neutral on the voting using Linkert scale.

5.2.3 Cost efficiency

Through literature review, it was clear that the cost of implementing a methodology was key in its adoption. The cost drives include: the cost of road condition data collection through surveys or any other data collection tools, the fixed costs such as cost of field materials as well as hire costs of machinery and transport, and labour costs for both skilled and none skilled.

5.2.4 Data collection

Data related requirements assessing the ease of data collection during the data campaign process, the availability of dependable data for empirical data requirements. Flexibility of data manipulation to update data is important in assessing the responsiveness of the methodology, this helps in refining data and ensuring quality of data.

5.2.5 Validity of results

The accuracy and validity of the results expected to accrue from the collected data and eventual modelling are very important. Researchers are always more concern with the availability of dependable data for modelling.

5.2.6 Time efficiency

Methodology requires different time inputs; the time element is commonly important to the nature of data required and how long it takes to collect it. Time for analysis and compilation of reports are equally important. If there is a lot of delay, the research may not yield its intended purpose. There is need to conclude the research in reasonable time.

5.2.7 Clarity in processes

The involved processes should be clear and auditable throughout. The processes should be able to list the benefits and costs easily, the methodology of data collection, analysis and modelling, and result interpretation should also be clear. Variability of data should be minimal, and the results should be comparable. Standardisation is key for repeated procedures.

5.3 Review and analysis of responsiveness

As indicated in chapter two (literature review) and adopting the parameters in this chapter item 5.2, the responsiveness for all techniques reviewed were assessed and tabulated. With the help of 10 experts coordinated in a workshop and based on the 5-point Linkert scale scores the monetising methods were ranked as indicated in table 21. Common 5-point Linkert scale adopted is reproduced in table 19. The main question to be answered was “whether you agree or disagree if the method was responsive to the parameters in table 18”.

Table 19: Scoring based on Linkert scale

Statement	Scores
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

5.4 Ranking and selection based on Linkert scale

5.4.1 Validation and ranking of techniques

In order to choose and validate the most responsive or viable technique, a team of 10 (Ten) eminent professionals in the road sector was convened at the request of the researcher. The team comprised of professional road engineers in the private sector, the economist from national planning authority of Uganda, the technical team from Uganda road fund, technical team from Uganda National Roads Authority, the academia from Makerere University, technical staff from Kamuli District local government members of the roads committee from Kamuli district, colleagues from Uganda Association of Consulting Engineers (UACE).

The core activities of the team were to: review the literature on the advantages and disadvantages of the previously selected techniques, rank them based on Likert scale and select the most responsive technique. The team was also to discuss and advise on the possible modifications in the selected technique for effective use in the monetisation of social benefits.

5.4.2 Linkert scale assessment process

Through a Linkert scale process, responsiveness of the techniques to the selected parameters were assessed and rated based on the parameters indicated in table 18. A Likert scale is one of the rating scales used to measure people's behaviours, opinions, and or attitudes. Based on a question asked in line with the objectives of the thesis, respondents are requested to choose from five answer statements that best represents what they feel about the statements and the question. This method has two extremes and a neutral option and a number of intermediate options. There are many forms of Linkert scales but for this research a five-point scale was adopted. Linkert requires that a number of respondents give their opinions, thus for this thesis, a workshop was convened, and 10 (Ten) participants engaged to assess the most responsive methodology in line with the agreed parameters.

The adopted Linkert question was "whether to agree that a technique was responsive to the parameter or not or be neutral". The adopted typical 5-point Linkert scale is shown in table 19 and calculation and interpretation as indicated in table 20.

Table 20: Interpretation of Linkert scoring system

Statement	**Scores**	**Range (calculated)**	**Interpretation**
Strongly Disagree	1	1.00-1.80	Strongly non-responsive (SNR)
Disagree	2	1.81-2.60	None responsive (NR)
Neutral	3	2.61-3.40	Neutral (N_e)
Agree	4	3.41-4.20	Responsive
Strongly Agree	5	4.21-5.00	Strongly responsive (SR)

From the literature review assessments and Linkert scale process, the selected techniques and the common parameters adopted were discussed and assessed by 10 (ten) selected respondents. The Linkert question was based on “whether the technique considered the parameter as responsive or non-responsive”. The average mean results are indicated in table 21, figures 21 and figure 22.

Table 21: Likert scale score results,

	Parameters	**Consumer surveys**	**Social return on investment**	**Cost benefit analysis**	**Travel Cost Method**	**Social cost benefit analysis**	**Social accounting**	**HDM4**	**RED**
1	Monetisation of social impacts - General	3.95	4.1	2.2	3.7	2.9	3.25	2.3	2.4
2	Monetisation of social Benefits for rural roads	3.7	4.15	2.35	3.1	2.65	2.5	3.15	2.55
3	Cost efficiency	3.57	4.33	3.7	3.33	2.87	3.67	2.47	2.6
4	Data collection	3.4	4.34	2.94	3.78	3.74	3.28	2.4	3.1
5	Validity of results	3.58	4.28	4.1	3.8	3.68	3.18	3.62	3.08
6	Time efficiency	3.7	4.33	4.33	4	3.63	2.9	2.53	3.17
7	Clarity in processes	3.7	4.22	4.25	3.47	3.28	2.93	3.8	3.27
	Over all mean	**3.66**	**4.25**	**3.41**	**3.6**	**3.25**	**3.1**	**2.9**	**2.88**
	Interpretation	**Responsive**	**Responsive**	**Neutral**	**Responsive**	**Neutral**	**Neutral**	**Neural**	**Neutral**

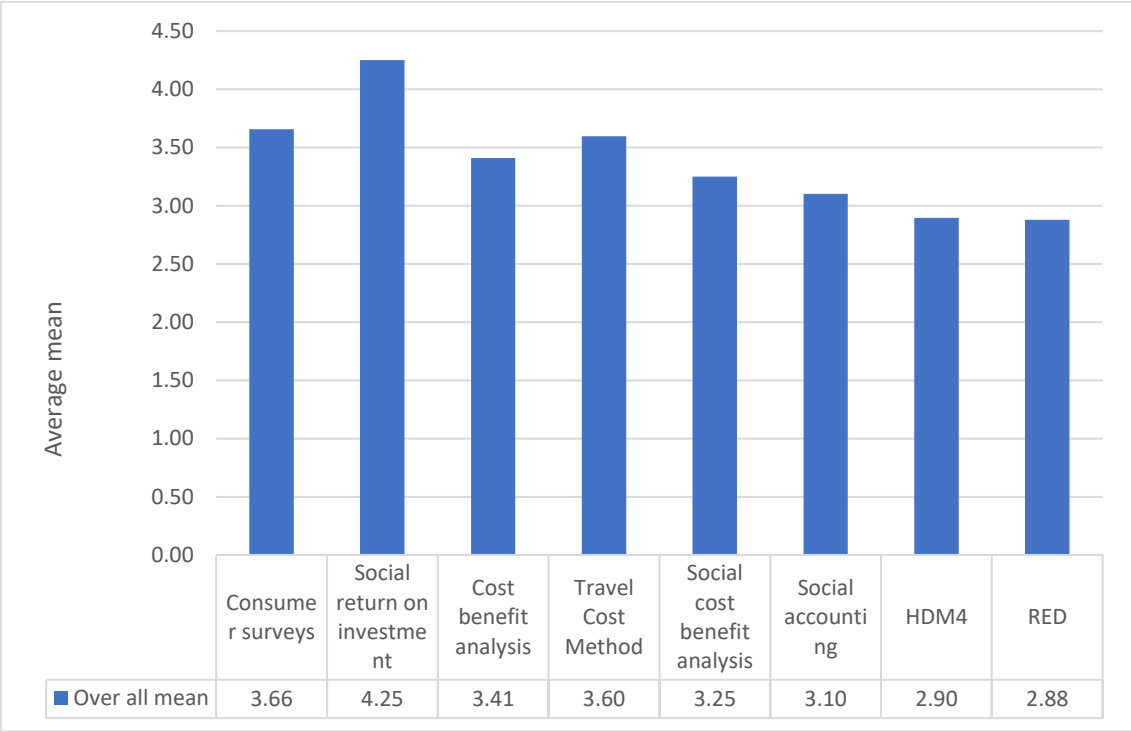

Figure 21: Average mean based on Linkert scale

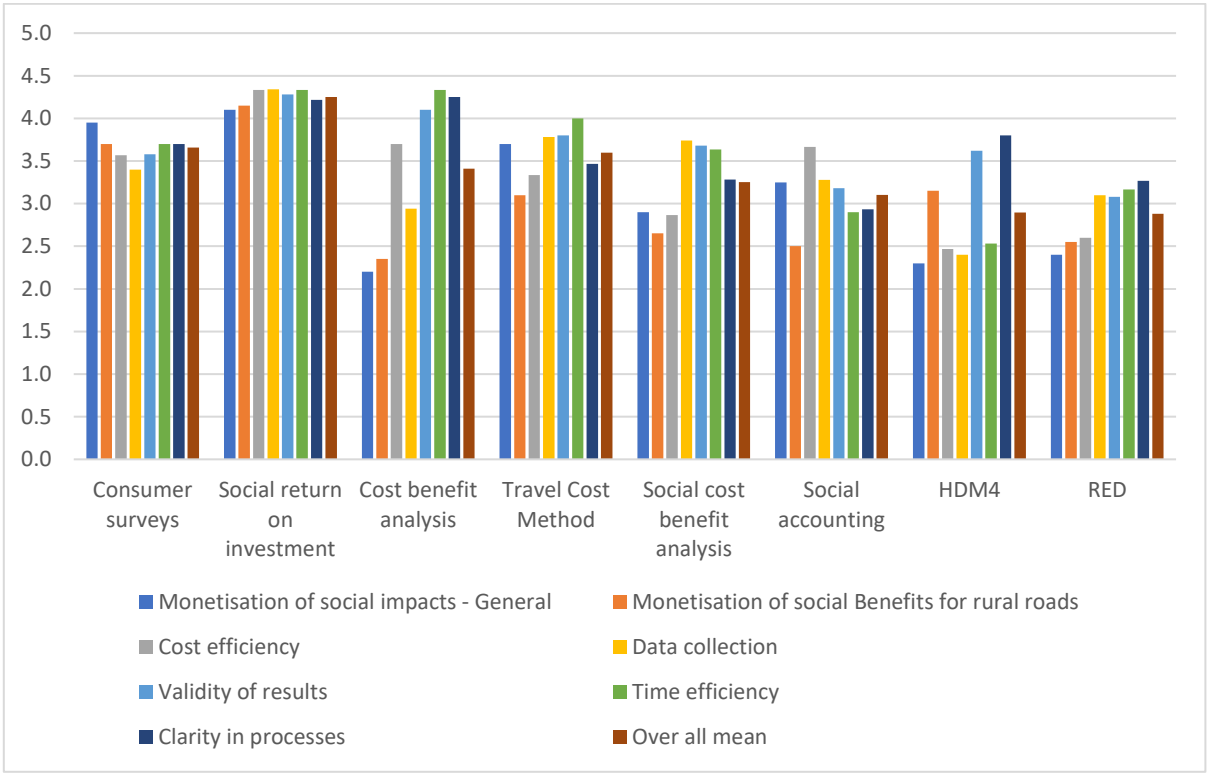

Figure 22: Technique response to parameters

5.5 Discussion

Based on the tabulation of the methodologies upon calculation using Linkert scale (table 21), and literature review on the selected methodologies reviled that; social return on investment, Consumer surveys, and Travel cost method were responsive to the set parameters in table 18, while all the other methods returned a neutral mark. It was also established that social return on investments (SROI) had the highest overall mean, posting strong responsiveness. Given this finding, the SROI was adopted as the basis for monetisation of social benefits accruing from rural roads. However, it's not devoid of limitations like other monetisation methods, modifications are required for its use.

5.6 Summary

Having established and reviewed the common methodologies of monetizing social benefits accruing from other sectors like health, education and environment. It was clear that none of the searched methodologies provide the requisite solutions for monetization of benefits accruing from rural roads. An analysis of advantages and disadvantages of selected common methodologies indicates crosscutting parameters such as; Variability, Comparability, Standardisation, Accuracy of results, and Availability of dependable data as some of the common parameters. There was need to find an accommodative methodology that will take into consideration impacts accruing from rural roads for which SROI was proposed as the most viable option for adoption.

6 CHAPTER 6: PROPOSED MONETISATION FRAMEWORK FOR RURAL ROADS

6.1 Introduction

Through literature review and analysis of the comparative study for the monetisation methods for valuation of social benefits accruing from maintenance of rural roads, social return on investments was identified as the most responsive technique that may be adopted. Social return on investment is measured as a ratio of the total present value of the net benefits to the total inputs. A measure of social impacts on the communities due to the improvement of road infrastructure is a measure of the changes caused by the improved road infrastructure. The changes identified by the community during a stakeholder meeting in Kamuli District are categorised as: social impacts, spatial impacts, mobility impacts, economic impacts, environmental impacts, the health impacts, agricultural impacts and educational impacts. This thesis is limited to only social benefits and does not include economic valuations, although it borrows some economic concepts for completeness of the thesis.

The proposed valuation model for rural roads encompasses the use of both Social Return on Investment (SROI) and Willingness to pay methods. The basic inputs relate to available economic models making use of net present values of the benefits. The base model in this project relate to social return on investment (SROI). SROI is an outcomes-based measurement tool that helps organisations to understand and quantify the social and environmental value they are creating. SROI is a ratio calculated by assigning monetary value to outcomes through survey process based on willingness to pay or proxy values from similar activities in the neighbourhood and then comparing them to total inputs (investments), the formula used is indicated in the equation 7 in chapter 3 (Methodology).

6.2 Key assumptions

The key assumption for the modelling process for this research is as indicated here below.

a) The increase in benefits follows a continuous linear progression until it reaches a maximum point
b) Linkert scale process is appropriate to rank the benefits for further analysis
c) The respondents to Linkert scale are well conversant with the requirements for Linkert scale and social benefits of the user communities
d) Respondents of Willingness to Pay are not biased
e) The village population is unknown and thus sample space calculated uses the unknown population method
f) The population of the houses in the area is derived from the housing census and can be derived from the Uganda bureau of statistics (UBOS)
g) The level of employment is derived from UBOS

h) The Survey assistants have all been well trained and appreciate the needs of the research

i) The survey respondents know and appreciate what they want and can comprehend the nature of social benefits to be able to attach a value

j) All assumptions for social return on investment, holds in this research

6.2.1 Data sources for Social Return on Investment (SROI)

Data sources for this thesis includes internet-based sources, reports, books and journals and data collected through semi-structured questionnaires and focus group discussions. The required data and data sources are tailored to cover SROI methodology requirements and among them the sources for proxy financial values, institutions such as health, education, and markets. National institutions such as NEMA, UNRA, URF, UBOS, and the Kamuli district local government were contacted for high level data. Table 22 summarises the data requirements and their sources.

Table 22: Summary of general data sources for SROI methodology

No.	Data requirements	Data Source
1.	Population	National statistics office, Village local council
2.	Road network	Road's authority of local Government engineer's office
3.	No of amenities (Schools, Health Centres,)	Village leaders local Government education office
4.	No. of Shops	Commercial office's office
5.	Road maintenance funding data	local Government
6.	Dead weight	Local community through PRA Surveys
7.	Willingness to pay data	Questionnaire
8.	Environmental data	National Environmental Management body
9.	Health sector data	Local health centres
10.	Education data	Local schools
11.	Employment data	Statistics bureau
12.	Housing census	Statistics bureau
13.	Village/ community development focus discussions	PRA data

6.2.2 Data collection

Data for SROI methodology is collected based on well-maintained rural roads over a period of 3 year on which social benefit can be collected over the same period by tracking social changes. Data collection is carried out based on selected survey processes to cover both quantitative and qualitative data. The PRA process and the semi-structured questionnaire process were used in data collection. Willingness to pay methodology is included in the questions to provide on spot values required for calculation of SROI. Values for outcomes that cannot be monetised based on the surveys are sourced from proxy sources elsewhere as indicated in table 10. Road physical infrastructure related data such as road condition data and road structures assessment data are collected based on standard forms used by many roads' institutions around the world.

6.2.3 Data processing, Modelling and analysis

Data processing and modelling are aided by an excel spreadsheet developed by the researcher based on literature review findings, SROI concepts and as a combination of many other methods of monetizing social benefits. The spreadsheet makes use of correlation, the significance test, regression, and discounting methods commonly used in economics.

Inputs from surveys are used to assign values and calculate SROI. Growth rate used for discounting the calculated impact may be adopted from the government department of statistics. Details for investment funds segregated per road section in the 3-year period under review may be provided by road administrations and local government. The resultant data is analysed for consistency among other parameters.

6.3 Monetization of Social Impacts

Social impacts accruing from rural roads may be monetized based on social return on investment (SROI) principals backed up by the theory of change process, willingness to pay (WTP) methodology and proxy values collected from similar projects or activities. The process of SROI includes the following steps;

a) Stage 1: Stakeholder mapping, and tracking changes
b) Stage 2: mapping; Inputs, outputs and outcomes
c) Stage 3: Evidence outcomes and give them a value
d) Stage 4: Consider the dead weight, attribution, drop off and establish Impact
e) Stage 5: Calculation of present value and SROI ratio
f) Stage 6: Sensitivity analysis
g) Stage 7: Reporting

The SROI process schematic flow diagram indicated in figure 23.

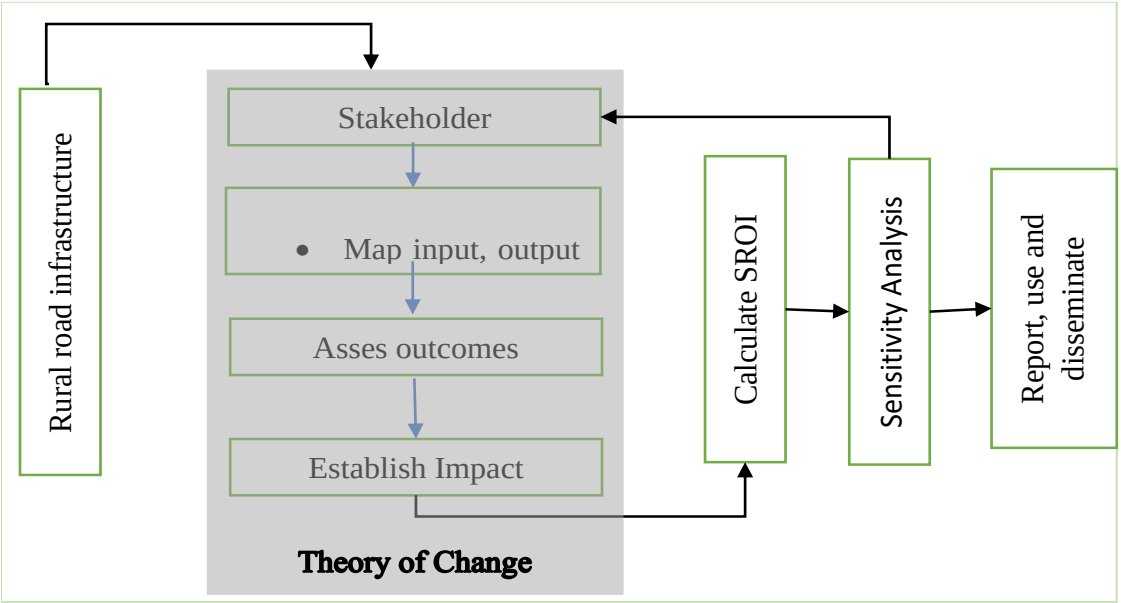

Figure 23: Conceptual approach, SROI process

6.3.1.1 Stage1: Stakeholder mapping, and tracking changes

Stakeholders are people affected by the project (who has an effect on the road maintenance and are affected by the road maintained). Stakeholders in this research are considered to be the beneficiaries of the road infrastructure sometimes called customers and those responsible for maintenance of the road. They include, the central government, the local; government and their respective departments, drivers, passengers, shop owners, farmers, school children and teachers, patients and staff of health centres and the entire community served by the road.

The total size of the group of beneficiaries is provided by the national statistics department and the sample size is calculated based on the formulas noted in the methodology chapter section 3.7.2.1. For this research, the entire population of the community served by the road is considered as beneficiaries. The number of the beneficiaries to be consulted will be considered after the survey but expected to meet the calculated sample size. Changes are tracked through a survey tool and confirmed by the stakeholder's meeting conducted at the locus. The stakeholders and the changes expected from the rehabilitation and or maintenance of rural roads stage 1 processes are summarized in table 23.

Table 23: Stakeholder mapping, and tracking changes

Stage 1: Stakeholder mapping, and tracking changes for rural roads maintenance		
Sector	**Stakeholders**	**Social changes**
Economic influenced social changes	Employers, Employees	Change in levels of Employment opportunities
	Property managers, property owners, landlords	Change in Land use values and property values (Rental & purchase)
	Business owners/ traders	Change in trading activities
Spatial related social benefits	Facility owners, utility managers	Change in access to facilities and services
	Farmers	Change in arable land to build-up land
Road infrastructure improvement	Vehicle owners, Passengers, transporters,	Changes in travel cost /fare/ freight cost
		Change in travel time
		Introduction of new modes of transport
	Vehicle owners, Passengers, transporters	Changes in traffic volumes
	Local government officials and URF supervisors	Improved road condition
	Government, road mangers, policy makers	Improved road condition
Environment related social changes	NEMA, Kamuli district environment office,	Number of road closures
		Changes in pollution levels
		Reduction in noise pollution
Social changes related to wellbeing of the community	Village members, households	Change in level of integration
		Change in levels of residents' displacement/migration due to road condition
		Change in level of Crime
Health related social changes	Village members, health workers	Change in health levels
	Drug shop owners, village members	Change in the cost of drugs and availability
	Health officers, Police traffic department	Reduction in road accidents reported to health facilities in the community

	Village members, midwives at health facilities	Changes in Maternal birth reported at the facility
Agriculture related social changes	Famers, village members, traders	Changes in volume of agricultural products
Education related social changes	School owners and head teachers, parents and learners	Change in Education standards
		Change in the cost of education for private primary day schools

6.3.2 Stage 2: The theory of Change process

Social benefits or Impacts associated with rural road are many, however for this research only the identified changes recorded and tracked are monetized to provide a value for the social benefits enjoyed by the community served by the road. The process of social change in terms of inputs, out puts, outcomes and impact is termed the theory of change.

6.3.2.1 The Inputs, outputs and outcomes (Theory of Change)

Monetization of social benefit is actually the measurement of change. The process of tracking of change is called the change theory (Campanion Guidance, 2017) , (Connell & Kubisch, n.d.-b). The changes accruing from the maintenance of selected rural roads as agreed upon in the stakeholders meeting. The changes are tracked by mapping inputs, outputs and outcomes. inputs in this research refers to what each stakeholder invests, or brings on board such as the funding, and time. While Output is the immediate direct or indirect tangible result of the actions taken or activity. Activities such as a well-maintained road a new road are considered outputs. For SROI process out puts are considered as summary of activities in numbers. Outcome refers to long-term changes resulting from the activities or the outputs. Examples include; increase in employment, reduced crime rate, improved environment and improved quality of life among others.

Stage 3: Evidence outcomes and financial value

For the researcher to accord a value to outcomes, it’s important that they are identified and evidenced.

The value of the outcomes can either be obtained via surveys based on willingness to pay or derived from proxies (Waikar et al., 2011.). The value of the outcome is used to calculate the quantity after the drop off is considered. The resultant quantity is used in the calculation of the impact value. Impact is the final part of the theory of change.

6.3.2.2 Stage 4: SROI Filters and establishment of the Impact

6.3.2.2.1 Filters

Impact value represents the future values in the economic terms. It is used to calculate the present value (PV) using the economic models of net present value after decomposition of the process over years using the dead weight, attribution, drop off mechanisms which are off are key factors to be considered. These issues are discussed and agreed on during focus group session with the affected community under PRA process. Using trends provided by the elders of the village, analysis and the decomposition of present value is calculated.

Deadweight: This input proposes the estimation of the value that would have been created had program intervention not taken place. The agreed percentage was discussed in the focus groups per village and calculated using Linkert scale based on the five responses of strongly agree, agree, neutral, disagree, strongly disagree.

Displacement: This provides an allowance of how much of the activity displaced other outcomes. It is understood that not all outcomes emanate from the road maintenance activities. As for the dead weight, the percentage was agreed upon by the stakeholder in the focus group discussion per village. Calculations were based on Linkert scale process.

Attribution: This refers to the fact that intervention might not be wholly responsible for all of the value created by the road maintenance activities.

Drop off: This considers the fact that there will be an annual reduction of the outcomes due to changing neighbourhood, cost of living, and other social changes. Through this drop off process, the impact value is decomposed over 3 years of consideration based on the estimated drop off percentage value. The three calendar years of decomposition are from 2019 to 2021. The decomposition of the impacts using the trade-offs is activity specific.

6.3.2.2.2 Calculation of the Impact value

The impact value is decomposed over years of consideration based on the estimated drop off percentage value. The formula for calculating the impact was indicated chapter 3 (Methodology) and reproduced here for information (refer to chapter 3, equation 6)

$$Impact\ Value = \frac{Fin.v\ x\ (100 - Dw)\ x\ (100 - Disp)x\ (100 - Attr)}{100\ x\ 100\ x\ 100}$$

6.3.3 Stage 5: Calculation of present value and SROI ratio

6.3.3.1 Present value calculations

Present value is calculated based on the impact value using the common relationship based on future present value after the years of consideration in which, change occurred. The research considers three years. It's should be noted that the impact value should be discounted using discount rates for the period of research as provided by UBOS in Uganda and national statistics in other countries. In this thesis the discount rate was adopted as 5% after the decomposition of the impact. The Present value, and the total present value are calculated as in equations 12, and 13 :

$$\boldsymbol{Present\ Value\ (PV)} = \frac{\boldsymbol{Impact\ Value}}{\boldsymbol{(1+r)^n}} \quad \boldsymbol{12}$$

$$\boldsymbol{Total\ Present\ Value\ (TPV)} = \sum_{\boldsymbol{n=1}}^{\boldsymbol{n=i}} \boldsymbol{PV} \quad \boldsymbol{13}$$

6.3.3.2 SROI Ratio calculations

SROI ratio as described in the previous chapters refers to the ratio of net present value of benefits to the total investment or inputs. The total inputs are the monetary inputs invested in the projects that are responsible for causing social change. The net present value of the benefits (NPV) is the difference between the total present value of all the benefits and the total in puts into the project, (NPV = total PV -total inputs). The Social return on Investments (SROI) is calculated using equation 7 in chapter 3.

6.3.4 Stage 6: Analysis of results and Sensitivity analysis

6.3.4.1 Analysis of results

The results are analysed using linear regression methods through which Pearson correlation coefficient, the coefficient of determination, standard error, Significance F, the null and alternative hypothesis discussed in chapter three were considered.

6.3.4.2 Sensitivity analysis

Subject to outcome, a sensitivity analysis may be carried out due to inconsistencies in the figures and the changes in discounting rates. The most fluctuating figures in the data collected are adjusted and the changes noted for analysis. From the model, total present values (TPV), Net present value (NPV) and SROI ratio are calculated. A negative ratio would mean that the investment was not viable while a positive ration would imply a viable investment. One to one (1:1) ratio indicates a state of no value addition by the inputs or investments.

6.3.5 Stage 7: Reporting

Reporting is by charts, graphs and other generated formats. It's important that the reports are as clear as possible.

6.4 Limitations

a) Not all benefits can be monetized, some outcomes are not easily associated with monetary value

b) Most of the social changes are intertwined with economic changes and sometimes one leads to another. This made it complex to disaggregate.
c) SROI can be time and resource intensive
d) May be difficult to find up to date cost estimates and proxy values
e) Just attaching financial values to the targets, you have achieved in not considered as SROI

7 CHAPTER 7: CASE STUDY – KAMULI DISTRICT (UGANDA)

7.1 Introduction

A case study approach is one of the most commonly used methodologies of research and particularly useful to employ when there is a need for an in-depth appreciation of an event, issue, or interest, in its natural real-life context,(Priya, 2014). The major role of a case study is in generating theoretical propositions with broader applicability and considerations of feasibility inters of positionality, resources, and skills, and interest. The activities to be undertaken in a case study research activity include: defining the case; selecting the case(s); collecting and analysing the data; interpreting data; and reporting the findings. For this thesis, Kamuli district was selected upon fulfilment of the parameters considered appropriate for a case study.

Table 24: case study details

No.	Parameter for case study suitability	Attributes to selection of case study
1.	Location	Actual location of the sites to be surveyed and analysed. Should be well suited to encompasses all the required details
2.	Accessibility and or Proximity from the location of the researcher	The site should be accessible easily and from the location of the researcher
3.	Population served (Millions)	Details on demography's or population are important
4.	Area covered (Thousands sq. km)	Area covered by the research project may be important
5.	Administrative institutions	Well-structured administration may be key to the research
6.	Availability of a good road network	Availability of a good road network is desirable
7.	Knowledge of the language used for communication	The researcher's knowledge of the local language is important on the collection of data and focus group meetings with the communities.
8.	Availability of data	Available data is important for trend analysis, or importation to support the collected data
9.	Cost of data collection	The cost of data collection is very key. Low-cost value data collection is desirable.

7.2 Kamuli district Case study area

Kamuli district is one of the local governments found in the Eastern part of Uganda, East Africa. It is located on GPS coordinates of 0°56'42.0"N, 33°07'30.0"E Latitude:0.9450; Longitude:33.1250 and is approximately 112.4 km via Kampala–Jinja Highway. Kamuli district is a decentralized local government with semi-autonomy mandate to offer services, Kamuli district was selected with prior knowledge of a similar project called AFCAP GEM project. Some of the required data was available for use in this research, the survey added the extra data required for a PhD thesis. In the similar way, ten rural roads and ten villages were selected for analysis. Figure 26 shows the location of Kamuli District in Uganda.

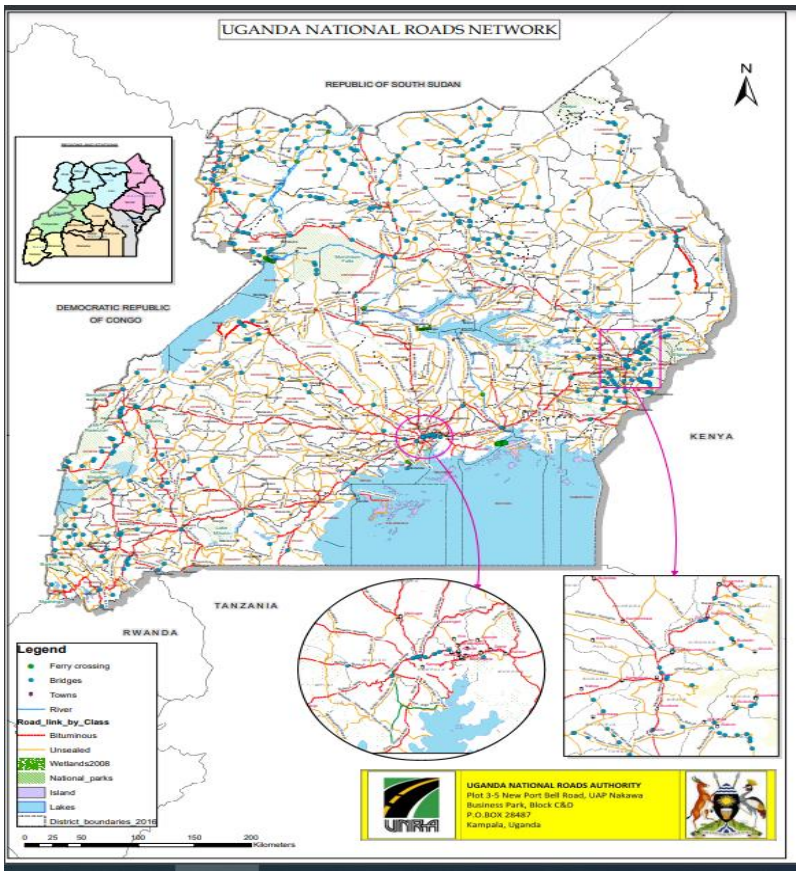

Figure 24 : Map of Uganda showing the road networks (UNRA, 2023)

7.3 Description of the study areas

Like any other Government entity, Kamuli District Local Government (KDLG) has different road types varying from access earth roads to paved loads. This research has adopted ten of the rural roads in Kamuli district under the management of the district administration and maintenance funded by Uganda road fund (URF) and managed by the District Engineers office, Kamuli district local government. Details such as GPS coordinates, population, distances from district centre, average travel time, and the number of days the roads are closed due to bad weather were reviewed. Details of the selected rural road sections are indicated here below;

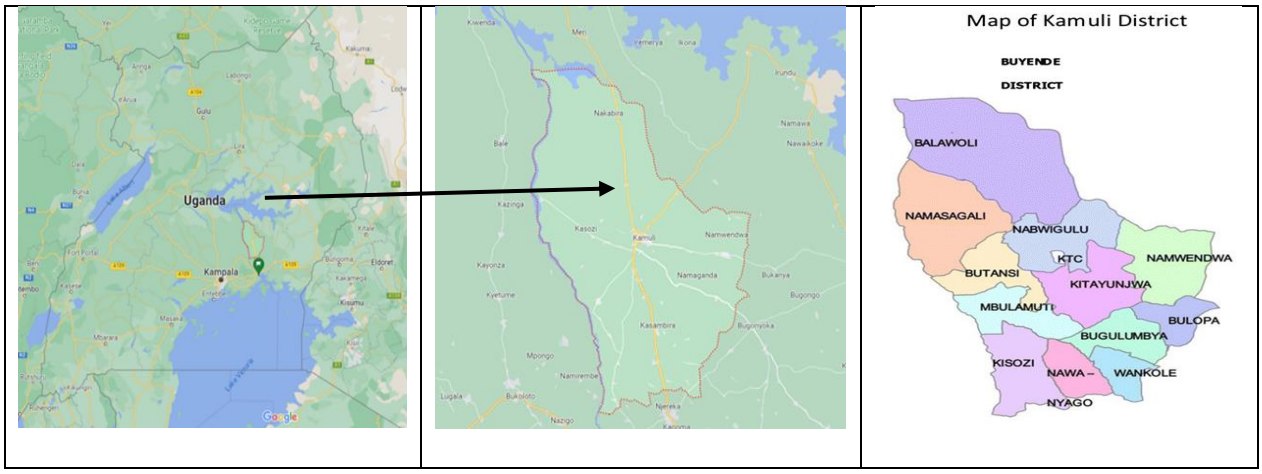

Figure 25: Maps of Kamuli showing roads (Google maps, August 2023)

Table 25: case study details

No.	Parameter for case study suitability	Attributes to selection of Kamuli district, Uganda
1.	Location	Kamuli is approximately 72 km, by road, north of Jinja, the largest city in the Busoga Sub-region, on an all-weather tarmac highway. The coordinates of Kamuli are 0°56'42.0"N, 33°07'30.0"E (Latitude:0.9450; Longitude:33.1250).
2.	Accessibility and or Proximity from the location of the researcher	The district is easily accessible from the capital city Kampala and the surroundings, takes only 2hours from Kampala via Kayunga and across river Nile.
3.	Population served (Millions)	National Housing census 2014 provides 486,319, people of which 236,389 are males and 249,930 are females.
4.	Area covered (Thousands sq. km)	1,557 km^2 (601 sq. mi)
5.	Administrative institutions	The district has total number of 81 parishes while the total number of villages are 773 of which 693 are for the rural and 80 zones for the urban.
6.	Availability of a good road network	The district has a number of rural roads and different levels of maintenance funded through the Uganda road fund • Total Rural Road length (km) – Network about 200k • Total Paved roads length (km) – Network about 68km
7.	Knowledge of the language used for communication	The researcher is well conversant with the language being a native (Lusoga) and the community understands English as the second language.
8.	Availability of data	There is enough data on the social economic status of the communities in Kamuli district. The most recent being the data collected by AFCAP GEM project 2018 in which the researcher was involved
9.	Cost of data collection	The cost of data collection is low due to locally available low cost (cheap) enumerators, transport, internet, accommodation. No need to hire interpreters.

Like any other Government entity, Kamuli District Local Government (KDLG) has different road types varying from access earth roads to paved loads. This research has adopted ten of the rural roads in Kamuli district under the management of the district administration. Maintenance is funded by Uganda road fund (URF) and managed by the District Engineers office, Kamuli district local government. In this research, 10 villages with corresponding 10 rural roads were considered as study areas. Details such as GPS coordinates, population, distances from district centre, average travel time, and the number of days the roads are closed due to bad weather were reviewed. Details of the selected rural road sections are indicated in table 27.

Table 26: Details of the selected rural road sections

No.	Name of trading centre/village	Name of the road serving the trading centre/village	approximate Population	Distance from nearest paved road	Distance from district centre. *Kamuli*	Average travel time to district centre - *Boda*
	Units	**Name**	**No.**	**Km**	**Km**	**Minutes**
1	Kiwungu	Bulunda-Kakindu	6147	6	9	20
2	Namaira	Balawoli-Namasagali	3855	14	14	25
3	Nabulezi	Balawoli-kymatende	7150	19	19	20
4	Kagumba	Nawantale-Kibuye	7718	27	27	32
5	Wandegeya	Kasambira-Bugulumbya	5660	5	17	10
6	Nawandyo	Kasambira-Wankole	7102	8	20	15
7	Namagandа	Naminage-Bulange	3761	17	19	20
8	Kiyunga	Namaganda-Bugondha	7103	11	24	18
9	Ndalike	Namwendwa-Ndalike	8813	24	24	30
10	Kyeya	Namwendwa-Kyeeya	6151	22	22	28

7.4 Data Bases / Data Sources for case study area

Varying sources of data have been accessed in this research. Both primary and secondary data sources have been accessed as indicated in table 27. Special data to be used as proxy values for Monetisation process have also been surveyed.

Table 27: Data sources for Case study

No.	Data requirements	Data Source
1.	Population	Uganda national bureau of Statistics (UBOS) Village local council
2.	Road network	URF, UNRA, District local Government
3.	No of amenities (Schools, Health Centres,)	Village local council District local Government
4.	No. of Shops	District Commercial office's office Uganda revenue Authority local office,
5.	Road maintenance funding data	URF, District local Government
6.	Dead weight	Local community through PRA Surveys
7.	Willingness to pay data	Local community through PRA Surveys and semi-structured questionnaire
8.	Environmental data	National Environmental Management Authority (NEMA)
9.	Health sector data	Ministry of health, Local health centres
10.	Education data	Ministry of Education, Local schools
11.	Employment data	Ministry of Labour, Gender and social development. Local recruitment agencies in the area
12.	Housing census	UBOS, Ministry of Lands housing and urban planning.

7.5 Methodology for Case Study

The methodology followed in this case study is the same as the one described in chapter three. However, it emphasizes the practical part of the methodology. This chapter seeks to demonstrate the use of social return on investment in the monetization of social benefits accruing from rural roads. A summary of the methodology includes;

a) Literature review on study area
b) Data collection based on semi-structured questionnaires, PRA techniques, and proxy surveys. Questionnaire based data collection was facilitated by KoboCollect online software (Ref: Chapter three)
c) Normalising of the data using straight line transformation process. (Ref to chapter six)
d) Data processing using excel data analysis tool. Carrying out linear regression analysis and plotting out the results for further analysis
e) Calculate SROI ratio for the sites based on social return on investment impact calculation method.
f) Carry out sensitivity analysis to ensure accuracy of the results.
g) Present the results using statistical plots, such as histograms, and pie charts

7.6 Data collection

Data collection based on semi-structured questionnaires, PRA techniques, proxy surveys, field notes, observations and secondary data based on internet and other sources were collected. Questionnaire based data collection was facilitated by KoboCollect toolbox online software as indicated in chapter three.

7.7 Stage 1: Stakeholder mapping, and tracking changes

7.7.1 Stakeholder mapping

Stakeholder mapping is a continuous visual process. It locates stakeholders to their influence and inputs. Stakeholders are those with an interest or a stake in the subject under research. Thus, Stakeholder maps for this research were for purposes of information gathering from focus groups. Table 29 indicates the sectors that have evident changes, the stakeholders involved, and the type of consultations. The overall size and the consulted number of beneficiaries were also noted for completeness.

Table 28: Stakeholder mapping for Bulunda-kakindu Road

Stage 1			
Sector	**Stakeholders**	**Intended/ unintended changes**	**Data collection method**
	Who do we have an effect on us and who do we have an effect on	**What do you think will change for them**	
Economic influenced social changes	Employers, Employees	Change in levels of Employment opportunities	Questionnaire, and focus group discussions
	Property managers, property owners, landlords	Change in Land use values and property values (Rental & purchase)	Questionnaire, and focus group discussions
	Business owners/ traders	Change in trading activities	Questionnaire, and focus group discussions
Spatial related social benefits	Facility owners, utility managers	Change in access to facilities and services	Questionnaire, and focus group discussions
	Farmers	Change in arable land to build-up land	Questionnaire, and focus group discussions
Road infrastructure improvement	Vehicle owners, Passengers, transporters,	Changes in travel cost /fare/ freight cost	Questionnaire, and focus group discussions
		Change in travel time	Questionnaire, and focus group discussions
		Introduction of new modes of transport	Questionnaire, and focus group discussions
	Vehicle owners, Passengers, transporters	Changes in traffic volumes	Questionnaire, and focus group discussions
	Local government officials and URF supervisors	Improved road condition	Questionnaire, and focus group discussions
	Government, road mangers, policy makers	Improved road condition	Questionnaire, and focus group discussions

Environment related social changes	NEMA, Kamuli district environment office,	Number of road closures	Questionnaire, and focus group discussions
		Changes in pollution levels	Questionnaire, and focus group discussions
		Reduction in noise pollution	Questionnaire, and focus group discussions
Social changes related to wellbeing of the community	Village members, households	Change in level of integration	Questionnaire, and focus group discussions
		Change in levels of residents' displacement/migration due to road condition	Questionnaire, and focus group discussions
		Change in level of Crime	Questionnaire, and focus group discussions
Health related social changes	Village members, health workers	Change in health levels	Questionnaire, and focus group discussions
	Drug shop owners, village members	Change in the cost of drugs and availability	Questionnaire, and focus group discussions
	Health officers, Police traffic department	Reduction in road accidents reported to health facilities in the community	Questionnaire, and focus group discussions
	Village members, midwives at health facilities	Changes in Maternal birth reported at the facility	Questionnaire, and focus group discussions
Agriculture related social changes	Famers, village members, traders	Changes in volume of agricultural products (Rice)	Questionnaire, and focus group discussions
	Famers, village members, traders	Changes in volume of agricultural products (Maize)	Questionnaire, and focus group discussions
Education related social changes	School owners and head teachers, parents and learners	Change in Education standards	Questionnaire, and focus group discussions
		Change in daily attendances for learners and teachers	Questionnaire, and focus group discussions

7.7.2 Size of beneficiaries

Based on survey methodology, the estimated sample space for data collection purposes was calculated using equation 1 in chapter 3 section 3.4.5.1 for unknown population and reproduced here for completeness.

$$Sample\ Size\ (n) = \frac{(Z - Score)^2 x\ StdDev\ x\ (1 - StdDev)}{(Confidence\ interval)\text{^}2}$$

The required parameters are;

- Population (N) – unknown or available data is not reliable
- The z-score (extracted from the tables)
- The Standard deviation (Use 0.5 if not sure)
- Confidence interval (Margin of error

From the case study, the following parameters are used to calculate the sample size (n)

Table 29:Calculation of expected sample space

No.	Parameter	Adopted value
1.	Sample space (n)	To be calculated
2.	Population (N)	Unknown or available data is not reliable
3.	Z-Score for confidence interval of 95%	1.96
4.	Standard Deviation (StdDev)	0.5 commonly used for unknown standard deviation – industrial practice
5.	Confidence interval (Margin of error)	±5%
Sample Size (n) =		$\frac{1.96^2 x\ 0.5x\ (1-0.5)}{(5\%)\text{^}2}$
Calculated		384.16
Approximately (persons) per road		**385 persons**

From the calculation, a total of 385 people was surveyed for this research. For a good balance, the 385 people included; men and women but excluded all those below 18 years of age.

7.7.3 Tracking social changes for case study communities

Kamuli district has seen many changes in recent years in particular communities served by rural access roads. In order to discuss social changes caused my maintaining the rural roads, it's important to consider trend analysis described in the methodology chapter 3 of this thesis. Old people in the selected villages were consulted for their opinion during the consultative meetings. From literature review, sectors considered in analysis for measurable changes include; Economic, Spatial / Road infrastructure, Environment, Social, health, agriculture, and education. Details are indicated in Table 31.

Table 30: social changes accruing from Road maintenance – Kamuli District, UGANDA

Sector	Intended/ unintended changes What do you think will change for them	Indicator How would you measure
Economic influenced social changes	Change in levels of Employment opportunities	increase in number of people in formal employment
	Change in Land use values and property values (Rental & purchase)	Changes in lettable space of I bedroomed house
	Change in trading activities	increase in number of sops
Spatial related social benefits	Change in access to facilities and services	Number of rentals occupied
	Change in arable land to build-up land	Available land for agriculture (Acres) for rent
Road infrastructure improvement	Changes in travel cost /fare/ freight cost	Difference in passenger numbers
	Change in travel time	Difference in trip numbers
	Introduction of new modes of transport	Number of new modes
	Changes in traffic volumes	Increased traffic volume
	Improved road condition	Number of assessment reports
	Improved road condition	Difference in km improved
Environment related social changes	Number of road closures	number of road closures in days per year
	Changes in pollution levels	concentration, measured in parts per billion, ppb, or parts per million, ppm
	Reduction in noise pollution	measured intensity in decibels (dB). on a scale from 0 to 130.
Social changes related to wellbeing of the community	Change in level of integration	Number of times a family interacts with another per month
	Change in levels of residents' displacement/migration due to road condition	Number of residents displaced from the village
	Change in level of Crime	Number of crime cases reported to Police
Health related social changes	Change in health levels	Record books at the health facilities
	Change in the cost of drugs and availability	Record books at the health facilities

	Reduction in road accidents reported to health facilities in the community	Record books at the health facilities
	Changes in Maternal birth reported at the facility	Record books at the health facilities
Agriculture related social changes	Changes in volume of agricultural products	Different in volume of produce in TONES
Education related social changes	Change in Education standards	Increase in number of childes passing in exams per year in the selected village
	Change in daily attendances for learners and teachers	change in enrolment of students

7.8 Stage 2: Mapping Inputs, outputs and outcomes (Theory of Change)

Mapping in puts, outputs and out comes were carried out in ten villages one on each road section. The mapping process was done based on the selected focus groups. Results of the inputs, outputs and outcomes per village are appended as appendix A summary of the details is indicated in table 14.

In this theory of change, we map the Inputs, outputs and outcomes. The inputs describe what the stakeholders invest in the project or program, in this case in the maintenance and or rehabilitation of rural road. The outputs are derived from the effects of the investment, in this case the well-maintained road is in itself an output and its long-term impacts are the outcomes. All though other stakeholders do not invest money directly as their inputs, they invest time which yields outputs and outcomes as indicated in table 32.

Table 31: The theory of change – Summary

Intended/ unintended changes	Inputs		outputs	Outcomes
	Description of Investment	**Value (UGX)**	**Summary of activity in numbers**	**Description of the change**
Change in levels of Employment opportunities	Time	0	Number of people in formal employment	Increase in number of employed persons in the village
Change in Land use values and property values (Rental & purchase)	Time	0	Improved number of rental properties	Increase in property lettable space
Change in trading activities	Time	0	Number of shops in the area	Increase in number of shops in the area
Change in access to facilities and services	Time	0	Improves accessibility	Increased occupancy rate
Change in arable land to build up land	Time	0	increase in Acres of land for agriculture	change in land use
Changes in travel cost /fare/ freight cost	Time	0	Reduction in travel cost	Increased number of passengers using common modes (Boda-boda, Taxis, Dump trucks)
Change in travel time	Time	0	Reduced travel time	Increased number of passengers and number of trips
Introduction of new modes of transport	Time	0	Increased number of new vehicle modes	improved passenger choices
Changes in traffic volumes	Time	0	Increased number of vehicles on road	Increased traffic on road
Improved road condition	Supervision time	14,400,000	Annual assessments made by supervisors	Well maintained road section

Improved road condition	Money, time	30,000,000	New improved road infrastructure	Number of Kms maintained in motorable condition per road section
Number of road closures	Time	**0**	reduced road closures	All weather roads working throughout the years without closures
Changes in pollution levels	Time	0	Reduction in pollution figures	reduction in pollution concentration
Reduction in noise pollution	Time	0	Reduction in noise figures	relative intensity of sound on a scale from 0 to 130
Change in level of integration	Time	0	increased level of integration	Number of interactions between village members
Change in levels of residents' displacement/migration due to road condition	Time	0	number of residents displaced /migrated	number of residents displaced/ migrated
Change in level of Crime	Time	0	Reduction in number of crimes reported at the police	Change in crime numbers
Change in health levels	Time	0	Reduced number of patients	Change in patient numbers per month
Change in the cost of drugs and availability	Time	0	Reduced referrals for patients	Change in patient numbers
Reduction in road accidents reported to health facilities in the community	Time	0	Reduction in accident patients	Change in accident patient numbers
Changes in Maternal birth reported at the facility	Time	0	Increased number of child birth	Change in patient numbers

Changes in volume of agricultural products (Rice)	Time	0	Increased production in tones	Improved wellbeing of the farmers
Changes in volume of agricultural products (Maize)	Time	0	Increased production in tones - maize	Improved wellbeing of the farmers
Change in Education standards	Time	0	Increase passing rate	well educated community
Change in the cost of education for private primary day schools	Time	0	Increased enrolment	well educated community
Total investment (Input)		**44,400,000**		

7.9 Stage 3: Evidence outcomes and financial value

For the researcher to accord a value to outcomes, it's important that they are identified and evidenced outcomes. The value of the outcomes is used to calculate the quantity after the drop off is considered. The resultant quantity is used in the calculation of the impact value. Impact is the final part of the theory of change.

Table 32: Evidence outcomes and financial value for Kamuli rural road

Source			**Quantity**	**Duration**	**Stage 3: Outcomes**	**Financial proxy**	**value**	**Value**
Source of information	**Before**	**After**	**how much change was there**	**Calenda r Years**	**Indicator**	**What proxy would you use to value the change**	**What is the value of the change from surveys/ Proxy**	**Financial Value**
questionnaires, one off interviews.	130	158	28.00	1	**How would you measure**	UBOS labour data	1,200,000	33,600,000
DCO	25	120	95.00	1	increase in number of people in formal employment	letting charges from DCO office	50,000	4,750,000
DCO	20	26	6.00	1	Changes in lettable space of I bedroomed house	letting charges from DCO office	50,000	300,000
questionnaires and interviews	25	60	35.00	1	increase in number of sops	questionnaire	50,000	1,750,000
questionnaires and interviews	8500	8540	40.00	1	Number of rentals occupied	questionnaire	100,000	4,000,000

questionnaires and interviews	254	282	28.00	1	Available land for agriculture (Acres) for rent	questionnaire	50,000	1,400,000
questionnaires and interviews	254	282	28.00	1	Difference in passenger numbers	questionnaire	50,000	1,400,000
questionnaires and interviews	2	5	3.00	1	Difference in trip numbers	questionnaire	50,000	150,000
Traffic count	45	70	25.00	1	Number of new modes	Traffic count	3,000	75,000
Local Authority	0	3	3.00	1	Increased traffic volume	Local Authority	1,000,000	3,000,000
Uganda road fund and District engineer/ District Budget	0	6	6.00	1	Number of assessment reports	URF- Cost per km for routine maintenance	653,595	3,921,569
Questionnaires/ interviews	0	0	0.00	1	Difference in km improved	value of work per day from District labour office	0	-
NEMA / District Environmental officer	220	120	100.00	1	number of road closures in days per year	NEMA / District Environmental officer	50,000	5,000,000

NEMA / District Environmental officer	90	40	50.00	1	concentration, measured in parts per billion, ppb, or parts per million, ppm	Measurement from NEMA / District Environmental officer	50,000	2,500,000
questionnaires and interviews	300	345	45.00	1	measured intensity in decibels (dB). on a scale from 0 to 130.	questionnaires and focus groups	50,000	2,250,000
LC1 Office records	20	5	15.00	1	Number of times a family interacts with another per month	LC1 Office records	50,000	750,000
Police records	210	251	29.00	1	Number of residents displaced from the village	Average resource reallocation to the justice system per young person being detained each year	50,000	1,450,000
Health centre records	350	310	48.00	1	Number of crime cases reported to Police	Cost of treating a patient of simple illness at heath centres	200,000	9,600,000

Health centre records	56	40	16.00	1	Record books at the health facilities	Cost of treating a patient of simple illness at heath centres	100,000	1,600,000
Health centre records	40	25	15.00	1	Record books at the health facilities	Cost of treating an accident patient at heath centres	0,03000	4,500,000
Health centre records	11	56	45.00	1	Record books at the health facilities	Cost of antenatal attendances	25,000	1,125,000
DAO	4900	5100	200.00	1	Record books at the health facilities	DAO/DCO	2,000,000	400,000,000
DAO	7200	7800	600.00	1	Different in volume of produce in TONES - rice	DAO/DCO	1,000,000	600,000,000
DEO	5200	6300	1,100.00	1	Different in volume of produce in TONES - maize	Records from selected Schools	100,000	110,000,000

Selected schools	750	1805	1,055.00	1	Increase in number of childes passing in exams per year in the selected village	Records from selected Schools	100,000	105,500,000
					change in enrolment of students			**1,298,621,569**

7.9.1 Financial value

Stake holders through discussions and questionnaires are asked to assign values they think the investment has added to their community/ village in line with the benefits accruing from the investment. In cases where it's not easy to directly assign a financial value, financial proxies were considered for adoption. A financial proxy provides an estimate of financial value for outcomes or benefits that have no direct market value (SROI Guide, 2020). In this research a number of financial proxies have been adopted as indicated in table 34.

Table 33: Financial proxies adopted

Indicator	**Financial proxy**	**Source**
How would you measure	***What proxy would you use to value the change***	***Where did you get the information from***
increase in number of people in formal employment	UBOS labour data	UBOS
number of road closures	value of work per day	Ministry of labour
Number of crime cases reported to Police	Average resource reallocation to the justice system per young person being detained each year	Police records at police head quarters
Record books at the health facilities	Cost of treating a patient of simple illness at heath centres	Health Centre records
Record books at the health facilities	Cost of treating a patient of simple illness at heath centres	Health Centre records
Record books at the health facilities	Cost of treating an accident patient at heath centres	Health Centre records
Record books at the health facilities	Cost of antenatal attendances	Health Centre records
Difference in passing rate	Schools / educational institutions	Schools / educational institutions
change in enrolment of students	Schools / educational institutions	Schools / educational institutions

The financial values as adopted from proxies, and surveying as aggregated are indicated in table 35.

Table 34: Financial values

No.	ROAD NAME	VILLAGE NAME	Total input (Ugx))	Financial value
1	Bulunda-kakindu	Kivungu	44,400,000	1,244,700,000
2	Balawoli-Namasagali	Namaira	84,400,000	1,341,367,000
3	Balawoli-Kymatende	Nabulenzi	109,400,000	1,442,506,000
4	Nawantale-Kibuye	Kagumba	149,400,000	1,567,114,000
5	Kasambira-Bugulumbya	Wandegeya	99,400,000	1,339,606,000
6	Kasambira-Wankole	Navandayo	54,400,000	1,549,336,000
7	Naminage-Bulange	Namaganda	99,400,000	1,400,200,000
8	Namaganda-Bugondha	Kiyunga	69,400,000	1,265,456,000
9	Namwndwa-Ndalike	Ndalike	134,400,000	1,898,486,000
10	Namwendwa-Ndalike	Kyeya	124,400,000	1,901,204,000

7.10 Stage 4: SROI Filters and establishment of the Impact

7.10.1 Filters for Impact calculation

Table 35: Trade-offs for calculation of Impact

Filters	Description	Average decomposition in percentage
Deadweight	Estimation of the value that would have been created had program intervention not taken place	37
Displacement:	How much of the activity displaced other outcomes	26
Attribution:	This refers to the fact that intervention might not be wholly responsible for all of the value created by the activity or service or it could be possible that respondents might credit other activities for the resulting outcomes	52
Drop off	This considers the fact that there will be an annual drop off of the outcome achieved or the impact of intervention would decrease every passing year	24

7.11 Stage 5: Calculation of present value and SROI ratio

7.11.1 Calculation (Monetisation) of Impact

The resultant impact value was calculated based on the equation 8 below. The results are indicated in table 29. The overall input specific to the maintenance of rural roads was Ugx 1,108,000,000 as recorded in Kamuli district engineer's annual report of 2019. This was a one-off funding in 2019. The formulae for impact calculation is derived from Chapter 3 methodology and reproduced her for completeness.

$$Impact\ Value = \frac{Fin.v\ x\ (100 - Dw)\ x\ (100 - Disp) x\ (100 - Attr)}{100\ x\ 100\ x\ 100}$$

- Fin.v = Financial value
- Dw = Deadweight
- Disp = Displacement
- Attr = Attribution

Table 36: Calculated impact value and SROI per village

Road name	Village name	Calculated impact value at baseline
Bulunda-kakindu	Kivungu	208,108,706
Balawoli-Namasagali	Namaira	227,741,571
Balawoli-Kymatende	Nabulenzi	243,208,992
Nawantale-Kibuye	Kagumba	261,704,534
Kasambira-Bugulumbya	Wandegeya	223,655,467
Kasambira-Wankole	Navandayo	259,272,935
Naminage-Bulange	Namaganda	236,601,369
Namaganda-Bugondha	Kiyunga	216,021,655
Namwndwa-Ndalike	Ndalike	317,165,510
Namwendwa-Ndalike	Kyeya	316,964,168

7.12 Present values (PVs) and Social Return on Investment (SROI) ratio

7.12.1 Calculation of present value and SROI ratio

Based on impact value, the present value is calculated based on the impact value using the common relationship based on future present value after the years of consideration in which, change occurred. The research considers three years. It's should be noted that the impact value should be discounted using discount rates for the period of research. Present value, the total present value and SROI ratios are calculated.

Present Value (PV) = $$\frac{Impact\ Value}{(1+r)^n}$$

Total Present Value (TPV) = $$\sum_{n=1}^{n=i} PV$$

7.12.2 Calculation of SROI ratio

In line with the equation 7 Social return on investment (SROI) ratio is calculated as a ratio of the net present value of benefits to the total investment. Social return on investment (SROI) for each of the ten road sections and benefiting communities is tabulated in table 17. It is noted that all roads yielded benefits and the SROI ratio was positive in all the ten cases. SROI as described in the previous chapters refers to the ratio of net present value of benefits to the total investment.

SROI = (Net present Value of benefits (NPV)) / (Total investments (Ti)

Table 37: Results of SROI for the selected villages

ROAD NAME	VILLAGE NAME	SROI RATIO
Bulunda-kakindu	Kivungu	8.32
Balawoli-Namasagali	Namaira	4.63
Balawoli-Kymatende	Nabulenzi	3.76
Nawantale-Kibuye	Kagumba	2.91
Kasambira-Bugulumbya	Wandegeya	10.18
Kasambira-Wankole	Navandayo	7.72
Naminage-Bulange	Namaganda	4.05
Namaganda-Bugondha	Kiyunga	5.36
Namwndwa-Ndalike	Ndalike	4.00
Namwendwa-Ndalike	Kyeya	4.32

7.13 Stage 6: Sensitivity analysis

The accuracy of the data and results were checked for any consistencies and or outliers. From the data collected, there was no need for sensitivity analysis since that was within range of the expected results.

7.14 Analysis of the results

The data was analysed for correlation using Pearson correlation coefficient based on excel spreadsheets, regression analysis based on analysis tools in excel and social return on investment methodology (SROI) also through excel spreadsheets. The SROI methodology was discussed in chapter six of this PhD thesis. Modelling of results using correlation and regression analysis

Upon collection of data and entry into excel. Using inbuilt data analysis tools, correlation and simple linear regression analysis were conducted. Correlation analysis, is primarily concerned with analysing the existence of a relationship between variables and determination of the magnitude and action of that relationship. However, Regression analysis may be used to draw a conclusion as to whether or not there are any true relationships between a dependent and independent variable(s). Significance is then used to determine whether the relationship exists or not. Simple regression analysis was considered due to the number of the dependable variable involved. Result tables are indicated here below.

7.14.1 Correlation

For this research, data collected from the case study was analysed for correlation to ascertain the relationship between dependent and independent parameters. This was meant to aid correlation coefficient calculations, regression analysis and eventual calculation for SROI as previously discussed in chapter three. The calculation for correlation coefficient was aided by statistical formulas in excel as discussed in chapter 3. The table 16 below derived from field data collected from Kamuli district local government was considered for calculation for correlation coefficient based on Pearson's correlation coefficient (r) calculation procedure

Table 38: Selected field data for Kamuli District

VILLAGE NAME	ROAD NAME	Road length (km)	Distance from nearest paved road (Km)	Distance from district Centre. Name of Centre: Kamuli (Km)	Maintenance funds allocated by the URF (UGX)	Population	Av. Travel time (Min)	Road condition
Kivungu	Bulunda-kakindu	6	6	9	44,400,000	6147	20	60
Namaira	Balawoli-Namasagali	14	14	14	84,400,000	3855	25	65
Nabulenzi	Balawoli-Kymatende	19	19	19	109,400,000	7150	20	70
Kagumba	Nawantale-Kibuye	27	27	27	149,400,000	7718	32	45
Wandegeya	Kasambira-Bugulumbya	5	5	17	99,400,000	5660	10	80
Navandayo	Kasambira-Wankole	8	8	20	54,400,000	7102	15	78
Namaganda	Naminage-Bulange	17	17	19	99,400,000	3761	20	65
Kiyunga	Namaganda-Bugondha	11	11	24	69,400,000	7103	18	67
Ndalike	Namwndwa-Ndalike	24	24	24	134,400,000	8813	30	68
Kyeya	Namwendwa-Ndalike	22	22	22	124,400,000	6151	28	69

7.14.2 Regression analysis

Using the excel tools, the impact values calculated based on the theory of change were considered as a dependent variable and entered as Y-variable. In this model the impact values are the values we want to predict. Input values were considered as independent variables and entered as X-Variable. Upon checking all relevant boxes, a regression model was run. Important to note the box for confidence level was not checked purposely to keep the default 95% set in the model. All residual boxes, line of best fit and normal probability plots was checked for presentation of the results.

Table 39: Regression analysis results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.653118018
R Square	0.426563146
Adjusted R Square	0.354883539
Standard Error	31144317.37
Observations	10

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	5.77225E+15	5.77225E+15	5.950969388	0.040598634
Residual	8	7.75975E+15	9.69969E+14		
Total	9	1.3532E+16			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	179411498.8	30971879.14	5.792722423	0.00040854	107990217.4	250832780.1	107990217.4	250832780.1
Total input (Ugx))	0.739246562	0.303036859	2.439460881	0.040598634	0.040442313	1.438050811	0.040442313	1.438050811

RESIDUAL OUTPUT

Observation	*Predicted Impact Value at baseline*	*Residuals*	*Standard Residuals*
1	212234046.1	-4125339.866	-0.140493806
2	241803908.6	-14062337.85	-0.478911177
3	260285072.7	-17076080.4	-0.581548093
4	289854935.1	-28150401.13	-0.958698466
5	252892607	-29237139.78	-0.995708762
6	219626511.7	39646423.01	1.35021042
7	252892607	-16291238.28	-0.554819275
8	230715210.2	-14693555.42	-0.500408111
9	278766236.7	38399273.05	1.307737109
10	271373771.1	45590396.67	1.552640162

PROBABILITY OUTPUT

Percentile	*Impact Value at baseline*
5	208108706.3
15	216021654.8
25	223655467.3
35	227741570.8
45	236601368.8
55	243208992.3
65	259272934.8
75	261704534
85	316964167.8
95	317165509.8

7.14.2.1 Discussion of regression analysis results

The model returned Multiple R – Pearson correlation coefficient value 0.653118018 which denoted a very strong correlation between the input (investment) and the resultant impacts created by the same. Also, the R square and adjusted R square were also calculated by the model. R square is sometimes called the coefficient of determination, it accounts for how much the variance of the dependent variable can be accounted for by the independent variable. The mode calculated a value of 0.426563146, in percentages, this value is 42.7% indicating that 42.7% of the variance in the impacts created can be accounted for by the input (investment) in the road maintenance activities and balance accounts for other inputs in the study area.

A standard error on the total input was calculated as 0.303036859 and a regression standard error of 31144317.37. This error is in the same units as the dependent variable (Total input value). The standard error of the regression is considered as the average distance of the observed values from the regression line. Therefore, the smaller the standard error, the more precise the linear regression model. With a small error margin, the calculated regression model is precise for this calculation.

7.14.2.2 Significance F.

In the regression model, significance is used to determine whether the relationship exists or not. It is considered as p-value of the model. It is also noted that If the P value for the overall F-test is less than proposed significance level, then it should be concluded that the R-squared value is significantly different from zero. To check for the significance of the data, P-value is considered for rejection or acceptance of a null hypothesis. This is because the p-value tests the null hypothesis whose coefficient tends to zero, thus the lower values of P, lower that the significance level adopted at (<0.05), the null hypothesis may be rejected otherwise null hypothesis will hold. And if this is also true for P-value less than 0.05 then the line of best fit, fits the data well.

7.14.2.3 Hypothesis

Two hypotheses, the null and alternative discussed in chapter three were considered for this thesis.

20. **Null hypothesis:** There is no linear relationship between input values provided for investment and the impact values accruing from the investments if P>0.05
21. **Alternative hypothesis:** There is a linear relationship between input values provided for investment and the impact values accruing from the investments if P ≤ 0.05.

From the results of the model indicated in table 3, the p-value is 0.040598634 which is below the 5% significance level allowable for this research project, fulfilling the P<0.05 requirement. This is enough evidence to reject the null hypothesis and hold the alternative hypothesis that indicates the existence of a linear relationship between input values provided for investment and the impact values accruing from the investments. This also signifies a strong relationship between input values provided for investment and the impact values accruing from the investments.

7.14.2.4 Simple Linear regression model

The model returns an intercept and a slope which are used to produce the regression model equation. The model equation as indicated in chapter three is of the type;

Y = mx +b

Where: *Y= predicted or dependent Y variable*

m = the slope

x = the independent x variable

C = the Y intercept

From the Kamuli district case study, the regression model equation accruing from the data as compared to the one discussed in chapter three is represented as;

y = 0.7392x + 179411498.8

Where: *the slope is 0.739246562*

The Y-intercept is 179411498.8

With this equation, if we know the investment or input value, we can predict the impact expected and thus can calculate the return on investment.

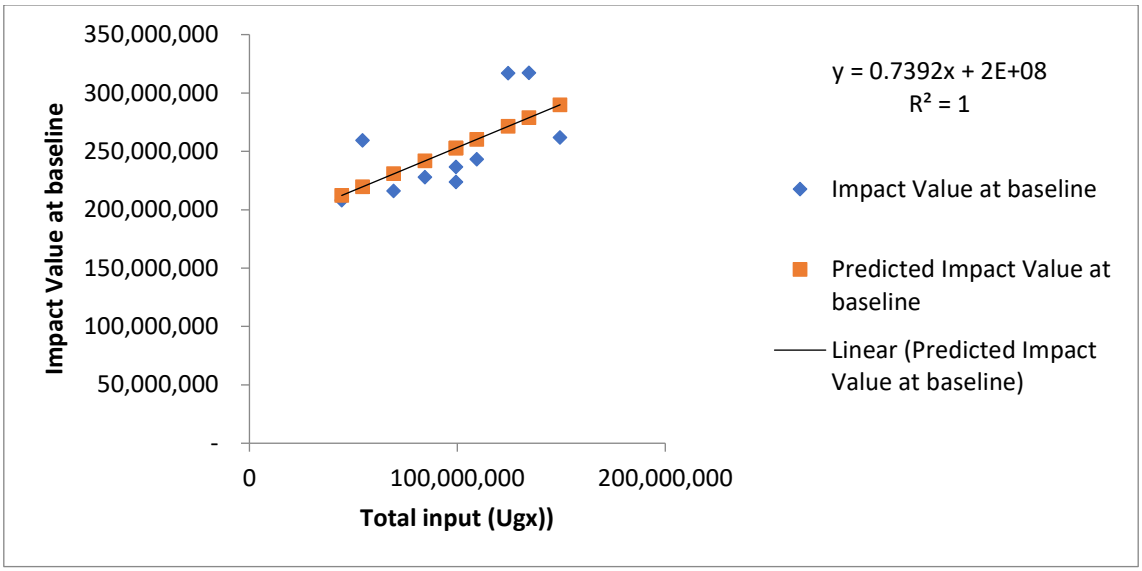

Figure 26: Total input vs Impact value

7.14.2.5 Interpretation of the P-Value;

In the model we have the t-statistics whose importance is to calculate the P-value. As explained before, P-value determines the relationship between the two data sets, for proper interpretation there is need to test for the respective hypothesis.

22. The null hypothesis; the intercept or slope is zero (Slope = 0)
23. The alternative hypothesis; the intercept or slope is not zero (Slope ≠0)

From the results of the model, both the intercept and slope are not zero (the slope is 1.54 and the intercept is 118578421, both failing the null hypothesis and holding the alternative hypothesis that requires the intercept or slope is not to be zero (Slope ≠0). This therefore, this means the investments is a significant variable that affects the social impact value.

7.14.2.6 Residual output

The model calculates a number of residual outputs and plots, in particular Residuals and Standard Residuals. Residuals are the difference between the actual values and the predicted values calculated by the model. However, the standardized residual is the residual divided by its standard deviation. While residual plots are very useful when assessing homogeneity of variance. In the normal calculations, the standardized residuals which are >±3 are considered as outliers and are not worth of further investigations in the regression analysis. Kamuli case study model analysis is well within the recommended range of >±3, thus no outliers recorded. 1.35021042 was the highest standardized residuals which is below the recommended range of >±3.

Table 40: standardised residuals

Observation	Predicted Impact Value at baseline	Residuals	Standard Residuals
1	**212234046.1**	-4125339.866	-0.140493806
2	**241803908.6**	-14062337.85	-0.478911177
3	**260285072.7**	-17076080.4	-0.581548093
4	**289854935.1**	-28150401.13	-0.958698466
5	**252892607**	-29237139.78	-0.995708762
6	**219626511.7**	39646423.01	**1.35021042**
7	**252892607**	-16291238.28	-0.554819275
8	**230715210.2**	-14693555.42	-0.500408111
9	**278766236.7**	38399273.05	1.307737109
10	**271373771.1**	45590396.67	1.552640162

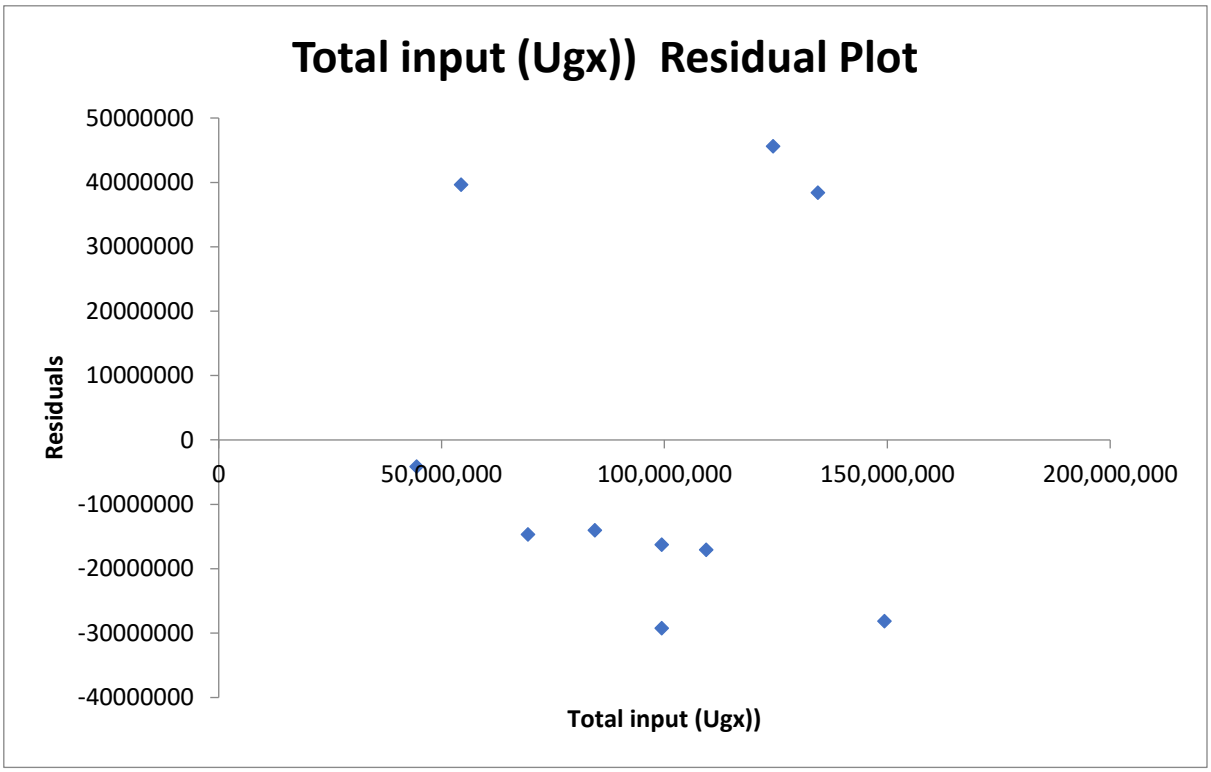

Figure 27: Total input vs Residuals

The probability output plot is useful in assessing normality of the dependent variable data.

The figure 28 was derived from the regression model.

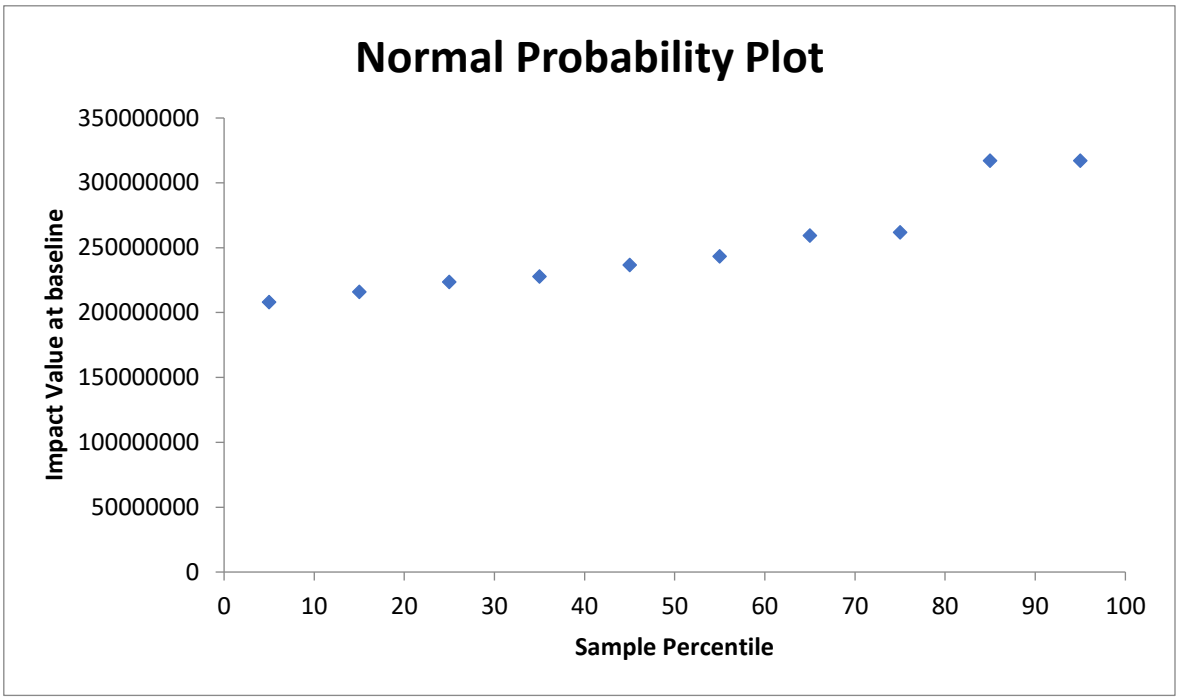

Figure 28: Normal probability vs net present value

7.15 Stage 7: Key findings, discussion and Reporting

Upon completion of the analysis of the results, the results were plotted using excel inbuilt tools and key findings compiled, plotted and discussed;

7.15.1 Comparisons of SROI ratio per village/ Road

Based on the SROI calculations for the ten villages, it was established that not all villages accrued the same impact value from the same funding per kilometre. There was a correlation between the quality of the road and the accrued impact value.

From figure 29, it is noted that Wandegeya village accessed by the fairest of the roads and with the shortest distance from the paved road and from the nearest trading centre accrued more impact value than other village areas and in particular Kagumba village whose road condition was very poor and is the furthest from the both the paved and the nearest trading centre of the roads under the study. Wandegeya village is 5km from the paved roads and 17km from the nearest trading centre whereas Kagumba village is 27km from paved

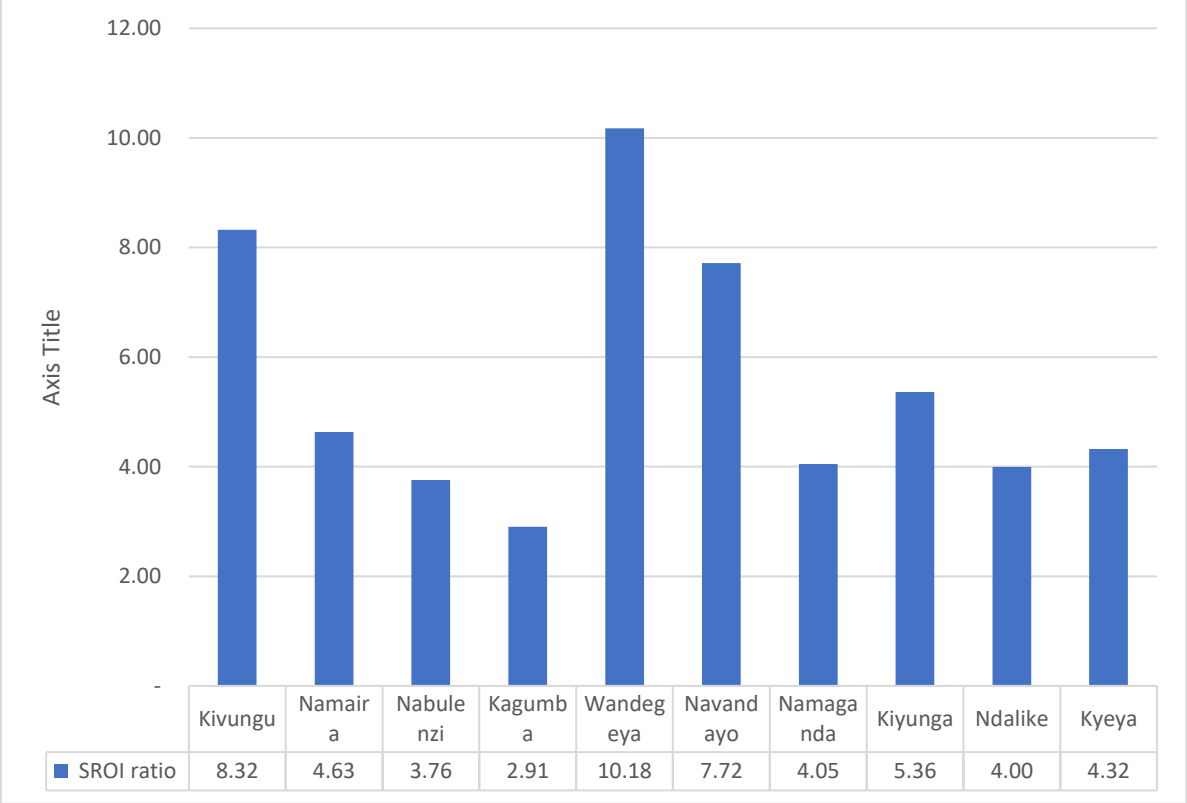

Figure 29: Results of SROI per village

7.15.2 Total input Vs Impact value

Total input and Impact value with a correlation coefficient of 0.653118018 denotes a fairly strong relationship between the two data sets, total input and Impact value. The plot for the two data sets is indicated in figure 30. The higher the input the more the impact not withstanding other inputs in the wellbeing of the community rather than rural road maintenance only.

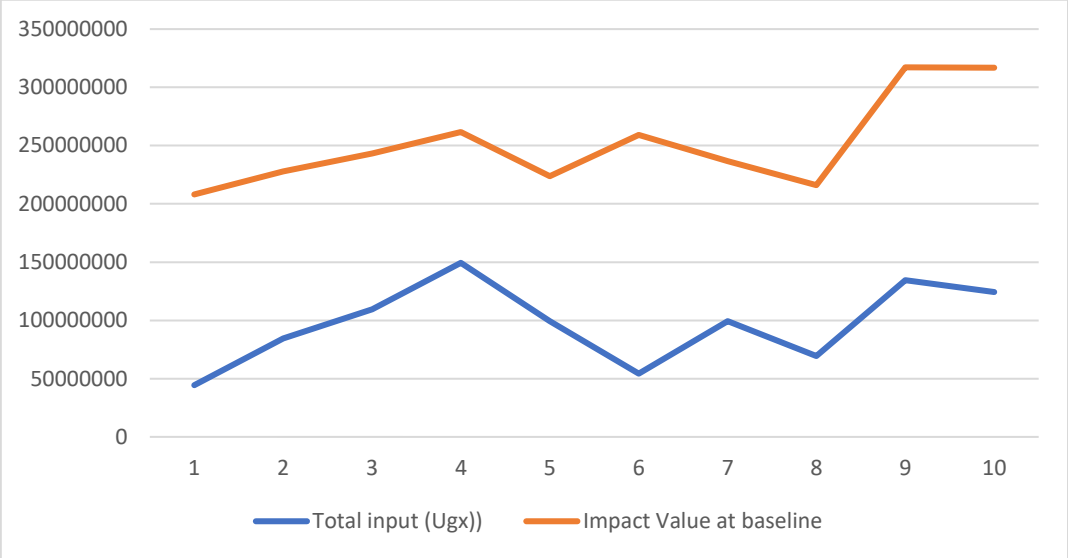

Figure 30: correlation between Total input and Impact value

7.15.3 Population vs road condition

Through surveys, it was established that there is no direct relationship between population of the village and the condition of the road accessing it. Changes in population are usually very small to be easily detected and the villages with high population doesn't necessarily have a better road. The figure 31 indicates the findings.

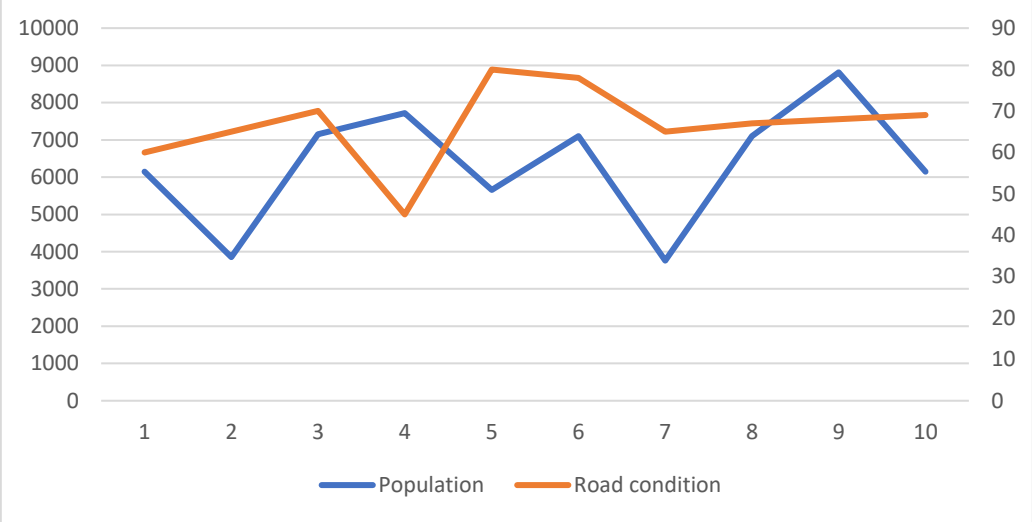

Figure 31: village population Vs road condition

7.15.4 Road condition Vs Impact value

Through an agreed grading system of five elements (very poor, poor, fair, good, very good) the condition of the selected roads was assessed and accorded a grading by the researcher appropriately. The grading system used is indicated table 42.

Table 41: Grading system for road quality (Own construction from literature)

Range	Grade
0-20	very poor
20-40	poor
40-60	fair
60-80	good
80-100	very good

Comparisons of the road condition with the impact value revealed a direct correlation. It is understood that change in the condition of the road is directly proportional to change in the impact value over a period of time. As discussed before impacts take long to be noticed but for this case over a period of 3 years, the impact in all the 10 roads is noticeable. The graph in figure 34 indicated the comparison between road condition and the impact value created.

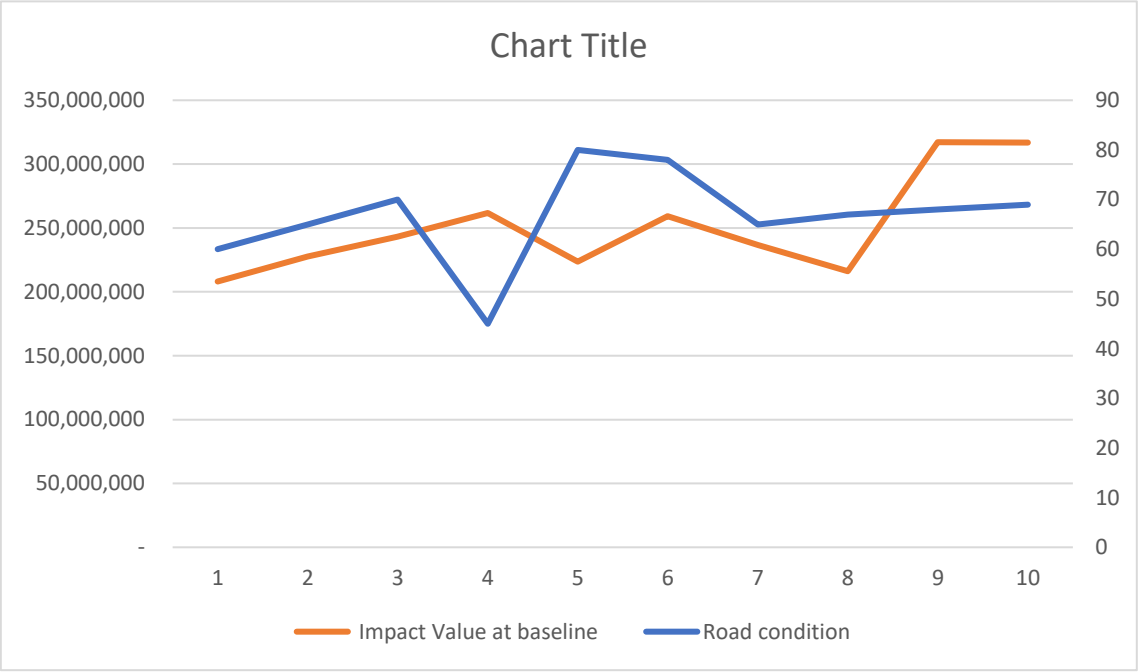

Figure 32: Road condition in relation to impact value

7.15.5 Total Input (Investment) Vs NPV

The total input or investment injected into the maintenance of the selected roads returned a 0.821correlation coefficient when compared with the net present value (NPV) using excel inbuilt formula.

A plot of the investment vis net present value is indicated in figure 35. The strong relationship of 0.774552263 calculated using the correlation-based tools, indicates value for money, the higher the investment into road maintenance the more the social benefit value accrued and the reverse is true. It should be noted however, that not all the social benefits enjoyed by the community accrue from maintenance of rural roads, other factors contribute to the benefits. In calculation for NPV, dumping factors such as; dead weight, displacement, attribution, and drop off are considered in calculating the overall impact leading to calculation of the net present value (NPV). The relationship between net present value and total input (money) is indicated in figure 35.

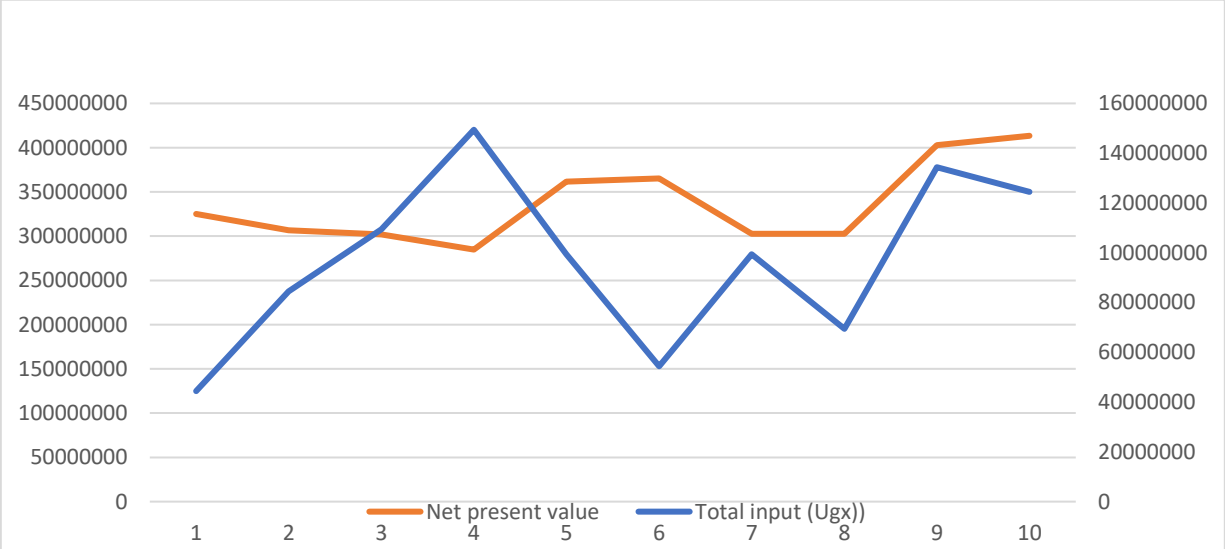

Figure 33: Total Input (Investment) Vs Net present value (NPV)

7.16 Main limitations

There was limited high level data such as population of the village, number of village members who relocated in the last 3 year mainly due to road rehabilitation or maintenance, the actual numbers of the housing units constructed in the last 3 years. Social changes take a long time to be noticed, so this thesis was limited to a few that could be traced.

It was not possible to segregate social and economic benefits since most of them were interrelated.

There were many studies in the area that did not provide feedback, many respondents were not keen to participate since they did not see the value of the study. However, civil servants, road administrators and local leaders showed a lot of interest in the study.

7.17 Calculation example for road 1 - Bulunda-kakindu Road

As an example, to the monetisation of social benefits, Bulunda-kakindu Road one of the roads was selected and a full calculation is indicated.

7.17.1 Stage 1: Stakeholder mapping, and tracking changes

Sector	**Stakeholders**	**Intended/ unintended changes**
	Who do we have an effect on us and who do we have an effect on	**What do you think will change for them**
Economic influenced social changes	Employers, Employees	Change in levels of Employment opportunities
	Property managers, property owners, landlords	Change in Land use values and property values (Rental & purchase)
	Business owners/ traders	Change in trading activities
Spatial related social benefits	Facility owners, utility managers	Change in access to facilities and services
	Farmers	Change in arable land to build-up land
Road infrastructure improvement	Vehicle owners, Passengers, transporters,	Changes in travel cost /fare/ freight cost
		Change in travel time
		Introduction of new modes of transport
	Vehicle owners, Passengers, transporters	Changes in traffic volumes
	Local government officials and URF supervisors	Improved road condition
	Government, road mangers, policy makers	Improved road condition
Environment related social changes	NEMA, Kamuli district environment office,	Number of road closures
		Changes in pollution levels
		Reduction in noise pollution
Social changes related to wellbeing of the community	Village members, households	Change in level of integration
		Change in levels of residents' displacement/migration due to road condition
		Change in level of Crime

Health related social changes	Village members, health workers	Change in health levels
	Drug shop owners, village members	Change in the cost of drugs and availability
	Health officers, Police traffic department	Reduction in road accidents reported to health facilities in the community
	Village members, midwives at health facilities	Changes in Maternal birth reported at the facility
Agriculture related social changes	Famers, village members, traders	Changes in volume of agricultural products
Education related social changes	School owners and head teachers, parents and learners	Change in Education standards
		Change in the cost of education for private primary day schools

7.17.2 Stage 2: mapping; Inputs, outputs and outcomes

Table 42: The theory of change – Summary

Stage 2 (Theory of Change)			
Inputs		**outputs**	**Outcomes**
Description	**Value (UGX)**		**Description**
What do they invest		**Summary of activity in numbers**	**How would you describe the change**
Time	-	Number of people in formal employment	Increase in number of employed persons in the village
Time	-	Improved number of rental properties	Increase in property lettable space
Time	-	Number of shops in the area	Increase in number of shops in the area
Time	-	Improves accessibility	Increased occupancy rate
Time	-	increase in Acres of land for agriculture	change in land use
Time	-	Reduction in travel cost	Increased number of passengers using common modes (Boda-boda, Taxis, Dump trucks)
Time	-	Reduced travel time	Increased number of passengers and number of trips
Time	-	Increased number of new vehicle modes	improved passenger choices
Time	-	Increased number of vehicles on road	Increased traffic on road
Supervision time	14,400,000	Annual assessments made by supervisors	Well, maintained road section
Money, time	30,000,000	New improved road infrastructure	Number of Kms maintained in motorable condition per road section
Time	-	reduced road closures	All weather roads working throughout the years without closures

Time	-	Reduction in pollution figures	reduction in pollution concentration
Time	-	Reduction in noise figures	relative intensity of sound on a scale from 0 to 130
Time	-	increased level of integration	Number of interactions between village members
Time	-	number of residents displaced /migrated	number of residents displaced/ migrated
Time	-	Reduction in number of crimes reported at the police	Change in crime numbers
Time	-	Reduced number of patients	Change in patient numbers per month
Time	-	Reduced referrals for patients	Change in patient numbers
Time	-	Reduction in accident patients	Change in accident patient numbers
Time	-	Increased number of child birth	Change in patient numbers
Time	-	Increased production in tones - Rice	Improved wellbeing of the farmers
Time	-	Increase passing rate	well educated community
Time Total funds	- 44,400,000	Increased enrolment	well educated community

7.17.3 Stage 3: Evidence outcomes and give them a value

Table 43: Evidence outcomes and financial value for Kamuli rural roads

Stage 3: Evidence outcomes and financial value								
Outcomes								
Indicator	**Source**			**Quantity**	**Duration**	**Financial proxy**	**value**	**Value**
How would you measure	**Source of information**	**Before**	**After**	**how much change was there**	**Calendar Years**	**What proxy would you use to value the change**	**What is the value of the change from surveys/ Proxy**	**Financial Value**
increase in number of people in formal employment	questionnaires, one off interviews.	130	158	28.00	1	UBOS labour data	1,200,000.00	33,600,000
Changes in lettable space of I bedroomed house	DCO	25	120	95.00	1	letting charges from DCO office	50,000.00	4,750,000
increase in number of sops	DCO	20	26	6.00	1	letting charges from DCO office	50,000.00	300,000
Number of rentals occupied	questionnaires and interviews	25	60	35.00	1	questionnaire	50,000.00	1,750,000
Available land for agriculture (Acres) for rent	questionnaires and interviews	8500	8540	40.00	1	questionnaire	100,000.00	4,000,000

Difference in passenger numbers	questionnaires and interviews	254	282	28.00	1	questionnaire	50,000.00	1,400,000
Difference in trip numbers	questionnaires and interviews	254	282	28.00	1	questionnaire	50,000.00	1,400,000
Number of new modes	questionnaires and interviews	2	5	3.00	1	questionnaire	50,000.00	150,000
Increased traffic volume	Traffic count	45	70	25.00	1	Traffic count	3,000.00	75,000
Number of assessment reports	Local Authority	0	3	3.00	1	Local Authority	1,000,000.00	3,000,000
Difference in km improved	Uganda road fund and District engineer/ District Budget	0	6	6.00	1	URF- Cost per km for routine maintenance	5,000,000.00	30,000,000
number of road closures in days per year	Questionnaires/ interviews	0	0	0.00	1	value of work per day from District labour office	0	-
concentration, measured in parts per billion, ppb, or parts per million, ppm	NEMA / District Environmental officer	220	120	100.00	1	NEMA / District Environmental officer	50,000.00	5,000,000
measured intensity in decibels (dB). on a scale from 0 to 130.	NEMA / District Environmental officer	90	40	50.00	1	Measurement from NEMA / District Environmental officer	50,000.00	2,500,000

Number of times a family interacts with another per month	questionnaires and interviews	300	345	45.00	1	questionnaires and focus groups	50,000.00	2,250,000
Number of residents displaced from the village	LC1 Office records	20	5	15.00	1	LC1 Office records	50,000.00	750,000
Number of crime cases reported to Police	Police records	210	251	29.00	1	Average resource reallocation to the justice system per young person being detained each year	50,000.00	1,450,000
Record books at the health facilities	Health centre records	350	310	48.00	1	Cost of treating a patient of simple illness at heath centres	200,000.00	9,600,000
Record books at the health facilities	Health centre records	56	40	16.00	1	Cost of treating a patient of simple illness at heath centres	100,000.00	1,600,000

Record books at the health facilities	Health centre records	40	25	15.00	1	Cost of treating an accident patient at heath centres	300,000.00	4,500,000
Record books at the health facilities	Health centre records	11	56	45.00	1	Cost of antenatal attendances	25,000.00	1,125,000
Different in volume of produce in TONES	DAO	4840	5300	460.00	1	DAO/DCO	2,000,000.00	920,000,000
Increase in number of childes passing in exams per year in the selected village	DEO	5200	6300	1,100.00	1	Records from selected Schools	100,000.00	110,000,000
change in enrolment of students	Selected schools	750	1805	1,055.00	1	Records from selected Schools	100,000.00	105,500,000

7.17.4 Stage 4: Consider the dead weight, attribution, drop off and establish Impact

Table 44:Trade-offs for calculation of Impact

	Stage 4: Trade-offs for Impact Calculation					
	Deadweight	**Displacement**	**Attribution**	**Dropoff**		
Intended/ unintended changes	**%**	**%**	**%**	**%**		
What do you think will change for them	**What would have happened without the activity?**	**how much of the activity displaced other outcomes**	**Who else contributed to the change?**	**Does the outcome drop off in future years?**	**Impact**	**Year 1 (After activity)**
Change in levels of Employment opportunities	80	20	80	10	1,075,200	967,680.00
Change in Land use values and property values (Rental & purchase)	70	30	70	30	299,250	209,475.00
Change in trading activities	60	40	60	10	28,800	25,920.00
Change in access to facilities and services	40	30	70	52	220,500	105,840.00
Change in arable land to build up land	30	20	80	5	448,000	425,600.00
Changes in travel cost /fare/ freight cost	30	20	80	5	156,800	148,960.00

Change in travel time	35	40	60	4	218,400	209,664.00
Introduction of new modes of transport	20	15	40	5	61,200	58,140.00
Changes in traffic volumes	20	20	60	10	19,200	17,280.00
Improved road condition		0	0	80	3,000,000	600,000.00
Improved road condition	0	0	70	80	9,000,000	1,800,000.00
Number of road closures	0	0	0	0	-	-
Changes in pollution levels	40	20	70	30	720,000	504,000.00
Reduction in noise pollution	35	30	50	30	568,750	398,125.00
Change in level of integration	40	60	60	30	216,000	151,200.00
Change in levels of residents' displacement/migration due to road condition	35	50	45	50	134,063	67,031.25
Change in level of Crime	60	40	30	30	243,600	170,520.00
Change in health levels	55	45	40	15	1,425,600	1,211,760.00

Change in the cost of drugs and availability	55	50	30	3	252,000	244,440.00
Reduction in road accidents reported to health facilities in the community	5	10	40	5	2,308,500	2,193,075.00
Changes in Maternal birth reported at the facility	5	10	55	5	432,844	411,201.56
Changes in volume of agricultural products	40	30	60	20	154,560,000	123,648,000.00
Change in Education standards	70	20	40	10	15,840,000	14,256,000.00
Change in the cost of education for private primary day schools	60	20	50	10	16,880,000	15,192,000.00
	37	**26**	**52**	**22**	**208,108,706**	**163,015,912**

7.17.5 Stage 5: Calculation of present value and SROI ratio

7.17.5.1 Discounting the impact

The social impact was discounted at 5% derived from Uganda Bureau of statistics (UBOS),

Table 45:Discounting the impact

Intended/ unintended changes		Discount rate 5%. After drop off		
What do you think will change for them	**Calculated Impact**	**Year 1 (After activity)**	**Year 2**	**Year 3**
Change in levels of Employment opportunities	1,075,200	967,680.00	870,912.00	783,820.80
Change in Land use values and property values (Rental & purchase)	299,250	209,475.00	146,632.50	102,642.75
Change in trading activities	28,800	25,920.00	23,328.00	20,995.20
Change in access to facilities and services	220,500	105,840.00	50,803.20	24,385.54
Change in arable land to build up land	448,000	425,600.00	404,320.00	384,104.00
Changes in travel cost /fare/ freight cost	156,800	148,960.00	141,512.00	134,436.40
Change in travel time	218,400	209,664.00	201,277.44	193,226.34
Introduction of new modes of transport	61,200	58,140.00	55,233.00	52,471.35
Changes in traffic volumes	19,200	17,280.00	15,552.00	13,996.80
Improved road condition	3,000,000	600,000.00	120,000.00	24,000.00
Improved road condition	9,000,000	1,800,000.00	360,000.00	72,000.00

Number of road closures	-	-	-	-
Changes in pollution levels	720,000	504,000.00	352,800.00	246,960.00
Reduction in noise pollution	568,750	398,125.00	278,687.50	195,081.25
Change in level of integration	216,000	151,200.00	105,840.00	74,088.00
Change in levels of residents' displacement/migration due to road condition	134,063	67,031.25	33,515.63	16,757.81
Change in level of Crime	243,600	170,520.00	119,364.00	83,554.80
Change in health levels	1,425,600	1,211,760.00	1,029,996.00	875,496.60
Change in the cost of drugs and availability	252,000	244,440.00	237,106.80	229,993.60
Reduction in road accidents reported to health facilities in the community	2,308,500	2,193,075.00	2,083,421.25	1,979,250.19
Changes in Maternal birth reported at the facility	432,844	411,201.56	390,641.48	371,109.41
Changes in volume of agricultural products	154,560,000	123,648,000.00	98,918,400.00	79,134,720.00
Change in Education standards	15,840,000	14,256,000.00	12,830,400.00	11,547,360.00
Change in the cost of education for private primary day schools	16,880,000	15,192,000.00	13,672,800.00	12,305,520.00
	208,108,706	**163,015,912**	**132,442,543**	**108,865,971**

7.17.6 Calculations for PV, NPV and SROI

Present value, Total present value (PV), Net Present value, and social return on investment (SROI) are all calculated using excel spread she

Table 46: Calculations for PV, NPV and SROI

Parameter	Formulae	Total input	Discount rate 5%. After drop off			
			Impact	Year 1 (After activity)	Year 2	Year 3
Total impact value			208,108,706	163,015,912	132,442,543	108,865,971
Present value	Impact Value/(1+r) ^n	44,400,000	208,108,706.25	155,253,249.35	120,129,290.52	94,042,518.81
Total present value (PV)	$\sum_{n=1}^{n=i} Pv$					369,425,058.67
Net Present value	*Total PV -Total inputs*					325,025,058.67
Social return on investment (SROI)	*Total present value/ Total inputs =* ***(*369,425,058.67/44,400,000)**					**8.32**

From the calculation, for every I shilling invested into maintenance of

7.18 Summary of the Case Study

The case study provided a good implementation guide to the selected methodology. It clearly demonstrates that SROI can be adopted for monetization of social benefits and that social benefits accruing from rural roads can be monetised. It also demonstrated a relationship between the quality of the road and the impact value accrued from maintaining the road in motorable conditions.

In calculating SROI, its important be mindful of the input data into the theory of change process and the actual changes to be considered for monetisation. The value of the impact is dependent on the input data, the assessed output and outcomes and the proxy values adopted from similar activities.

8 CHAPTER 8: SUMMARY AND DISCUSSION

8.1 Introduction

This chapter provides for discussion of findings clearly giving the corns and pros of the research findings. There are many data analysis methods available for use, the common ones are: decriptive analysis, exploratory analysis, daiginistic analysis, predictive analysis, presecriptive analysis, and statistical analysis. This research by its nature adopted the use of decriptive analysis and statistical analysis methodologies.

The core purpose of this chapter is to summaries and discuss the research. This process is made through a critical review of the methodology and an assessment of the accomplishment of the objectives outlined in chapter one of this PhD thesis.

8.2 Summary of the Research

The aim of this research project was to develop a technique that can be used to monetise social benefits accruing from maintenance of rural roads in low-income countries for use in Prioritisation of maintenance of rural road infrastructure as indicated in chapter one. Through literature review; all possible techniques were reviewed with the aim of zeroing on those that are responsive. It emerged that none of the methods reviewed had been applied on rural roads although some of them were successful in other sectors.

Through literature review, a critical information was obtained to provide a good understanding of the road asset management process and rural maintenance issues. The study also reviewed social impacts associated with rural roads to give a grounding of the social changes that are to be monetised. Monetization techniques were also reviewed based on agreed parameters; Cost efficiency, Data and data collection, Validity of results, Time efficiency, and Clarity in processes. These parameters are discussed in details in chapter five.

8.2.1 Proposing a monetization framework for rural roads.

Literature revealed that, there was no direct methodology that monetizes social benefits from rural roads. To arrive on this concurrence, comparative study for all the possible methodology reviewed was conducted. It was thus imperative that, a frame work be developed. Having found out in chapter 5 that social return on investment was the most responsive technique, an SROI leaning framework was developed. Data sources were proposed, data processing, modelling and analysis were discussed. Sensitivity analysis was also proposed and discussed because the results exhibited instability.

8.2.2 The application of the proposed theoretical framework for monetizing social benefits from rural roads

The usefulness and practical implementation of the proposed framework was demonstrated using a case study which considered ten rural roads serving ten rural Centres or villages. The case study followed all the processes simulating the actual scenarios. It demonstrated the issues of data sources and collection, data analysis, and results analysis. The results from the proposed framework were tested through sensitivity analysis. Problems associated with data collection and any form of processing were analysed and interventions agreed upon.

8.3 Fulfilment of the objectives of the research

The objectives of this research were proposed in chapter 1 section 1.5. this section discusses the progress made to meet the set objectives and their associated limitations of challenges.

8.3.1 Objective 1:

Chapter 4 of this PhD thesis deals with objective number one (To establish the effect of rural road maintenance on social changes and their drivers in the served communities). Through this objective, details about social benefits in general and rural road related changes in particular were expounded. The objective was well met in this PhD thesis.

8.3.2 Objective 2:

This research brought on board the assessment of the available techniques for monetisation of social benefits accruing from rural roads. This section fulfilled objective number two set out in this research (to assess the available techniques for monetisation of social benefits).

8.3.3 Objective 3:

Through literature review, there were no direct methodology that values social benefits accruing from the rural roads, it was however clear that using methodologies available and adopted for other sectors, a responsive methodology can be agreed upon. This methodology can be used with minor amendments. The agreed methodology/ framework fulfils objective number 3 of this thesis (To develop a framework for monetisation of social benefits and costs accruing from rural road) and was achieved as expected.

8.3.4 Objective 4:

Through a case study of ten rural roads in Kamuli district in Uganda, serving ten villages, objective six hinging on the effectiveness of the selected and modified methodology was demonstrated. Data was collected for the case study, analysed based on social return on investment and results discussed. It was established that, social return on Investment methodology is effective in monetising social benefits accruing from the rural roads' impacts. The fulfils objective number 4 (to demonstrate the effectiveness of the methodology and modelling technique through a case study – Kamuli District, Uganda). This objective was met.

8.3.5 Objective 5:

A protocol for prioritizing rural roads basing on social benefit values was not developed due to the limited scope of this thesis. Further study should be done to produce this protocol that will provide a quick but robust method to be used in arguing for maintenance funds by policy makers, road administration and technical managers. Objective 5 (Provision of a user friendly but robust protocol to prioritise rural road maintenance) was not met and this was proposed as future work.

8.4 Critical Review of the Research

The methodology adopted the use of a modified SROI for monetisation of social benefits accruing from rural roads. The critical review of this research is discussed under the following headings;

a) Monetisation Knowledge
b) Comparative Study of monetisation Techniques
c) Social return on Investment technique
d) Case study
e) Data issues

8.4.1 Monetisation Knowledge

The global knowledge of the monetisation of none market goods or the intangible goods is gaining traction quickly. Many sectors have embraced the use of social value to calculate for the value accruing from social change. The main challenge however is the possibility of incorporating all changes into the model for calculation basis. Some changes are still hard to value due to their nature and lack of proxy equivalents.

8.4.2 Comparative Study of monetisation Techniques

Literature review revealed luck of straightforward methodology that can be utilised in the monetization of social benefits caused by maintenance of rural roads. It also revealed that there are many methodologies in use for other sectors other than rural roads. For the researcher to zero on one most responsive methodology, a comparison of all the reviewed techniques was made, this comparison was based on the common parameters agreed upon by experts. However, the parameters adopted for comparison are for purposes of simple analysis and they can only hold for all techniques if other conditions are kept constant. The environment under which these methodologies apply are different as well as the personnel involved.

8.4.3 social return on Investment technique

SROI is a robust methodology that offers a comprehensive approach to understanding and communicating social benefits to beneficiaries, funders and policy makers. Monetization of social benefits provides a shared understanding for better inform decision-making through all stakeholders. It adopts the use of the theory of change, maps output, outcomes and eventually impacts through pre-determined processes. The SROI ratio is calculated by comparing the total value of the impact to total value of the investment. However, in calculating total value of the impact, it is important to improve the quality of the results by applying filters.

The filters applied include deadweight, displacement, attribution and drop off. The process described is appropriate, however there a number of limitations to this process which includes; resource and expertise limitations, training requirements, and new tools limitations as well as judgements made throughout the process.

8.5 Case study

Being a research related study and being resident in Uganda, the selection of Uganda as a country for the case study came naturally. As indicated and discussed in chapter seven, the selected ten road sections were those where the researcher had collected data for GEM project and the District had provided funds for maintenance. Also, the ten roads accessed ten villages or trading centres which were handy in the study. These sites had also gone through a number of maintenance cycle funded by Uganda Road Fund (URF) thus had available funding data at the district and central government. Since the researcher worked in this area, it was well known to him and can access services with ease. The acceptability and utilization of the proposed methodology was successfully demonstrated using the case study. Data collection through the questionnaires and discussion with stakeholders in focus groups and experts in the field of research provided the needed information. Formulas used in this calculation may be adopted for use in any situation. However, there will be need to improve the model through calibration to match different sites.

8.6 The Applicability of the methodology for Rural Roads

The developed methodology will be useful to the technical personnel, policy makers, road managers and politicians alike to provide support for road maintenance funding. The methodology may also be used as a means of road asset management. However, the monetization of none market goods like social benefits is still a growing area with a lot of challenges which should be investigated further.

8.7 Overall Performance of the monetization protocol

The monetization protocol proposed to be used by road administrations to voucher for funds to be used for maintenance of rural roads is well covered in chapters six and eight. As noted, the theory of change is the key trucker of the social benefits affecting the beneficiary community. It's the utility that is measured through monetization process. Its however clear that road maintenance is not the sole cause of change and should not take credit of all the impacts affecting the community. To counter this scenario, filters are applied in form of dead weight, attribution, and drop off to the impact value. Based on case study results, the methodology produced positive results for all the 10 villages interrogated. Despite the achieved success in utilizing the modified SROI model, the results indicated some discrepancies in the achieved values for the 10 rural roads and their respective villages.

8.8 Value of the Research

The value of the research was demonstrated by discovering a technique that can monetise social benefits accruing from rural roads. The case study demonstrated its practical usage and a robust protocol for monetization of social benefits was also developed in line with social return on investment as indicated in chapter eight. A combination of data collection techniques including the use of APR process and semi-structured questionnaires were key inputs in this research. Through literature review a number of methodologies involving monetization of social benefits were identified, however none of these techniques was directly linked to monetisation of social benefits accruing from rural roads. SROI technique was identifies as the most responsive and was adopted.

9 CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

Prioritisation of maintenance of rural roads is not considered important by many roads' administrators' in comparison with opening new roads and building highways or even upgrading gravel roads to asphalt standard. This is not because the impact caused by the roads is not visible but the impact cannot be valued. Common valuation models in use are based on economic or tangible inputs and do not consider the intangible or none market goods. This kind of valuation provides an incomplete valuation of inputs.

In order to provide a balanced and complete valuation, it is imperative that both the economic and social benefits and costs be valued. It's common knowledge that valuing the economic part of the road has been dealt with by many researchers. However, the monetization of social benefits remains the challenge in many sectors. This research aimed at investigation the best methodology to monetise social benefits, and if possible, adopt it for valuation of social benefits accruing from rural roads. In doing so social return on investment technique was found to be the most responsive and thus adopted for the same.

Through the case study in Kamuli Uganda, SROI methodology was tested on ten selected roads leading to ten selected villages. Data collected based questionnaires and PRA processes were analysed and results modelled. Results for all ten roads indicated positive correlation in the values obtained through SROI calculations. The results provided proof that SROI can be used to monetise social benefits accruing from rural roads. Its however, important to note that monetization based on SROI is not void of limitations, as indicated in chapter two, some of the limitations can be categorised as limitations due to resource requirements, expert needs, quality of data collection and data collection methods, data analysis and interpretation needs.

This research has led to the development of a rural road monetization protocol proposed to be used by all stakeholders in arguing for maintenance funds. The protocol is explained in details in chapter eight of this PhD thesis. Although this prioritisation protocol will be very helpful, there is need to improve it and prepare it inform of a software instead of an excel sheet. More validation should made in the data inputs, analysis and modelling. There is need for sensitivity analysis and or calibration to localize the protocol. The research is considered a success having fulfilled all the objectives set in chapter one and discussed in several chapters of the research PhD thesis.

9.2 Recommendations for Further Research

9.2.1 Improvement to SROI method

SROI is a tool predominantly used in many sectors other than rural roads. This research has successfully customized it to value social benefits from rural roads as demonstrated by case studies. However, the researcher recommends further study in the area of data inputs, data collection and modelling procedures to improve its implementation. Further, a tool or protocol to prioritise Monetisation of social benefits should be considered as further study. This will help in the valuation and prioritisation of roads to be maintained.

9.2.1.1 Developing a prioritisation software

As alluded in the previous sections of this thesis, there is need to develop a prioritisation protocol to be used for funding of maintenance of rural roads. The modified SROI may be used to develop the protocol given its immense adherence advantages over other reviewed methodologies.

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