ECONOMIC APPRAISAL AND PRIORITISATION OF FEEDER ROAD PROJECTS IN GHANA

by

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CERTIFICATION

I hereby declare that this submission is my own work towards the Master of Science degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the University, except where due acknowledgment has been made in the text.

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ABSTRACT

There have been concerns that procedures adopted by the Department of Feeder Roads for selecting road projects for improvement have neither been objective nor transparent (Hine, J. et al, 2000b). It was perceived that road projects were selected for intervention not necessarily due to their economic efficiency or social benefits to the communities, instead, projects were selected for political expedience (Fouracre et al, 1999). There is therefore the need for a prioritisation methodology that seeks to combine economic efficiency with inclusive decision-making procedures and institutionalised reviews to promote downward accountability.

To help minimise this problem, this research was setup with the aim to identify significant variables in economic appraisal process of feeder roads and develop an outline for analysing and prioritising feeder road projects in Ghana. In order to achieve its aim and objectives, the research adopted a three phase strategy comprising a review of literature, field questionnaire survey and data analysis. Data were collected from road agencies in Ghana, local consultancy firms in road sub-sector and donor/development partners to Ghana's road sector. The research achieved an overall response rate of 74.2%. Analytical tools including Relative Importance Index, Weighted Average, and Kappa Statistic for multiple raters using categorical classification and Discriminant Analysis were employed to analyse the field data leading to the following main conclusions:

Cost-benefit Analysis was ranked as the suitable technique for appraising feeder roads in Ghana. On cost of feeder road investment, initial construction/rehabilitation cost, major maintenance cost and routine annual maintenance cost were ranked in decreasing order as significant cost variables in appraising feeder roads in Ghana. On the other hand, travel time savings by passengers and freight (TTS), increased in reliability of transport service and stimulation of economic development in road zone of influence were ranked as significant benefit variables in appraising feeder roads investment in Ghana.

It was also concluded that, the inclusion of social benefits in appraisal of feeder roads become significant in Ghana where investment could provide significant improvement in vehicle access as in situation where there was no existing access at all or the access is at risk of been cut. It was also found that; prioritisation index was ranked as suitable economic evaluation criteria for selecting feeder roads for intervention in Ghana. Finally, project investment costs, delays in construction period and discounting/evaluation period were ranked as significant sensitive and uncertain variables in appraisal of feeder road projects in Ghana. Generally, there were high degrees of agreement beyond chance for all variables ranked among respondents.

After the study, it was recommended that the Cost-Benefit Analysis technique proposed by the study as the suitable technique for appraising feeder roads in Ghana be extended to include social benefits in order to enhance its efficiency. It was further recommended that a study be conducted to identify social benefits variables relevant to appraisal and prioritisation of feeder roads projects in Ghana.

DEDICATION

To my dearest wife, Mrs. Rosalind Atuahene and children, Judith Nkrumah Atuahene, Claudia Afia Atuahene and Vanessa Adobea Atuahene for their endurance, love, understanding and support during the course of my studies.

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CHAPTER ONE - INTRODUCTION

1.1 BACKGROUND TO TRANSPORT AND DEVELOPMENT

Road transport investment makes up a large proportion of the public expenditure in many developing countries (Kerali, 2003). This leads to the question of the impact of such high expenditure on a country's development. Many economists (Lombard and Coetzer 2006; van de Walle, 2002; Ojukwu, 2000 and Rwebangira, 2005) agree that road transport is a vital element for improving societal welfare. However, they do not agree on the impact of investment in road transport on a country's development, as a result no general theory exists which assesses the economic and social impact of road transport investment on development. Below are some of the widely held views on the impact of road transport investment on development as cited by Rwebangira (2005).

VOIGT Fritz (1959) sees the role of transport as similar to an introduction of a "big push" in an otherwise stagnate situation. This "big push" is due to the introduction of an efficient transport system and overcomes stagnation by increasing the marginal productivity of capital which gives incentives for new investments. The resulting spill-over effects have stronger impacts than the transport infrastructure itself, the attraction of purchasing power induces an expansion process with increasing demand, rising income, population growth and rural exodus. VOIGT (1959) judges the negative effects caused by the growing spatial disparities to be smaller than the benefits. His conclusion was that a transport system by itself is able to create special impulses for an economic growth process and therefore road transport investment should be undertaken even if they are not economically viable.

WILSON (1973) was among the few authors, who in the early 1970's argued that road transport investment was only a necessary but not sufficient precondition for development. Two things were distinguished in relation to transport investment namely: the creation of economic opportunity and the response to economic opportunity.

The first depends on the quality and quantity of resources in the area served, the actual change in transport rates and service quality and commodity price levels. On the other hand, factors influencing the response to new economic opportunities are: the awareness of its potential, the availability of finance and the magnitude of possible benefit relative to alternative investment opportunities. Wilson (1973) further argued that economic impact spill over effects do exist and are much stronger than the direct reduction in user costs. Access to transport system creates awareness that serves to induce a larger number of people to take advantage of the new economic potential. However, Wilson noted that roads in particular can cause dis-equilibrium.

According to Commission for Africa (2005) and Sachs et al. (2004), recent conceptual arguments and reports from multinational institutions such as the World Bank, United Nations Commission for Africa and European Union and the likes have positioned infrastructure provisions, amongst other elements such as good governance, debt cancellation and increased aid, as an important elements in the formulation of a cure plan, perhaps a panacea, for the economic stagnation of the African continent.

The Commission for Africa's report, the document which served as the basis for the United Kingdom's recent attempt to include Africa on the agenda of the G8 and European Union, proposed a 'big push' on many fronts at once to enhance Africa's economic growth (Porter, 2005). Rural roads in this report were seen as a key component for encouraging economic growth and therefore poverty reduction. Sachs et al (2004) have argued that tropical Africa is stuck in a poverty trap, also requiring a 'big push' in investments, especially infrastructure. According to Porter (2005), low domestic saving is not offset by large inflows of private foreign capital, for example foreign direct investment, because of Africa's poor infrastructure.

Rural roads again were held up as a necessary mechanism to improve economic growth. Porter (2005) argued that, "before high-intensity modern trade can get started, Africa needs an extensive road system both from the coast to the interior and within the interior".

The World Bank (2001) defined rural road provision as an 'intermediate' form of development, its demand being "derived from activities of other sectors (health, education, farming, manufacturing, etc.). So, too, other sectors are affected by, and respond to, transport". Grootaert (2002) and DFID (2004) explained that, impacts relating to rural road provision were distinguished and subdivided as direct and indirect effects: "direct effects are registered in the impact zone by reduced travel time to work, schools, hospitals, markets etc. and savings in fuel and other direct transport costs. The indirect effect consists of increases in income and other dimensions of well-being such as health, education, social interaction and political participation".

One prominent example of quantitative and qualitative research on impact of rural roads was the recent impact assessment on rural road provision in Peru (Schelling and Liu 2000). In this study, focus was given to 'human development' as well as income oriented measures. The findings proved illuminating, in particular, within the targeted areas "there appears to be a tendency to improved living conditions (such as availability of potable water, lighting, or communal facilities) or availability of goods (such as televisions, tractors or bicycles)" (World Bank, g2001). In another more economically oriented study across 129 villages in Bangladesh, villages with better access to roads were found to have "significantly better agricultural production, household incomes, wage incomes of landless labour, health and the participation of women in the economy" (Gannon and Liu, 1997). In Africa specifically a study in Tanzania, noted some interesting findings in social aspects as a result of road provision. There were found to be an increased attendance at hospitals and preventive health care facilities and also an increase in the participation of women in local government affairs "due to the increased feasibility of one-day roundtrip travel to meeting" (Grootaert, 2002).

In two similar studies in rural China and India, a remarkably stable trio of factors emerged, namely: education, rural road provision and research and development into food productivity. In India, rural road provision had the biggest single impact on poverty reduction (Liu Zhi, 2000) while in China it had the third largest (Dieter and Liu, 2000). The results in India led Fan et al (2000) to conclude that, "for every one million rupees spent on roads, 124 people are raised above the poverty line". van de Walle (2002) cites a study by Jalan and Ravallion that found "that road density was one of the significant determinants of household-level prospects of escaping poverty in rural China". Even as early as 1982, USAID was reporting the positive impacts of rural road provision. It was noted, for example, that rural roads enabled inhabitants to more easily reach health clinics (USAID, 1982).

The above cited studies appear to offer a persuasive argument to increase expenditure on rural road provision. Yet, neither the arguments nor the evidence were by any means conclusive in demonstrating the necessity of a 'big push' in rural road provision in Africa. As van de Walle (2002) states "unfortunately, there is as yet little convincing empirical evidence that rural roads affect social outcomes beyond what they would have been without the road".

van de Walle (2002) statement resonates in a number of other documents. For instance, in the World Bank's Poverty Reduction Strategy Paper (PRSP) sourcebook, it was stated that: "knowledge of the transport conditions of the poor, and especially how these interact with other factors is modest" (Gannon and Liu, 2000), while the 2004 World Development Report affirms that "baseline data is needed for rural roads with far-reaching impacts on poverty, health, and education outcomes" (World Bank, 2004).

As Howe (2003) states; "our ability to predict, either positive or negative social outcomes - resulting from specific investments - remains primitive. Investment in transport, especially if this is simply in the road element, as is commonly the case, without a corresponding effort to improve actual services – remains as a 'necessary but not sufficient' condition for changes to occur".

The equitable distribution of the economic benefits of rural roads has also been questioned. It has been argued that the economic benefits of rural road interventions accrue mainly to the rich and that this process is accentuated by the present rural road Cost Benefit Analysis (CBA) methodologies whose focus is on efficiency not effectiveness or equity (van de Walle, 2002; Gannon, et al, 1997 and Gannon, et al, 2000). This raises concerns about the viability of the suggestions of the Commission for Africa (2005) and Sachs et al (2004), as these arguments were premised on the ability of rural road interventions to impact upon the income of the poorest. The implication was that even with money spent on rural roads, poverty levels as measured by income could remain largely unaffected (Porter, 2005).

Given these methodological and contextual limits, some suggestions have been made to improve the knowledge of the impact of rural roads. Howe (2003) states that "re-orienting the debate away from a focus on investment in roads and towards more holistic changes in transport conditions has to be the key component of any way forward". This statement reverberates amongst other experts. Lebo and Schelling (2001) and van de Walle (2002), for example, focused on developing a methodology for measuring social benefits through combined equity and efficiency criteria.

In summary, the role of roads in poverty alleviation and social development has been stressed in recent literature and influential reports on Africa, yet some serious concerns remain about the extent to which rural road provision does actually act as an influential catalyst for development. Attribution of impacts to rural road provision has not been empirically robust.

1.2 STATEMENT OF THE PROBLEM

Rural transport network in most developing countries are still underdeveloped and of poor quality (Lebo and Schelling, 2001). Rural household, and particularly women, spend much time and effort on transport activities to fulfil their basic needs. Too many communities still do not have reliable access to main road network or motorized access (of the 3 billion estimated rural population in developing countries, 30% are living in villages without reliable access while ten percent (10%) are not provided with motorized access at all), while at the same time resources are being spent upgrading roads to economically unjustified standards for population that already have a sufficient level of access (Lebo and Schelling, 2001).

In recent years, renewed emphasis on assisting very poor populations through sustained rural development (Commission for Africa, 2005) has led governments and donors to accelerate resources flows to rural infrastructure, with a large proportion being directed at improving transport infrastructure. While these projects are sometimes sector-focused, they are increasingly taking the shape of multi-component rural development projects or social funds with an emphasis on local government and community-based program management (Lombard and Coetzer, 2006). While a cross-sector orientation in such projects is desirable, there is a need for sound technical advice on the design of sub-component and, in particular, on appropriate design and appraisal methods for Rural Transport Infrastructure (Hine, 2003).

Ensuring effective rural transport infrastructure systems are an essential requirement for rural development, although by itself, it is not sufficient to guarantee success (Porter 2005). Without adequate rural roads, communities lack the necessary physical access for basic domestic chores, agriculture activities, social and economic services and job opportunities (DFID, 2004). Without reliable access to markets and productive resources, economic development stagnates and poverty reduction cannot be sustained (Grootaert, 2002). Improvement of the intra- and near-village path and track network and the provision of all-season basic motorized access – if affordable and appropriate – are therefore essential conditions for rural development (Lebo and Schelling 2001).

There is clear evidence that poverty is more pervasive in areas with no or unreliable access (motorized access) as compared to more accessible areas. For example, in Nepal, where the percentage of people below poverty line is as high as 42%, in unconnected areas 70% of people are living below poverty line. In Bhutan, the enrolment of girls in primary school is three times as high in connected villages compared to unconnected ones (Fan et al. 2004). In Andhra Pradesh, India, the female literacy rate is 60% higher in villages with all-season road access compared to those with unreliable access (Liu, 2000). In Ghana, there is a high correlation between areas with unreliable access road and incidence of poverty, such as in the North-east Ghana (Hine et al, 2000b).

Improved rural road and transport are recognised by many stakeholders as vitally important to the alleviation of poverty in developing countries (Hine, 2003).

However, current transport investment prioritisation processes do not reflect this contention and instead focus on the very narrow set of benefits (from road investment) which are frequently insufficient to justify the proposed investment (DFID, 2004 and van de Walle, 2000). Thus there is a need to better represent the wide and significant range of impacts that improvements in transport conditions have on rural communities, particularly on the poor and disadvantage (Porter 2005).

1.3 JUSTIFICATION OF RESEARCH

Ghana's Department of Feeder Roads (DFR), as a matter of policy, seeks to enhance rural livelihoods through responsive investments in improving basic access. In the past, there have been concerns that procedures adopted by the Department for selecting road projects for improvement have neither been objective nor transparent (Hine et al, 2000b). It was perceived that road projects were selected for intervention not necessarily due to their economic efficiency or social benefits to the communities, instead, projects were selected for political expedience (Fouracre et al, 1999). There is therefore the need for a prioritisation methodology that seeks to combine economic efficiency with inclusive decision-making procedures and institutionalised reviews to promote downward accountability. The methodology should take into account the provisions of the Ghana Local Government Act (462), specifically the requirements for participatory decision-making. In so doing, it is expected that such methodology would be responsive to the priorities of beneficiaries, meet fundamental requirements of transparency and equity, and contribute to improvements in wellbeing for the poor and vulnerable. A transparent methodology would also be required to enable stakeholders and project's participants effectively monitor projects at the implementation stage and understand the reasoning behind various decisions taken at the project planning stage.

1.4 KEY RESEARCH QUESTIONS

The key research questions which were addressed are as follows:

- How is an investment in feeder roads development and maintenance analysed and prioritised in Ghana?
- What are the significant costs and benefits variables included in economic analysis of feeder road projects in Ghana?
- Under what conditions are the inclusions of social benefits become significant in the appraisal of feeder road projects in Ghana?
- What are the most suitable economic evaluation criteria for selecting road candidates for intervention in Ghana?

1.5 AIMS OF RESEARCH

The aim of the research was to develop an outline for economic appraisal and prioritisation of feeder road projects in Ghana.

1.6 RESEARCH OBJECTIVES

The above research aims were achieved based on the following objectives:

- To identify suitable economic appraisal technique(s) for feeder road interventions in Ghana;
- To identify significant cost variables included in economic appraisal of investment in feeder road projects in Ghana;
- To identify significant benefit variables included in economic appraisal of investment in feeder road projects in Ghana;
- To determine the conditions under which inclusion of social benefits becomes significant in economic appraisal and prioritisation of feeder road projects in Ghana; and
- To determine significant sensitivity and uncertainty test variables in appraising feeder roads in Ghana.

1.7 RESEARCH DESIGN AND METHODS

A quantitative strategy using both probability and non-probability sampling techniques were adopted for the study. The research was carried out in three phases. Firstly, a literature review from academic and professional journals, conference papers, reports, technical papers, working papers and the internet was carried out.

Secondly, a questionnaire was designed and administered to personnel from the Ministry of Roads and Highways, Ghana Highway Authority (GHA), Department of Feeder Roads (DFR), Department of Urban Roads (DUR), Local Consultancy Firms engaged in the road sector and donor institutions with Country offices in Accra. The survey sought to provide data and opinions relating to economic appraisal techniques for feeder roads and also identify significant variables included in appraisal of feeder roads in Ghana. The sample sizes for the three categories of respondents were determined using the Census Approach for small population size and the Kish Formula.

Thirdly, the responses from the survey were analysed statistically using analytical tools including Relative Importance Index, Weighted Average, Discriminant Analysis and Kappa Statistic for multiple raters using categorical classification. The results of the analysis were then used as the basis to determine significant variables in economic appraisal of feeder road investment in Ghana.

1.8 RESEARCH OUTLINE

The study is presented in six chapters. Chapter one introduces the topic. Chapter two provides an overview of theory, methods and some practical issues in economic appraisal of road projects in general. Chapter three presents an overview of theory and procedures for appraising low volume feeder/rural roads in developing countries. The fourth chapter highlights the research design and approach adopted to collect and analyse data towards the achievement of the research objectives. Chapter five analyses and discusses the response obtained from the survey leading to the determination of significant variables in economic appraisal and prioritisation of feeder road investment in Ghana. Chapter six looks at the conclusions and recommendations.

1.9 SUMMARY OF RESEARCH FINDINGS

The research achieved an overall response rate of 74.19% for both respondents from road agencies and local consultancy firms in the road sector. The following conclusions were made:

Cost-benefit Analysis was ranked as the suitable technique for appraising feeder roads in Ghana. On cost of road investment, initial construction/rehabilitation cost, major maintenance cost and routine annual maintenance cost were ranked in decreasing order as significant cost variables in appraising feeder roads in Ghana. In addition, travel time savings by passengers and freight (TTS), increased in reliability of transport service and stimulation of economic development in road zone of influence were ranked as significant benefit variables in appraising feeder roads investment in Ghana.

It was also concluded that, the inclusion of social benefits in appraisal of feeder road projects becomes significant in Ghana where investment could provide significant improvement in vehicle access or for remote new rural transport infrastructure investment.

On suitable economic evaluation criteria for selecting feeder roads for intervention in Ghana, Prioritisation Index was ranked first. In addition, project investment costs, delays in construction period and discounting/evaluation period were ranked as significant variables in Sensitivity and Uncertainty Testing. Generally, there were high degrees of agreement beyond chance for all variables ranked among respondents.

CHAPTER TWO – AN OVERVIEW OF ROAD PROJECT APPRAISAL

The Oxford Advanced Learner's Dictionary has defined the word "appraise" (v) as: "to consider or examine sb/sth and form an opinion about them or it". The Collins Gem English Dictionary on the other hand defined "appraise" as: "estimate the value or quality of sb/sth". The Overseas Road Note 5 (2^{nd} ed.) published by the Department for International Development (DFID), on the other hand, has defined "appraisal", which is a noun form of "appraise", in the context of investment in road projects as: "The process of justifying and reaching a decision to invest resources in the road being appraised".

The term appraisal as defined in the Overseas Road Note 5 is broad in nature, including both economic and engineering processes. It encapsulates topics such as economy-wide analysis, market structural analysis, and environmental impact assessment, social impact assessment, engineering design and analysis of specific decisions for individual projects or a group of projects.

However, this study was limited to the economic aspect of road project appraisal process (i.e. economic appraisal of road projects with emphasis on Feeder Road Projects in Ghana).

2.1 ROAD PROJECT APPRAISAL PROCESS

Belli et al (1998) and Hoffer et al, (1998) have both identified road project appraisal processes in the following nine steps as:

a) Define the objective;
b) Specify assumptions;
c) Identify alternatives;
d) Estimate benefits and costs;
e) Describe intangibles;
f) Compare benefits and costs and rank alternatives;
g) Evaluate variability of benefit-cost estimates;
h) Evaluate distribution impacts; and
i) Make recommendations.

The analytical considerations involved in each of these steps have been omitted from this report due to limited space. This notwithstanding, the key concept in the appraisal process is the comparison of the project against the situation that would have prevailed without the project. These are the basic ‘with’ and ‘without’ cases that are used in the economic analysis of the project. The appraisal process should always have this comparison in view (Hoffer et al, 1998).

Conventionally, these road project appraisal processes are planned and implemented within a framework of sequence of activities, often known as the ‘Project Cycle’. There are many ways of defining the steps in this sequence, but the following terminology have been adopted by the Transport Research Laboratory (2004):

a) Project identification;
b) Pre-feasibility;
c) Feasibility;
d) Design;
e) Procurement and negotiation;
f) Implementation;
g) Operation and
h) Monitoring and evaluation.

The first three steps (a, b and c) make up the planning phases of the project cycle, though evaluation (step h) may also be considered integral to the planning process by providing feedback on the wisdom and processes of past decisions. Within each of the planning phases (i.e. project identification, pre-feasibility and feasibility), the same basic process of analysis is adopted. Differences occur largely in the level of detail applied.

DFID (2005) recommends the steps shown in Table 2.1 below when conducting feasibility study within the planning phase identified above. It is evidently clear from Table 2.1 that, economic appraisal process is an integral part of the feasibility study phase of project cycle.

According to Belli et al (1998), the purpose of economic appraisal of road projects is to help design and select projects that contribute to the welfare of a country. It goes on to point out that, economic appraisal is most useful when used early in the project cycle, and of very limited importance when use solely as a single figure hoop through which projects must jump once prepared. According to Hoffer et al (1998), another purpose of the economic appraisal of road projects is to provide decision makers with a systematic approach in making resource allocation decisions leading to the undertaking of appropriate objectives in a least cost manner.

Table 2.1 – Main tasks in a Feasibility Study

Stage	**Task**
Context and Objectives	Define objectives and the macro-economic context
	Locate the project within its geographic, economic and social context and determine alternative ways of meeting objectives.
	Preliminary considerations, including assessment of institutional capabilities and governance.
Fieldwork and Surveys	Assess traffic demand (both vehicular and person movements)
	Geotechnical investigations for route location, materials, hydrology etc
	Environmental surveys
	Social surveys
	Safety considerations
Engineering Designs	Pavement design
	Geometric design
	Design of structures and drainage
Selecting the Preferred Option	Establishing project costs
	Establishing project benefits
	Comparative analysis (economic or cost-effectiveness, and financial if appropriate
	Sensitivity and risk analysis
	Reporting the feasibility study

Source: A guide to road project appraisal, Overseas Road Note 5 (2005), Transport Research Laboratory, UK.

Gwilliam (2000) argued that, economic appraisal of projects also ensures that selected projects are worthwhile [i.e. it yields benefits with a value in excess of their cost], are well designed [i.e. are of better value than alternative projects directed to the same end] and are practicable [i.e. the responsible agency has the capability and incentive to realise those benefits].

Economic appraisal of projects is normally based on an economic assessment which uses a framework of "Cost-Benefit Analysis" or "Cost-Effectiveness Analysis" approach which involves some form of ranking procedure for alternative projects. Where private capital is being invested in road projects, financial appraisal is normally included as part of project appraisal process (DFID, 2005).

2.2 ECONOMIC EVALUATION CRITERIA

The following are alternative ways of comparing costs and benefits within a typical economic appraisal framework.

a. Net Present Value (NPV)

Description: The Net Present Value (NPV) is simply the difference between the discounted benefits and costs over the project analysis period. It is probably the most common approach for appraising projects using discounted cash flow in both the private and public sectors. The present value of all benefits is compared to the present value of all costs. Alternatively, net cash flow are first calculated for each year of the project and then discounted to the present. NPV requires the selection of a discount rate. The final result is a numerical value in specified currency units.

Decision Criteria: For a single project, acceptability requires that NPV > 0. This would reflect a project where the present value of incremental benefits exceeds the present value of all capital and recurrent costs (Moran, K. 1995). For a capital budgetary process, where multiple projects are being appraised and the budget limits means that some projects could not be funded, NPV can be used to rank the projects in order of priority (Moran, K. 1995). The objective is maximization of NPV. Where budget rationing exists, NPV is probably the most preferred method of appraising projects. NPV addresses efficiency objectives.

b. Net Present Value/Cost Ratio (NPV/C)

One problem with the use of Net Present Value is that, all things being equal, a large project will have a larger NPV than a less expensive one, and based on this criterion, the former will be chosen. This can cause difficulties when only two or three projects are being compared. However, if all were appraised and ranked according to the size of the NPV/costs ratio, the best choice would be that giving the highest ratio. Thus several smaller projects which in aggregate had a higher NPV would be chosen over a single larger project.

The NPV/C can also be used when assessing alternative mutually exclusive schemes. Thus for example, two alternative routes on which an improved road could be constructed, or two alternative geometric design options, the incremental NPV/C can be used as below:

$$\frac{\text{NPV Option 1} - \text{NPV Option 2}}{\text{Cost Option 1} - \text{Cost Option 2}}$$

If the incremental NPV/Cost ratio is greater than the cut-off rate, then the more expensive scheme can be justified.

c. Internal Rate of Return (IRR)

Description: The IRR (alternatively called the rate of return on investment) is the discount rate for a project that will yield zero Net Present Value (NPV = 0). In order words, the IRR is the rate at which the present value of measured benefits equals the present value of measured costs. Where IRR is used in a broader economic analysis, the term "Economic Internal Rate of Return (EIRR)" is often coined. Unlike NPV, where a discount rate must be selected, the IRR derives a percentage value representing the rate of return on the project. IRR can be used to appraise individual projects, or provide information to help make decisions about appraising and ranking multiple investment opportunities.

Decision Criteria: With individual projects, the appraisal must compare the IRR with a pre-selected rate of return, often called the hurdle rate; this hurdle rate usually represents the organisation's cost of capital. The objective then is for the project to earn an IRR equal to or greater than this "hurdle rate". If an organisation were using the World Bank's opportunity cost of capital of say 12% (Gwillaim, 2000), the criterion for acceptance would be IRR $\geq$ 12 %.

For mutually exclusive projects or where similar projects are to be ranked, the IRR is usually used in conjunction with NPV. In this case, NPV is the first decision criteria and IRR can show relative investment efficiency between the projects. Most spreadsheet packages for financial analysis include a subroutine function to calculate IRR.

d. First Year Rate of Return (FYRR)

The FYRR is simply the sum of the benefits in the first year that the road project is opened to traffic, divided by the present value of the capital cost (both discounted to the same year) and expressed as a percentage. Thus the FYRR is given by:

$$FYRR = 100b_j / \sum_{i=0}^{j-1} c_i (r/100))^{j-i}$$

Where,

j	=	first year of benefits
i	=	current year, with i = 0 in the base year
b_j	=	the sum of all benefits in year i
r	=	planning discount rate expressed as a percentage
c_i	=	the sum of all costs in year i

If the FYRR is greater than the planning discount rate, then the project is timely and should go ahead. If is less than the discount rate, but the NPV is positive, the start of the project should be referred and further rate of return should be calculated to define the optimum starting date. Table 2.2 below summarises the advantages and disadvantages of the different economic criteria that can be used in Cost Benefits Analysis.

Table 2.2: Decision Criteria

Condition	NPV	IRR	NPV/Cost	FYRR
Economic validity of project	Good	Good	Good	Good
Mutually exclusive projects	Very good	Poor	Good*	Poor
Project timing	Fair	Poor	poor	Good
Robustness to changes in assumptions	Poor	Good	Very good	Poor
Project screening	Poor	Good	Very good	Poor
For use with budget constraints	Fair**	Poor	Very good	Poor
NOTE: * Needs incremental analysis ** Needs continuous recalculation				

Source: Overseas Road Note 5 (Revised edition), A guide to road project appraisal

2.2.1 Economic Appraisal versus Financial Appraisal

According Moran (1995), an economic appraisal is different from a financial appraisal in a number of important respects. Financial appraisal is usually carried out from the perspective of a particular individual or group of individuals while economic appraisal takes a wider, national perspective. Financial appraisal uses conventional "market prices" while economic appraisal use "economic prices" which only reflect the opportunity cost of using resources to the whole society, hence the taxation component of market prices are omitted.

In a financial appraisal, one is concerned with the ways and means of financing a project (e.g. floating bond or by levying toll) and the financial profitability of the project. Economic appraisal on the other hand is not concerned with the sources of financing, the availability of funds or the allocation of funds.

In the economic appraisal of projects, the total costs and total benefits that arise from the project are identified and measured, irrespective of who incurs the loss or who benefits from the project. Financial appraisal, on the other hand, captures only the costs and benefits streams that reflect in the financial statement only (van de Walle, 2002). Within economic appraisal, it is usual to treat each unit (GH¢ say) of benefit or cost as being of equal value to every single individual in the society irrespective of his or her income level or social status (DFID, 2004)

The main difference between financial appraisal and economic appraisal is that, financial appraisal looks at the net returns to equity capital or to private groups or an individual and the results act as an indication of incentive to adopt or implement a project, while economic appraisal determines the net returns to society and the end product is used to determine if government investment is justified on economic efficiency basis. Within the Project Appraisal Process, the usual approach is to begin with financial appraisal and then undertake a broader economic analysis. Companies tend to focus on financial while Governments and development banks tend to do both levels of analysis (McMahon G, 1997).

2.2.2 Objectives and Impact of Road Investments

The objectives of investing in a road project are many and varied, it may include:

- To support some other developmental activity;
- To provide fundamental links in the national, regional or district road network;
- To meet a strategic need;
- To increase the structural capacity or trafficability of an existing road to cope with higher traffic flows;
- To provide an alternative to an existing transport link or service;
- To address a major safety hazard, environmental or social problem;
- To rectify damage or failure that has caused sudden deterioration of the existing road.

Regardless of the project objective, it is expected that investment in road projects will lead to lower transport costs (Belli, P. et al, 1998). Consequently, economic activities will change throughout the economy as the saved resources are redeployed, producers adjust to their new cost and price structure and consumers adjust their pattern of expenditure. The extent to which the local economy within the road project's zone of influence benefits from the investment will be determined by its economic potentials, such as unused land and labour, and on the magnitude of change in transport costs and prices (DFID, 2005). The effect on the economy as a whole is extremely complex and it is virtually impossible to model in detail (Belli, P. et al, 1998).

For most road projects where vehicle access already exists, the principal benefits from the project should be measured as road user cost savings. In such situation, the "consumer surplus" approach of assessing benefits should be used (van de Walle, 2002). When evaluating generated traffic benefits, it is useful to consider the current traffic composition and the nature of the proposed investment.

Studies (Barrett, S. 1975; Belli, P. et al, 1998; Mackie, P. et al, 2003: and DFID, 2005) have shown that passenger traffic is more sensitive than freight traffic to changes in transport costs. Passenger fares are a direct component of consumers' final demand whereas freight cost represents only a small proportion of the final cost of both the product to the consumer and the revenue to the producer.

Upgrading long lengths of inter-urban roads to a high standard may have little effect on freight traffic, but may well have an important effect on passenger traffic, particularly for private motor car traffic, which is often deterred from using poor quality road surfaces (Kerali, 2003). However, upgrading short lengths of roads will change transport costs very little and, as a result, will have very little effect on traffic levels or on agriculture production (Hine, et al, 2002). The only exception to this is when roads are cut for long periods during critical periods of the crop season or if perishable crops, like bananas and pineapple for export, are damaged in transit (van de Walle, 2000).

According to DFID (2005), majority of rural access road projects involve upgrading roads and tracks of up to about 20km. For these projects, road user cost savings for forecast normal traffic is the most appropriate method of estimating benefits. Providing completely new vehicle access can change transport conditions dramatically. For example, the cost of head-loading is typically twelve times the cost of motor truck transport per unit of load carried (DFID, 2005). Where it is planned to provide access road to rural communities that previously had to rely on human or animal transport, then transport cost savings (including a valuation of passenger and walking time savings) for normal traffic will often be sufficient to justify the provision of motor vehicle access at minimum standard (Porter, 2005 and Belli, P. et. al, 1998). Initially, such access will probably require simple bridging, with the use of gravel surfacing material only in problems areas. Later on, if the traffic levels warrant, the road can be upgraded (Hine, J. 2003).

2.3 ECONOMIC APPRAISAL TECHNIQUES

McMahon (1997) identified a number of different techniques that can be employed to appraise investment road projects. However, most authors (McMahon, G. 1997; Hoffer, S. et al, 1998; Belli, P. et al, 1998; van de Walle, D. 2002; DFID, 2004 and ITEA, 2006) agree that the following are suitable for appraising public investment in road projects:

i. Cost Benefit Analysis (CBA);
ii. Cost Effectiveness Analysis (CEA);
iii. Multi-Criteria Analysis (MCA);
iv. Framework Approach (FA);
v. Fiscal Impact Analysis (FIA);
vi. Road Prioritisation Methodology/ Procedure (RPM);
vii. Maintenance Performance Budgeting Systems (MPBS); and
viii. Pavement Maintenance and Management Systems (PMMP).

The details of those methods are discussed below:

2.3.1 Cost – Benefit Analysis (CBA)

- **The Basic Concept**

Cost-Benefit Analysis is a systematic evaluation of the economic advantages (benefits) and disadvantages (costs) of a set of investment alternatives. Typically, a “base case” is compared to one or more alternatives [which have some significant improvement compared to the base case] (Mn/DOT, 2005). The analysis evaluates incremental difference between the base case and the alternative(s). In other words, a Cost Benefit Analysis tries to answer the question “what additional benefits will result if this alternative is undertaken and what additional costs are needed to bring it about”.

By convention, the term “Cost-Benefit Analysis” is given to investment appraisal, which seeks to identify all the social costs and social benefits arising from an investment project (Mn/DOT, 2005). It examines the effect of capital investment on the welfare of society as a whole but not any smaller part of it. Cost-Benefit Analysis asks the question whether society will become better off as a result of an investment (Belli, P. et al, 1998). A commercial appraisal asks only if the owners of the enterprise will be better off.

The need for Cost-Benefit Analysis arises precisely because commercial profitability may not be an indication of social profitability or benefit. For instance, a higher profit in the lumber industry may be obtained at the cost of increased risk of increased soil erosion of nearby farming area (Hine, J. et al, 2002). In Cost-Benefit Analysis, costs imposed on the third party who are not directly involved in the market transaction are included (Belli, P. et al, 1998). Social benefit replaces firm revenue as an indicator of return. Instead of the private cost of a firm, the concept of opportunity cost is used. This measures the social value foregone when resources in question are moved away from alternative economic activities into the specific capital project. Social or opportunity cost may be below market cost in the case of factors that would otherwise have been unemployed (Moran, K.1995 and van de Walle, D. 2002). The correction of market price to reflect social cost involves the use of shadow price (ITEA, 2006). These adjustments allow for considerations not reflected in the prices. Most economists would require, however, that in additions to having an excess of benefit over cost, a project should not have distributional effects, which are regressive or inequitable. (ITEA, 2006).

- **Consumer Surplus Theory**

A project may not only increase output but also reduce the price of the output to consumers. When a project lowers the price of the project's output, more consumers have access to the same product and old consumers pay a lower price for the same product (Mn/DOT, 2005). Valuing the benefits at the new, lower price understates the project's contribution to society's welfare (Hine, J. 2000). Similarly, if the benefits of the project are equated with the new quantity valued at the new price, the estimate of benefits ignores "consumer surplus", the difference between what consumers are prepared to pay for a product and what they actually pay (Hine, J. 2003). In principle, this increase in consumer surplus should be treated as part of the benefits of the project.

According to Hoffer, et al (1998); Belli, et al (1998) and DFID (2005), if reductions in transport cost result from a road project, there will be a direct benefit to road users which equals the product of the number of trips and the cost savings per trip. This cost saving, or consumer surplus, may be in vehicle operating costs, travel time costs, road accident costs and combination of the three.

Technically, there is only a consumer surplus if cost savings are passed on to consumers through lower fares and freight charges (Hine, J. 2003); otherwise they accrue to vehicle operators as "producers' surplus". It is therefore important to assess the prevailing market and make judgements as to how any reductions in transport costs are likely to be distributed (ITEA, 2004).

If the transport cost savings are sufficient, these may result in more trips being made and extra benefits will accrue as a result of this generated traffic. Thus, generated traffic resulting from a road project is a measure of the extra consumer surplus, and can be used to determine the project's developmental benefits. It should be noted, however, that generated traffic and associated benefits are difficult to measure in practice (Hine, J. 2003).

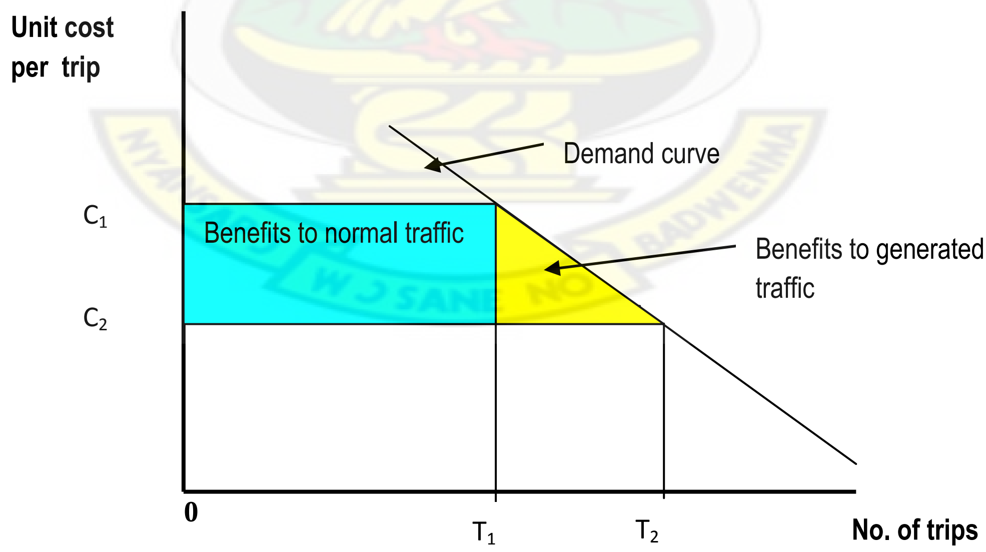


Figure 2.1: Benefits measured as consumer surplus

According to Hine (2003), consumer surplus benefits are best estimated using a demand curve as shown in Figure 2.1. If before the project is undertaken T_1 trips are made each day at a unit cost of C_1, then the transport cost is C_1T_1 per day. If as a result of the project, unit transport costs are reduced to C_2, then the transport cost is reduced to C_2T_2 per day giving

$$\text{Benefit to Normal Traffic per day} = (C_1 - C_2) \times T_1$$

If additional traffic is generated as a result of the savings in unit transport cost, additional benefits will accrue. The amount of traffic that is generated will depend on the size of the unit cost reduction and on the ability of the consumer to take advantage of this cost reduction. This ability is known as the elasticity of demand (Belli, P. et al, 1998). In this case, a cost reduction from C_1 to C_2 will result in an increased number of trips from T_1 to T_2: the greater the cost reduction, the more trips that will be generated. The demand curve can normally be approximated by a straight line whose gradient is related to the elasticity of demand (Belli, P. et al, 1998; Hoffer, S. et al, 1998); The area under the demand curve less the transport cost of the generated traffic, $C_2(T_2 - T_1)$, gives:

$$\text{Benefit to Generated Traffic per day} = \frac{1}{2}(C_1 - C_2) \times (T_2 - T_1)$$

In areas where there is already considerable economic activity and traffic levels are relatively high, the consumer surplus approach should normally be used to provide an estimate associated with a road project (ITEA, 2004 and DFID, 2005).

- **Producer Surplus Theory**

According to van de Walle (2002), in situations where no conventional road exist and a substantial improvement in vehicle accessibility is planned to help develop an area, the "producer surplus" approach may be the most appropriate way of estimating agriculture benefits arising from road investment. van de Walle (2002) further explains that, for this method to be used, it requires a great deal of knowledge of the agriculture production function such as might be the case in a rural development project. The predicted benefits arising from the reduced transport cost will normally be the same as that predicted by a consumer surplus approach.

On the other hand, Hine et al, (2000) argue that, when the producer surplus method is used, passenger benefits and other non-agricultural cost savings still need to be estimated separately. The forecast increase in agriculture production and the size of producer benefits are predicted from:

i. The rise in farm-gate prices brought about by the decline in costs of transporting produce to market;
ii. The decline in transport costs of agricultural inputs.

The practical application of the agricultural production approach in the field has been poor. The empirical justification for estimating changes in agricultural production has been weak and a failure to consider all the relevant costs of production has often led to the benefits being grossly overvalued (Hine, J. et al, 2002). The producer approach is not recommended unless there is a great deal of knowledge about agriculture and its likely supply response to changes in input and output prices (Hine, J. et al, 2002).

- **Application of Cost Benefit Analysis to Road Investments**

Traditionally, investments in road projects have been selected on benefit indicators derived from consumer surplus calculations of road user saving, comprising vehicle operating cost savings and travel time savings (van de Walle et al, 2000). Forecasts of traffic demand (reflecting both normal growth in traffic and traffic generated by the project) are used to derive willingness to pay estimates as proxy to project benefits (DFID, 2005). Over time, the approach has been implemented at different levels of sophistication, from only considering benefits accruing to motorized four-wheel vehicles to gains to non-motorized traffic and pedestrian based on reduction of travel time savings (Hine, J. et al, 2002). In some cases, estimates of the value of agriculture production increased induced by the road investment are included (Hine, J. 1982). The appraisals have generally not made distinctions between beneficiaries from different income or other socio-economic groups (Hoffer, S. et al, 1998).

- **Limitations of Cost-Benefits Analysis**

According to Hine (1982), a number of criticisms have been levelled at conventional Cost-Benefits Analysis. Based on the principles of "willingness to pay", one tends to be bias toward investments in richer areas since the demand for traffic and hence willingness to pay measure will be higher for the rich. Thus, van de Walle (2000) argued that, Cost-Benefit Analysis is appropriate for high traffic areas, but not for low traffic areas. It fails to capture some important but hard to quantify benefits from road investments. For these reasons, some observers (van de Walle, D. 2002; Banmaamar, M. 2003 and DFID, 2005) argued that the method led to under-investment in rural roads and in particular, rural roads serving poorer populations. There are projects that, by conventional Cost Benefit Analysis based on poorly measured benefits streams, do not have internal rate of return greater than the critical level, typically set at 12% for World Bank funded projects (Belli, P. et al, 1998; Gwillaim, 2000), yet yields higher social welfare gains than the projects that do pass the test (van de Walle, D. 2002).

Cornes (1995) argued that, Cost-Benefit Analysis as currently practiced in the transport sector continues to be riddle with problems of evaluating benefits for non-market goods for which prices are not known and the consumptions of which is subject to quantity constraints. According to Belli et al, (1998), another problem of CBA is the lack of agreement on social welfare functions on which valuation judgements are ultimately based. Conventional cost-benefits do not unambiguously answer the question of how much should be spent on rural roads. A fundamental source of the ambiguity has to do with the weights attached to the multiple objectives of policy (Hine, J. 1982 and Hine, J. et al, 2002).

The other problem with the conventional method for assessing rural roads relates to the alleged systematic exclusion of certain benefits, faulty measurement of the included benefits and failure to recognize that the assumptions needed to justify ignoring distributional impacts (and so focus solely on efficiency gains) do not hold in practice (van de Walle D., 2002).

Holvad and Preston (2005) argue that conventional Cost-Benefit Appraisal methods, even when combing consumer and producer surplus, are still likely to result in the underfunding of rural roads. They maintain that the techniques omit some key benefits, such as those accruing to individual and to society from increased attendance to schools, health and other facilities rendered accessible by the road investments. Furthermore, they may well be large but omitted risk insurance benefits from linking isolated poorer population to national transport and communication networks (Hine, J. et al, 2002).

These omitted benefits would be of less concern if it could be established that they are positively correlated with the included benefits, however, that is not plausible (van de Walle, D. 2002). Rural roads may well have high omitted benefits but low included benefits. Ranking road investment options in terms of observable benefits may be only weakly correlated with the ranking in terms of total benefits. If the alleged social benefits are real, conventional methods are unlikely to be a reliable guide to project selection (DFID 2005).

2.3.2 Cost Effectiveness Analysis

- **The Basic Concept**

Lan and Lundeen (2004) have defined Cost effectiveness analysis as a type of economic appraisal technique in which all cost is related to a single and common effect. Generally, the purpose of Cost-effectiveness analysis is to help decision makers identify the output of each of a number of equal cost options and then decide which of the alternative is best for producing the determined output level. Cost effectiveness analysis can also be used to compare different resources allocation options in like terms.

According to Hoffer et al, (1998), there are two main types of Cost Effectiveness Analysis:

a) Lease-cost studies: – appropriate where the level of effort is undetermined and relatively unconstrained but the level of output/benefit is fixed; and
b) Constant-cost studies: - appropriate in situations where the level of output/benefit is undefined but the budget/resources available for the project are fixed.

- **Application of Cost-Effectiveness Analysis**

According to Benmaamar (2003), for many low-volume roads, the level of traffic is often insufficient to justify any improvement using conventional Cost-Benefit Analysis as analytical tool. That is to say, the benefits that can be measured in monetary terms are insufficient to outweigh the cost of the project. However, there may well be other benefits that cannot be measured in monetary terms but which need to be considered in the appraisal process. In addition, Benmaamar (2003) argued that, Cost Effectiveness Analysis has been developed in order to address this problem of combining both quantified and non-quantified benefits. Cost Effectiveness Analysis also involves some process of ranking options on the basis of their performance against a set of pre-determined criteria which may or may not include economic component.

Within the Cost-effectiveness framework, the population served by a road is often used in ranking criteria as a direct proxy of social benefits arising from the road improvement (Benmaamar, 2003). The population is used either as a total proxy for all benefits, or in combination with other traffic related benefits (e.g. travel time savings, vehicle operating cost etc.). The following cost-effectiveness criterion is used:

$$\text{Priortisation Index Indicator of Link}_j = \frac{\text{Population Served by Link}_j}{\text{Cost of Upgrading Link}_j \text{ to Basic Access Standard}}$$

The decision criterion is that road/links that have the highest population/cost ratio are chosen in priority for the investment. As pointed out by van de Walle (2002), the two main drawbacks of this approach are that there is no measure of the change in road conditions (in fact the cost in improving access is likely to be highly correlated with the change in access provided) and secondary, no importance is attached to traffic.

According to Benmaamar (2003), another approach derives two indices: one for impassable roads and the other for passable roads. For impassable roads, ranking is based on the minimum cost per head of establishing access. Once access has been established the second prioritization index is calculated as follows:

$$PI = \frac{\text{Estimates of Trip} \times \text{Access Change}}{\text{Rehabilitation Cost per Km}}$$

The estimate of trip is derived from estimates of trips generated by district services, agriculture and fishing. The access is the "after" rating subtracted from the "before" rating on a scale where "0" is very poor and "5" is good. In this approach population is used as the measure of benefits for impassable roads while traffic is used as the measure for passable roads.

Alternatively, Benmaamar (2003) suggested another procedure which estimates social benefits as the product of the population multiplied by the prospective change in transport costs. In this procedure, two measures of benefits are used on both traffic (for both motor vehicles and other users) as well as on adjacent population.

The variants of Cost-Effectiveness Analysis include Multi-Criteria Analysis, Framework Analysis and Fiscal Impact Analysis.

- **Cost Effectiveness Analysis and Cost Benefit Analysis Compared**

According to van de Walle (2002), the key difference between cost-benefit and cost-effectiveness calculation is that, the latter work only in situations where total expenditures for a program or projects are fixed. In such a case, one only needs to decide how to allocate the budget in the best possible way. There is no need to use a consistent matrix of benefits that could be the basis for comparison with other program or resources use nor is there a need for this benefits indicator to be expressed in monetary units or for it to be comparable with indicators used for other projects or program. Instead, the only requirement is to obtain an output indicator per amount spent. It is an indicator specific to the particular program and would not necessary be of interest to any other program.

Lan and Lundeen (2004) argued that, although both cost-benefit and cost-effectiveness measure the ratio of benefits to costs, the "benefits" units are different. To put the cost-effectiveness indicator in a broader context would require a comparable measure of the social value of the project outcomes.

In addition, Gwillaim (1997) maintains that while in Cost-Benefit Analysis, projects are normally deemed “uneconomic” when their economic rate of return falls below a specific level (e.g. 10% – 12% for World Bank funded Projects) there are no well established criteria for determining the “opportunity cost” threshold when ranking on the basis of cost-effectiveness. According to Benmaamar (2003), such a determination is left to the policy maker.

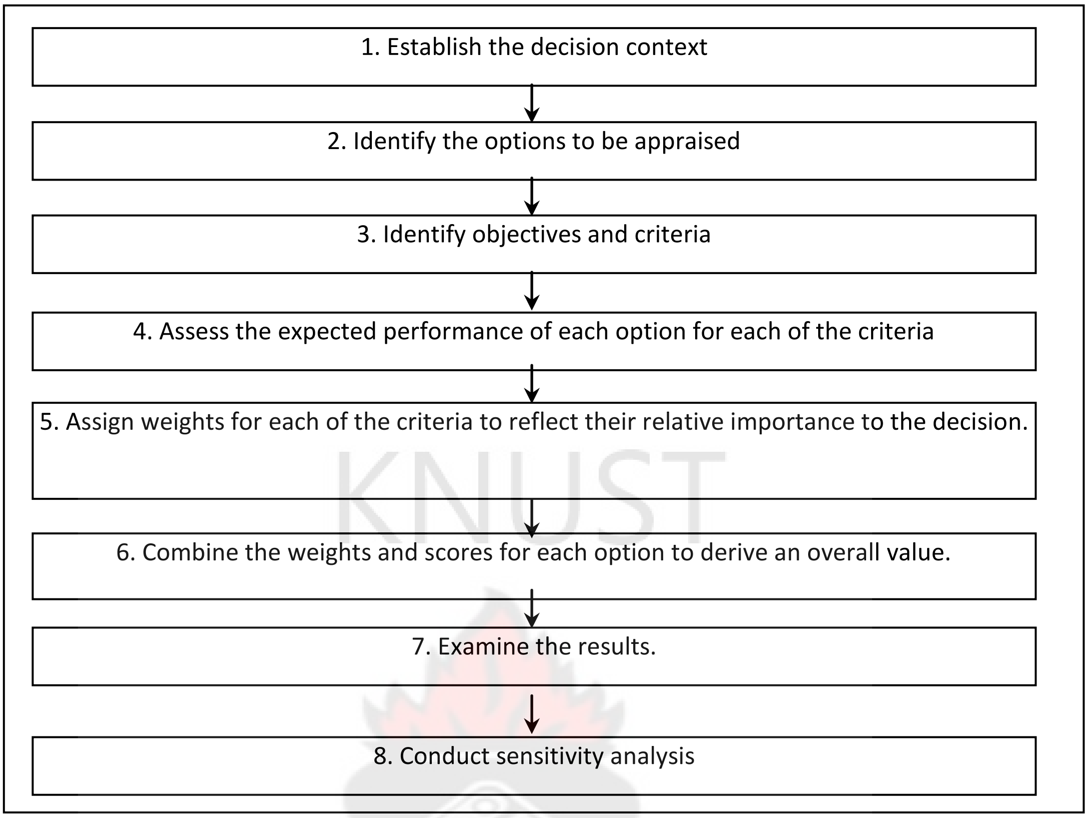
In addition, Cost-Benefit Analysis ranking has an established theoretical framework and that practitioners can test their assumptions, through research, against an external reality. In contrast, Cost-Effectiveness Analysis procedures are much more dependent upon the subjective values of those who initially constructed the criteria and by those consulted in its implementation (DFID, 2005).

2.3.3 Multi-Criteria Analysis (MCA)

According to DFID (2005), this method of economic appraisal is a variant of the Cost-Effectiveness Analysis approach which combines economic, social, environmental and other considerations in arriving at the final selection of alternatives for road investment.

Cook and Cook (1990) said that multi-criteria analysis has typically been used when traffic volume is too low (< 50 vehicle per day) for which conventional consumer surplus is not suitable to measure benefits, yet, it is strongly believed that there will be important social benefits arising from investment in the road project.

According to n/e/r/a (1997), MCA can be used to either retrospectively evaluate projects to which resources have already been allocated or to appraise project proposals. Its key advantage is that it provides a method of involving local people in the appraisal process. A disadvantage is that the MCA is quite an intensive process of consultation and therefore it may be impractical to conduct it on more than just a selected few proposed schemes. The steps used in MCA are shown in Figure 2.2 below:



Source: National Economic Research Association (1997)

Figure 2.2: Steps in Applying MCA.

A summary of the MCA procedure as explained in the n/e/r/a (1997) paper is given below:

The establishment of the decision context, (Step 1) should include the identification of the decision makers and key players in the project and the statement of clear aims and objectives. A socio-technical system is required, a framework to determine the times when the key players contribute to the MCA and how the MCA would be used and implemented. At this stage the context of the MCA should be considered, including a SWOT analysis to highlight possible pitfalls in order for them to be avoided to aid the success of the MCA by achieving its goals.

In Step 2, more than just one option should be appraised. There is always the "do-nothing" scenario which should be fully analysed. Flexibility is required as other options may be uncovered as the MCA unfolds and these may need to be included in the process.

Step 3 is the identification of the criteria by which each option is assessed and the organisation of these criteria by clustering them under higher-level and lower-level objectives. This clustering facilitates the scoring of each option. The scoring system used in MCA (step 4) requires a little explanation. The key idea is to construct scales representing preferences for the consequences of each criterion (see Figure 2.3). Each criterion is weighted according to their relative importance.

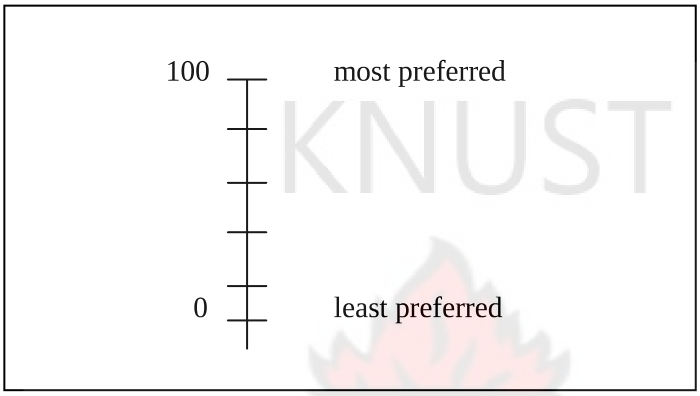


Figure 2.3 Preference Scales

A score is given between 0 and 100 on the scale, allowing qualitative judgements to be quantified. Criteria that are already quantitatively measured can be converted to the scale score, allowing comparisons to be made. The scores must be consistent otherwise they cannot be compared.

As important as scoring the criteria is the weighting given to each. The weight on a criterion reflects both the range and difference of the options and how much that difference matters. An overall score for each criterion is calculated taking account of the weighting.

With MCA, a key question to ask of any criteria or activity is “will this activity, whatever its outcome, make any difference to a decision?” If not, then the activity is not worth pursuing, therefore reducing the requirement of data collection and analysis.

In Step 6, weights are then assigned to each characteristic and overall score is obtained as a product of the rank and the weight. A typical output of the process is as shown in Table 2.3 below:

An examination of the results is then conducted to determine the way forward or make recommendations. The n/e/r/a (1997) paper advises that sensitivity analysis may be used to examine the extent to which vagueness about the inputs or disagreements between people makes any difference to the final overall results.

Table 2.3: Typical Multi Criteria Analysis Output

Criteria	**Alternatives**					
	Project Option 1			Project Option 2		
	Rank	Weight	Score	Rank	Weight	Score
Economic evaluation	x_1	y_1	x_1y_1	z_1	y_1	z_1y_1
Environmental evaluation	x_2	y_2	x_2y_2	z_2	y_2	z_2y_2
Development	x_3	y_3	x_3y_3	Z_3	y_3	z_3y_3
Public transport	x_4	y_4	x_4y_4	Z_4	y_4	z_4y_4
Accessibility/Severance	x_5	y_5	x_5y_5	z_5	y_5	z_5y_5
Overall Score			$\sum x_n y_j$			$\sum z_i y_j$

Source: A guide to road project appraisal, Overseas Road Note 5, Transport Research Laboratory, UK

The use of MCA in the context of appraising low volume feeder roads may be appropriate if just a few schemes are under consideration, possibly after an initial screening process has taken place. Its use as a tool to aid the ranking of a number of projects is probably inappropriate due to time and cost of the MCA procedure.

According to van de Walle (2002), where there is little difference in performance among two alternatives, they may take the same ranking. Sometimes within multi-criteria framework, the components of the projects (e.g. resettlement and environmental mitigation) may be introduced separately although, if they are, then there is the danger that "double counting" of costs and benefits may occur if economic decision criteria such as the NPV or IRR are also included in the final choice analysis.

It is far more difficult to develop the weighting procedure. This is very subjective and best carried out through a process of wide consultation with different experts (Hine et al., 2000a). It must be noted however that, the weighting procedure relates only to the comparison between choices but not the assessment of the absolute value of any of the characteristics or criteria (Hine et al., 2000a).

One important weakness of his approach is that, sometimes, small difference in one characteristic can often be given undue prominence within the procedure and thus override major difference in other characteristics (DFID, 2005).

2.3.4 The Framework Analysis

The Framework Analysis also adopts the cost-effectiveness system of analysis and combines economic, environmental and other factors (DFID, 2005). With this system of analysis, different effects and characteristics of a road project are summarized within a framework in such a way that the advantages (benefits) and disadvantages (costs) of the different alternatives are presented in a tabular form and are easily seen and understood (DFID, 2005).

The components are not explicitly weighted; however, through a process of paired comparisons, the reasons behind the recommended choice become transparent. Inevitable, within the procedure, there is a danger of "double counting" the costs and benefits. However, because the process is transparent and different effects are not weighed and added up (as in Multi-Criteria Analysis), the user is in position to take account of these factors and make necessary adjustments in the final choice. The framework approach relies on the good judgement of those involved in preparing the approach to make sensible decisions.

DFID (2005) summarises a typical framework approach procedure as follows:

i. The key quantifiable and non-quantifiable effects and characteristics of each alternative option are summarized within a table; particular attention is given to the critical difference between the alternatives;

ii. Alternative pair of "project cases" is then compared together. Through comparison of the key difference, one alternative of each pair is rejected;
iii. The pair-wise comparison is continued until one "project case" remains. This is recognised as the most desirable investment option. This alternative is then compared with the "base case" or "do-minimum case"; and
iv. A recommendation is then made whether the project should go ahead or not.

The factors that might be included within a Framework Analysis are key components of the economic and environmental evaluations as well as results from participatory exercise and any other ancillary structures. Examples of quantified component identified include:

- Vehicle operating cost, travel time savings, accident savings and noise levels;
- The number of properties within a given distance from the road;
- The area of land acquisition covering different land uses;
- People affected by resettlement and environmental mitigation costs;
- Construction costs, NPVs or IRRs;
- The percentage of people that prefer each option.

Examples of non-quantifiable aspects might include statement on the following:

- The effect on public transport;
- Visual intrusion and the way that local amenities may be used and affected;
- The differential effects on future development;
- The nature of the wider effects on the natural environment;
- Severance and accessibility effects on different communities.

2.3.5 Fiscal Impact Analysis

According to Siegel et al (2004), Fiscal Impact Analysis estimates the expected effects of a development project on governmental budget balance. The fiscal impact is the difference between the revenue and expenditure generated by the proposed project. There are a number of methods that may be employed in conducting Fiscal Impact Analysis. They include:

- Average per capita method;

- Adjusted per capita method;
- Disaggregated per capita method; and
- Dynamic method.

2.3.6 Ranking/Prioritisation Procedure

Hine et al (2000b) argued that, whichever method for analysing each individual project is used, it is important to be able to rank the projects to determine priorities. For appraisal of low volume feeder roads, ranking methods (e.g. Feeder Road Prioritisation Methodology) are becoming popular as they overcome the disadvantages of traditional economic appraisal techniques.

According to Hine et al (2000b), Ranking/Prioritisation Procedure can be used at any stage during project appraisal process. It may be employed to identify from a host of potential projects those warranting detailed analysis. Ranking techniques can also be used to specify the relative merits of criteria affecting the project. In comparison to other approaches, Ranking is usually fairly simple to execute and therefore can be easily understood and accepted by a cross section of officials and interested parties (Hine et al., 2000a).

Ranking is usually flexible and criteria can be modified to suit local conditions. However care must be taken to ensure that the procedure is consistently applied to any one group of roads. An advantage of the Ranking procedure is that results are quick to obtain, allowing the appraisal of a scheme to be quickly completed. As time is saved, the cost of the appraisal process is kept to a minimum.

2.4 COMPUTER BASED APPRAISAL MODELS

2.4.1 Highway Development and Maintenance (HDM-4) Model

HDM is an international effort to develop improved road investment appraisal methods. It was jointly undertaken by the British Overseas Development Administration, the Asian Development Bank, the Swedish National Road Administration, the Inter-American Federation of Cement Manufacturers and the World Bank. This study built upon the widely-used Highway Design and Maintenance Standards model, HDM-III. The HDM model adopts the consumer surplus approach.

According to Archondo-Callao (1999a), the HDM-4 model is recommended for basic analysis including economic evaluation in assessing optimum work program, phasing, choice of technological options, etc. The HDM-4 model used data from the road maintenance management system database, giving information on road network, pavement condition, traffic data, flood damage, bridge condition and project monitoring. From the information available on HDM, it does not appear that social considerations were specifically taken into account or that there is scope for local participation. Archondo-Callao (1999a) argued that HDM-4 is not customised for use on low volume roads and therefore demands a lot of effort in terms of input requirements.

2.4.2 Highway Design and Maintenance (HDM-III) Model

The HDM III model is recognised by most funding donors as a proven highway development and management tool and has been used on projects in Ghana (Fouracre et al, 1999). The model ranks schemes by their lowest net present value divided by the economic cost of the project (NPV/C).

2.4.3 Road Economic Decision (RED) Model

The Road Economic Decision (RED) Model was developed to improve the decision-making process for the development and maintenance of low-volume rural roads, where traffic was less than 200 AADT (Archondo-Callao, 1999a). The model performs an economic evaluation of road investment options using the consumer surplus approach and is customized to the characteristics and need of low-volume roads such as the high uncertainty of the assessment of the model inputs, particularly the traffic and condition of unpaved roads, the importance of vehicle speed for model validation, the need for a comprehensive analysis of generated and induced traffic and the need to clearly define all accrued benefits (Archondo-Callao, 1999a)

RED computes benefits for normal, generated, induced and diverted traffic and takes into account changes in road length, surface condition, geometry, accidents and days per year when the passage of vehicles is further disrupted by highly deteriorated road conditions (i.e. Wet season). The RED model was funded by the Road Management Initiative -RMI, a component of the Sub-Saharan African Transport Policy Program - SSATP (Archondo-Callao, 1999a). Road Management Initiative was launched in 1998 by the United Nations Economic Commission for Africa (UNECA) and the World Bank.

2.4.4 Road Transport Investment (RTIM3) Model

The Transport Research Laboratory (TRL) developed the Road Transport Investment Model (RTIM) for the economic appraisal of road schemes in developing countries (Cundill et al, 1995). The model compares road expenditure on road improvements and road maintenance with the operating cost over the life of a road. It can be used to determine if improvements or a given maintenance standards are economically justified (Cundill et al, 1995).

The main elements of the model are road deterioration relationship, which predict how the condition of a road will change during its life, and vehicle operating cost relationships, which calculate how road user cost will vary with the state of the road. RTIM has been in use for more than twenty years and has been applied to projects in over thirty countries (Cundill, et al, 1995).

2.4.5 Social Benefits Software Tool

The Social Benefits Software Tool has been developed using the Analytical Hierarchy Process (AHP) method (DFID, 2004). This method systematically transforms the analysis of competing objectives into a series of simple comparison between the constituent elements. In particular, the approach does not require an explicit definition of trade-off between the possible values of each attributes and it allows users to understand the way in which outcomes are reached and how the weightings influence the outcomes (DFID, 2004). The Social Benefits Software Tool requires three major inputs, namely:

- A clear definition of mutually exclusive investment alternative (for each road section) to be compared;
- The main goal, objectives, criteria and attributes under which the alternatives are to be compared;
- A statement of preference on the set of objectives.

A score is calculated for each alternative using the AHP. The scores can be considered as the utility index in terms of social benefits value that each investment alternative could yield and can therefore be used as an indicator for ranking or prioritization of projects. The ratio of the utility index to the cost of implementing alternative also provides a useful prioritization index. The social benefit software was designed to be compatible with well established road appraisal tools such as HDM-4 (DFID, 2004).

2.4.6 Cost Benefits Analysis Software (COBA11 Program)

The COBA11 Program is a computer program developed for the UK's Department for Transport (DfT) to undertake an economic appraisal. The COBA program compares the costs of providing the road scheme with the benefits derived by road users (in terms of time, vehicle operating cost and accidents savings) and expresses the results in terms of a monetary valuation. The aim of COBA was to carry out economic appraisal in accordance with the DfT's Transport Analysis Guidance (WebTAG – www.webtag.org.uk). COBA is used in the appraisal of trunk road schemes in England, Wales and Northern Ireland.

COBA is not applicable to the economic appraisal of all trunk road schemes, for example where the modelling of interacting junctions forms an important part of the appraisal or schemes where traffic related response other than reassignment are considered significant.

2.4.7 Transport Users Benefit Appraisal (TUBA) Program

TUBA is a computer program developed for the UK's Department for Transport (DfT) to undertake an economic appraisal for a multi-modal study. The aim of TUBA is to carry out economic appraisal in accordance with the DfT's Transport Analysis Guidance (WebTAG – www.webtag.org.uk). TUBA undertakes matrix-based appraisal with either fixed or variable trip matrices. It takes trip, time and distance and charge matrices from a transport model. These matrices may be disaggregated by vehicle type, purpose and person type. The user also inputs other costs associated with the "do-minimum" and "do-something" schemes. TUBA will then calculate the user benefits in time, fuel, vehicle operating cost (VOC), non-fuel VOC and charge; operator and government revenues; and the scheme costs, discounted to present year value. Values calculated from input models data will be interpolated and extrapolated to cover full appraisal period necessary. TUBA does not however, calculate benefits that are due to changes in accidents costs (www.dft.gov.uk and www.webtag.org.uk).

2.4.8 Statistical Appraisal Model (SAM)

Jensen (1993) has proposed the adoption of Statistical Appraisal Methods (SAM) in economic evaluation of capital projects in lieu of the traditional Cost-Benefit Appraisal method. According to Jensen (1993), the Statistical Appraisal Method can undertake cost-efficient programming of road projects in which a large number of projects are to be examined and data are scarce or difficult to acquire, as is the case in most developing economies (Benmaamar, M. 2003). The use of SAM Model eliminates the need for tremendous data required under Cost-Benefit Analysis models. The application of statistical regression technique on readily available date or those with low collection cost is suggested as a method for limiting the requirement for data with high collection cost. In additions, Jensen (1993) has suggested introduction of Budget Level Test (BLT) to measures the efficiency of the simplified appraisal method (i.e. SAM) compared with that of the Cost-Benefit Analysis. According to Jensen (1993), the application of the programming methodology in economic appraisal has the potential to reduce data requirement in project appraisal by approximately 50 percent without jeopardizing the quality of the appraisal.

2.4.9 Multi-Criteria Analysis of Scheme Options in Transport (MASCOT)

MASCOT is a Personal Computer based decision support tool developed by the University of Leeds in conjunction with United Kingdom Local Authorities to help rank proposed road schemes in order of greatest benefit. Multi-criteria analysis is used to assess the benefits (Hine et al, 2000b). However, as the model has been developed for the United Kingdom situation, without further analysis it may be assumed that the criteria and parameters may not be appropriate to assess low volume feeder roads in the developing world. If time allows, further investigation of the MASCOT Model may yield some benefit as certain elements of the model may be relevant to a rural application.

2.5 THE COSTS OF ROAD INVESTMENTS

2.5.1 Cost Elements of Road Investments

Mn/DOT (2005) has defined cost of road investment as the value of all the resources that must be consumed to bring the road project about. According to Hoffer et al (1998) on the other hand, costs of transport investment may include all capital, labour and natural resources required to achieve a project whether they are explicitly paid, involve an opportunity cost, or constitute an external cost which is involuntarily imposed on third parties.

According to Hoffer et al (1998), the total cost of any road investment should include estimates on capital cost, opportunity cost, sunk cost, external costs, average incremental cost, depreciation and inflation.

On the other hand, Belli et al, (1998) argued that fiscal impact cost and social impact cost must be included in total cost of road investment. Minnesota State Department of Transport (2005) has shown that capital cost (i.e. initial construction cost), major rehabilitation cost, routine annual maintenance cost and remaining capital value were significant components of road investment cost.

The DFID (2005) has indicated the following as general cost components of road investment:

i. Engineering works included in the main contract

ii. Environmental mitigation works that are not included in the main contract
iii. Engineering works carried out by others
iv. Supervision
v. Land acquisition
vi. Resettlement
vii. Any survey, investigations, or other special contracts
viii. Value added tax and other taxes
ix. An allowance for contingency
x. Engineering studies and design cost
xi. Procurement process and tendering cost
xii. Annual maintenance cost (i.e. life cycle cost)

It is important to note that economic appraisal does not emphasize who incurs the cost but rather aims to include any and all cost that are involved in realizing the project (Mn/DOT, 2005). However, depending on the type of development, not all of the above listed costs items may be relevant in a given road project. Some of the costs components are discussed below:

a. Capital Costs

Capital costs makes up the total investment required to prepare a road improvement for service, from engineering through landscaping. When possible, capital costs should be grouped onto similar life-cycle categories. These include: engineering, right of way, major structures, grading and drainage, sub-base and base, surfacing and miscellaneous items. These life-cycle groupings make it easier to calculate remaining capital value. Estimates of capital, ranging from detailed engineer's estimates to planning-level cost estimates, should be as refined as appropriate for the project's stage in the project development process.

b. Major Rehabilitation Costs

Within a cost-benefit analysis period, future investments may be needed to maintain the serviceability of road. For example, with new or reconstructed road, pavement overlays may be required at specified periods after the initial construction year. The cost of overlay or other major preservation activities should be included in the analysis and allocated to the year when they are anticipated to occur.

c. Routine Annual Maintenance Costs

When evaluating road development investments, it is important to account for the future operating and maintenance costs of the facility. Bridges require preventive maintenance and road lane markings and road signs have to be ploughed and patched periodically. In the case of upgraded roadway, it is necessary to estimate the marginal or additional maintenance costs that would be required for the alternative as compared to the "base case". For a new facility (new alignment), the entire additional maintenance costs should be included as the incremental increase in costs.

d. Residual Capital Value

Many components of a project retain some residual useful life beyond the appraisal period, typically 20 years (Mn/DOT, 2005). At the end of the analysis period, the infrastructure that has been put in place generally has not been completely worn out and will continue to provide benefits to users into the future. It is important to reflect this value in the analysis.

The remaining capital value is calculated by determining the percentage of useful life remaining beyond the analysis period and multiplying that percentage by the construction cost for that component. The estimate of the remaining capital value at the end of the period is then converted to a present value and subtracted from the capital cost.

2.5.2 Preliminary Cost Estimation Techniques

Several techniques are available to help the estimator arrive at the cost of a project. Based on the project's scope, purpose of the estimate, time available and the availability of estimating resources, the estimator may choose one or combination of techniques to arrive at the costs of road investment (Mn/DOT, 2005).

DFID (2005) identified Global Rate Method, Unit Rate, Simplified Unit Rate and Operational Rate as the basic estimating techniques. However, with the exception of the Global Rate estimating techniques, the remainder will not be suitable for estimating costs of road investment at the economic appraisal level due to the project data required by these estimating methods.

However, Wideman (1997) and Hoffer et al. (1998) have identified the following techniques of estimating preliminary cost of a project:

a. **Order of magnitude estimating: -** approximate estimates made without detailed information. Relies on very scanty information, it's essentially a "best guess" and useful for initial evaluation or comparison at the planning stage. The technique is also known as preliminary, conceptual or pre-feasibility estimating.

b. **Parametric or "top down" estimating: -** appraisal of costs of an item based on knowledge gathered from similar, but different projects. It typically uses parameters such as number, weight, power, area, volume, line-of-code, or other characteristics of the system to estimate or scale the cost of the item in question. It is often used as a result or part of feasibility study.

c. **Appropriation estimating: -** it is prepared from best available information, though not necessarily complete information. It is used to establish a budget submitted for funding approval (i.e. an appropriation). It is also known as a "Budget estimate".

d. **Specific analogy estimating:-** it depends upon the known cost of an item used in prior system as the basis for the cost of similar item in a new system. Adjustments are made to known costs to account for difference in relative complexities of performance, design and operational characteristics.

e. **Cost review and update estimating:-** an estimate is constructed by examining previous estimates of the same project for internal logic, completeness of scope, assumptions and estimating methodology and updating them with any changes.

f. **Expert opinion technique:** - when other techniques or data are not available, this method may be used. Several specialists are consulted repeatedly until a consensus cost estimate is established.

2.5.3 Sources of Cost Data

According to Hoffer et al. (1998), estimation data are normally obtained from three principal sources namely:

- Project-specific data collected for a particular project and therefore related to specific location and time;
- Data banks of previous or current projects collected by an individual estimator or estimating organisation; and
- Published data.

2.6 BENEFITS OF ROAD INVESTMENTS

Benefits of road investment are the direct positive effects of that project; that is to say, the desirable things obtain by directly investing in the project (Mn/DOT, 2005). In road Cost-Benefit Analysis, the usual procedure is that benefits are first estimated in physical terms and then valued in economic terms (Belli, P. et al, 1998). For instance, the analyst has to first estimate the number of accidents eliminated, travel time saved, and/or vehicle-kilometres reduced before assigning or calculating monetary values.

According to DFID (2004), benefits from road investments may be categorized into primary and secondary benefits. The primary benefits are the directly measurable "first round" traffic related effects. Examples of primary benefits include transport or accident costs savings. The secondary benefits arise at a later stage and may include changes in land values or wider economic development generated from the investment. Secondary benefits are very difficult to measure and isolate; in addition, it would involve double counting to add primary and secondary benefits together (Hine, J. 2003). For instance, in theory, reduced transport cost or travel time savings may directly induce a rise in land values; to add changes in land values to transport cost savings would involve double counting.

In general, the more competitive and less distorted an economy is, the more likely it is that the primary traffic benefits will cover the full consequence of a road investment (Hine, J. 1982).

Fouracre et al. (2003) and Bryceson et al. (2004) have argued that, the introduction of secondary benefits into the analysis of road investment is strongest under the following circumstance:

- Where there is a desire to weight conventional traffic benefits to different classes of existing users (e.g. provide higher weightings to the poor);
- Where existing traffic volumes are very low or where the population is very remote;
- Where investment can provide a very significant improvement in vehicle access as in situations where there is no existing access at all or the access is at risk of being cut.

On the other hand, according to Hine (2003), DFID (2004) and DFID (2005) the arguments for introducing secondary benefits or social benefits into the analysis of road transport are most likely to be highly significant in the following circumstances:

- For remote new rural transport infrastructure investment;
- Where a relatively large change in transport cost are anticipated;
- Where there are unemployed and/or underemployed resources;
- Where the local economy is perceived to be uncompetitive and weak.

However, it is not every road project that will generate every one of these benefits and not all of these benefits are equally difficult to measure (Hine, J. 2003). For instance, savings in vehicle operating cost is the easiest to measure in monetary terms, while the value of environmental improvement and increased comfort and convenience are the most difficult (Bryceson, D. et al, 2004)

According to Belli et al, (1998), Mn/DOT (2005) and DFID (2005), the expected primary or direct benefits of road investments may include:

- Reduction in vehicle operation cost after investment in road project;
- Reduction in road accident costs (human life and property);

- Time savings by travellers and freight after road improvement;
- Economies in road maintenance (i.e. Savings in maintaining the existing road condition before road construction);

Road projects also generate indirect/secondary benefits, of which the most commonly cited include:

- Stimulation of economic development;
- Increase in reliability of transport services;
- Environmental improvement;
- Improvement in social mobility and network;
- Changes in transport cost associated with eliminating vehicle impassibility;
- Changes in transport cost associated with seasonal improvement in trafficability;
- Increased in travel comfort;
- Implicit benefit associated with modal change; and
- Social benefits like easy access to public services (e.g. hospitals, school etc).

Examples of other social benefits developed from a USAID (1982) study includes social change, impact on women, health and nutrition, education, migration and perceived quality of life.

The direct quantitative benefits normally included in economic appraisal of road investments are discussed as follows:

2.6.1 Vehicle Operating Costs (VOC) Savings

According to Archondo-Callao et al (1994), vehicle operating costs usually includes fuel, lubricants, tires, maintenance and vehicle wear and tear. These costs depend in turn on road geometry (i.e. grades, curves, and super-elevations), road surface conditions (i.e. unevenness or roughness), driver behaviour, and traffic control (ITEA, 2007). Vehicle operating costs are higher on grades and curves, rough surfaces and slower roads. However, changes in any of these parameters will result in a change in vehicle operating costs (DFID, 2005). The component of vehicle operating cost with their approximate respective contribution to the total vehicle operating cost are given in Table 2.4

The ITEA (2007) has classified vehicle operating costs into fuel and non-fuel cost and are given in a mathematical relationship as follows:

$$\mathbf{L = a + b.v + v.c^2 + d.v^3} \quad \text{(Vehicle operating fuel costs)}$$

$$\mathbf{C = a_1 + b_1/ V} \quad \text{(Vehicle operating non-fuel costs)}$$

Where,

L = Consumption expressed in litres per kilometre

v = average speed in kilometres per hour

a = constant per km relating to vehicle operating cost

b and c = coefficient of vehicle operating cost varying with speed

d = value of time of vehicle occupants

Table 2.4: Relative Contribution of Vehicle Operating Cost Component

Component	**Percentage contribution**	
	Private cars	Trucks
Fuel consumption	10 – 35	10 – 30
Lubricating oil consumption	< 2	< 2
Spare parts consumption	10 -40	10 – 30
Vehicle maintenance labour hours	< 6	< 8
Tyre consumption	5 – 10	5 – 15
Vehicle depreciation	15 – 40	10 – 40
Crew costs	0	5 – 50
Other costs and overheads	10 - 15	5 – 20

Source: Integrated Transport Economic Analysis (ITEA), Transport Analysis Guide (TAG) Unit 3.5.6

C = cost in pence per kilometre travelled

V = average link speed in kilometre per hour

a_1 = parameter for distance related cost define for each vehicle category

b_1 = parameter for vehicle capital savings defined for each vehicle a, b, c, d, a_1, b_1, are defined for each vehicle category and are given in Table 10 of Transport Economic Note (TEN10) published by the Department for Transport, United Kingdom.

However, discussions with professionals in the road sector indicates that, in Ghana, primary data collected from the field are used in either Highway Development or Management or Road Economic Decision programs to generate the necessary vehicle operating costs.

- **Vehicle Operating Costs for Non- Motorized Transport (NMT)**

Lebo and Schelling (2001) argued that methods for calculating non-motorized transport user cost savings for road investment have recently become part of project evaluation though non-motorized transport have been important in many locations of the developing world. Recent studies in Bangladesh and Indonesia indicated how to realistically assess change in the cost of transport services by non-motorised transport (Lebo and Schelling, 2001). Head loading, bicycles, rickshaws and animal powered transport are widely used to move both freight and passengers. Where the analysis calls for information on these types of transport, estimates of the costs of operating these various forms of non-motorized transport can be made from surveys of the providers.

2.6.2 Passenger and Freight Time Savings

Time is a resource, just like any physical resource and is therefore valuable. Any project that saves time produces measurable benefits. Time savings are important benefit of transport projects (Mackie et al, 2003). In many cases, the value of time saved is reflected in demand for faster service and the price that consumers are willing to pay for it. The value consumers attach to time saved must be derived indirectly (Mackie et al, 2003).

According to Kerali (2003), there are two main methods of estimating the value of time. They include:

1. Revealed Preference (RP): - this is based on observing choices where people can choose between a slow but cheaper form of transport compared with a more expensive but faster form; and
2. Stated Preference (SP):- this is based on asking people to choose between different combinations of hypothetical choices.

Although the Revealed Preference approach may be considered to be more reliable, in practice the approach is constrained by limited range of choices that are practically available. Because of its inherent flexibility, the Stated Preference approach is now the principal method of valuing time (Kerali, 2003).

Most authors (Belli, P. et al. 1998; van de Walle, 2002; Mackie et al, 2003; DFID, 2005 and ITEA, 2007) consider that the value of time saved depends on the purpose of the trip. Working trips are valued at the value of output produced, net of associated input costs. Trips undertaken for pleasure are valued at the individual's willingness to pay for leisure time. Trips undertaken for the delivery of merchandise have yet another valuation. Value of time savings according to its use is discussed below:

a. The Value of Working Time

According to Belli et al (1998), the most usual approach to valuation of working time is the cost savings approach, which is based on the marginal productivity theory of factor reward. Mackie et al (2003) argued that trips undertaken by a working person during working hours is time not used at work. Working time saved, therefore, is working time that can be used to produce and its value is the value of the additional goods or services produced, net of costs. Under conditions of full employment and perfect labour market, Mackie et al (2003) maintains that, employers will adjust their use of labour to the point where the value of the marginal product is just equal to its marginal cost, that is wage rate plus any other costs associated with employment such as social security taxes, etc. On this basis, savings in working time may be valued at the cost to the employer. In situation of high unemployment rates, or severely distorted labour market, using one or more shadow wage rate would be justified as they would better reflect the opportunity cost of the labour employed (Mackie, et al, 2003).

b. **The Value of Non-working Time**

The value of time saved in trips undertaken for non-working purpose is determined by individuals' willingness to pay (Belli P. et al, 1998). According to DFID (2005), studies have shown that the value put by individuals on journey time savings accruing outside working hours is between 25 – 45 percent of their earnings and that higher unit value of time savings should be ascribed into higher income groups than to lower income groups. In practice however, this is rarely done because it is considered inequitable.

Belli et al, (1998) has recommended that, in the absence of evidence to the contrary, a good rule of thumb is to value all leisure time saved equally and at about 30% of household income. This is supported by studies based on Revealed Preference studies in many countries (DFID, 2005). DFID (2005) further reports that, in the United Kingdom, a flat rate equivalent of 43% of the average hourly earnings are used in the evaluation of non-working time travel savings for all adult employees. Where governments wish to adopt a policy that maximizes gross domestic product rather than leisure time preference, a zero value should be used for leisure time whilst maintaining working time values (Mackie, et al, 2003). On the other hand, DFID (2005) argued that using a percentage of average wage may lead to underestimation of the costs in developing countries because only the comparatively wealthy can afford to travel, even by bus, and certainly by car.

c. **The Value of Walking and Waiting Time**

Studies (Belli P. et al, 1998 and Grant-Muller, S. M., 2001) have shown that, most people hate to wait and to walk for non-recreational purposes. Consequently, walking and transfer times are usually valued more highly than travel time. According to Kerali (2003), recent studies in Europe have shown that the value of time saved in transfer and waiting is valued a third to two times more than in-vehicle time. However, 50% higher than in-vehicle time has been recommended for waiting and transfer time has been reported by DFID (2005).

d. **Valuing Travel Time Savings in Developing Countries**

According to Bryceson et al (2004), valuation of travel time has focused on conventional journey of people by road and reflects the traditional arguments of transport economists. These involve around the use of resource assessment of value or inferring resources value from the behaviour of travellers. Walking trips and those by other non-motorized means of transport have largely been ignored. Moreover, debate has generally centred on the issue of valuing journeys in working time or non-working time. These categorizations are appropriate to the economic and social structure of developed countries, yet they are less helpful when the study population comprises rural household members who are predominately self-employed and characteristically engage in multi-purpose or simultaneous task trips.

The latter is especially true of women who in many societies are the dominant transporters at the house level (Bryceson, 1995). According to Belli et al (1998), most transport economics literature assumes that the majority of the rural population in developing countries will be in non-wage employment and it is therefore considered to be travelling in non-working time which is ascribed a zero value. This clearly does not make sense, either in resource or behavioural terms. Walking journeys consume both energy and time, which are both valuable resources in rural subsistence households.

2.6.3 Accident Costs Savings

Jacobs (1995) argued that investment in road transport projects may affect safety of movement on the infrastructure by either changing the amount of movement undertaken or by changing the conditions in which the movement occurs. The impact may be positive, if the project reduces accidents rates, or it may be negative if the project increases them. For instance, a new road that makes it safe to travel at high speed may actually increase the accident rate if the improvement is not accompany by the additional safety factors such as better markings of lanes, etc.

According to Adams et al (2003), DFID (2005) and Jacobs (1995), there are two steps involved in measuring benefits stemming from accident reduction. The first is to assess the likely reduction in the incidence of accidents. The second is to estimate the value of the reduction in the incidence.

a. Methods of Valuing Road Accidents

In their papers on the cost of traffic accidents and evaluation of accident preventions in developing countries, Hills (1981) and Jones-Lee (1983) as cited in Jacobs G. (1995) and Belli et al (1998) identified six different methods that have been proposed for placing cost on road accidents. In the mid 1970's, Barrett (1975) had identified four of these methods. All the methods outlined were applicable to non-fatal as well as fatal accidents but, for reasons of clarity and simplicity, they concentrated on describing accidents involving one fatality only. The methods are discussed below:

i. **The "Gross Output" (or Human Capital) Approach** – in this method, the cost of a traffic accident involving a fatality can be divided into two main categories. Firstly there are the costs that are due to a loss or diversion of current resources and secondly there are the costs due to a loss of future output. Included in the former were the cost of vehicle damage, medical treatment and police/ administration costs. Usually there is little disagreement as to what should be included in this category. Determining loss of future output of the person(s) killed however, is unclear. Usually, average wage rates are used to determine lost output both for the year in which death occurred and then for future years discounted to present year value. Estimates are based on average (i.e. national) outputs or earnings data together with appropriate estimated damage, medical and police costs. According to DFID (2005) and Belli et al, (1998), in some variants of this approach, a significant sum is added to reflect the "pain, grief and suffering" of the accident victim and to those who care for him or her.

ii. **The "Net Output" Approach: -** This differs from the above in that the discounted value of the victim's future consumption is subtracted from the gross output figure. It may be difficult to visualise how an estimate can be derived of what a person "consumes" (in terms of food and fuel etc) throughout his or her lifetime. When this method was use in United Kingdom to cost accidents (being replaced in the early 1970's by the gross output approach), the "total consumer expenditure and the public authorities "current expenditure on goods and services" was divided by the total population. A crude estimate of "consumption per head" was thus obtained. In this approach the difference between an individual gross output and future consumption may be regarded as a measure of the rest of society's economic interest in his or her continued survival.

iii. **The "Shadow Price" Approach** derives from society's political judgement, an implicit value of human life in cases where death are increased or decreased by public policy.

iv. **The "Insurance Method"** seeks to calculate the value a man sets on his life from the premium he is willing to pay and the probability of his being killed in a particular activity.

v. **The "Court Award" Approach** – with this approach, the sums awarded by the courts to the surviving dependents of those killed or injured as a result of either crime or negligence are regarded as an indication of the cost that society associates with the road accident or the value that it would have placed on its prevention. In the United Kingdom for example, the sum awarded by the courts must take into account complex issues such as degree of negligence of the defendant, whether the person killed or injured was partly to be blame, whether or not the employer of the injured person is continuing to pay them any wages and whether industrial injury benefits are to be paid. In addition, any sum awarded by the courts will have all taxes removed (Jacobs, 1995). From the above, it can be seen that to use court award as implied value for loss of life in an accident would be very much an imperfect solution.

vi. **The "Value of Risk Change" or "Willingness-to-pay" Approach** – this is base on fundamental premise that decisions made in the public sector concerning the allocation of scarce resources should reflect the preference and wishes of those individuals citizens who will be affected by the decisions (Jone-Lee, 1989 as cited by Jacobs, 1995). Accordingly, the value of a given improvement in road safety (i.e. reduction in risk) is defined in terms of the aggregate amount that people are prepared to pay for it. Conversely the cost of reduction in safety is defined in terms of the amount people would require in compensation of the increased risk. More specifically, the value of a particular safety improvement is defined as the sum of the entire amount that people (affected by the improvement) would be willing to pay for the (usually very small) reduction in risk provided by the safety improvement. Thus the value of prevention of one accident involving one fatality is defined as the total amount that all affected individuals would pay for the very small risk-reduction, both for themselves and for those they care about.

There are difficulties associated with each of the above approaches to the valuation of human life. The Gross Output Method depends on the Gross National Product being the sole criterion for economic performance. It does not take account of the other goods and factors such as the suffering of the victims, the loss of utility from being alive, and the bereavement of relatives and friends. Beesley and Evans (1967) as cited in Jacobs (1995), argued that gross output is also subject to qualification as a measure of the value of life. No one would surrender the whole of his future income to escape a fatal road accident unless he preferred death by starvation. Income net of subsistence costs is suggested as the amount, which people would pay in order to escape death.

The Net Output Approach could lead to the death of a person whose productive life span had ended being treated as a benefit to society. It measures only the effects on the survivors of the death and does not include the loss to the victim. The Net Output approach was also criticised by Barrett (1975) and Jacobs (1995) on the grounds that, if benefits are measured after the fatal accident has been prevented, then the person saved is alive to enjoy his consumption. The Consumption should not therefore be deducted from output and a gross output estimate of cost should be used.

According to Jacobs (1995), the derivation of a value for human life from the political process faces many difficulties. Governments in any democratic environment are elected on a general mandate. It is not usual to have a popular voting on a particular item of expenditure. There may also be wide disparities in the value of human life derived from different public programme.

The valuation of a life based on insurance premium only provides for compensation to others. The amount of insurance a person takes is an indication of his concern for his family and dependents rather than an index of the value he sets on his own life (Barrett S., 1975).

In addition, Belli et al (1998) argued that, the important factor missing in all six approaches is the “Pareto Compensation Principle”. This principle states: “The value of a person’s life is the minimum amount/sum he is prepared to accept in exchange for it”.

Jacobs (1995) maintains that, the calculation of this figure would require conditions of certainty in the project evaluation. If the project in question required the death of a specific person, the value of life to that person could be ascertained and included as cost of the project. Only after compensating this person fully would it be possible to make all members of the community better off by redistribution of the net gains. Under conditions of uncertainty only the risk of injury rather than its certainty can be included in the evaluation. The costs to be included are sums required to compensate all persons in the community for the additional risk to which they are exposed.

Jacobs (1995) was therefore not surprised that the six approaches discussed above produced substantially different costs and values for accident involving one fatality. Jone-Lee (1983) emphasise the point that the method used for costing road accident depends on the objectives being pursued (i.e. either for maximisation of national output objective or for pursuit of social welfare objectives like minimisation of injury accidents or fatalities in relation to traffic). The most appropriate of these is the “willingness to pay” approach, but there is difficulty in obtaining reliable empirical estimates and so the “gross output” approach is preferred.

In order to capture some of the ‘humane’ considerations reflected in the “willingness to pay” approach, DFID (2005) recommends that, the “gross output” values be augmented by a further allowance for pain, grief and suffering of those involved in road accidents. The percentage additions to the total resource costs for fatal, serious and slight accidents of 46%, 100% and 8% respectively may be used as a first approximation.

b. Classification of Accidents

DFID (2005) has defined accident according to severity as follows:

i. **A fatal accident** is one in which one or more persons are killed as a result of the accident, provided death occurs within 30 days;

ii. **A serious accident** is one in which there is no deaths but one or more persons are seriously injured i.e. usually detained in hospital as an in-patient;

iii. **A slight accident** is an accident in which there are no deaths or serious injures but a person sustains an injury of a minor character such as a cut, sprain or bruise or receives outpatient treatment;

iv. **Damage-only accident** is one in which no one is injured but damage to vehicles and/or property is sustained.

Accident severity is defined by the most serious casualty class of any of the victims of the incident and road accidents are normally costed by the class of the accident. Thus the 'cost of an accident' is not the same as the 'cost of casualties' resulting from that accident (DFID, 2005).

c. Costs of Accidents

The costs associated with a road accident may include:

i. Value of the lost of output

ii. Cost of medical treatment

iii. Cost of damage to vehicles and other properties

iv. Administrative and other costs

v. Subjective or "human" cost including pain, grief and suffering.

2.6.4 Economies in Road Maintenance

According to TUDTR (2005), savings in road maintenance cost are a potential benefit from many types of project and are particularly welcome because they release scarce resources for maintenance of other roads. Maintenance savings can normally be obtained with the following types of projects:

i. Paving a gravel road where traffic levels have increased;

ii. Strengthening or reconstructing a road which has deteriorated badly.

These benefits are discussed as follows:

a. Paving Gravel Roads

In order keep gravel roads in an acceptable and economic conditions, their surface will normally need grading several times a year and regravelling every few years. The frequency at which these activities are needed depends on the level of traffic, the type of gravel material and local climate (Archondo-Callao, 1999b). As traffic levels increases, the frequency of the maintenance activity needs to be increased and eventually the cost of maintenance is so high that it becomes cheaper to provide a paved road (Archondo-Callao, 1999b).

The actual traffic level at which paving becomes economic varies depending on factors like relative costs of grading, regravelling and paving which, in turn, will depend on local circumstances. The higher the relative cost of grading and regravelling, the lower will be the traffic level at which paving becomes justified (Archondo-Callao, 1999b).

b. Strengthening and Reconstruction

A bitumen road with a rapidly deteriorating surface needs increasing amount of maintenance if it to continue serving its intended purpose. A bitumen road may require patching of pothole, repair of eroded edges or shoulders, sealing and repairing of cracked areas (spot improvement). Compared to this, the overlaying or reconstruction of the road can produce immediate savings by eliminating the need for continuous routine maintenance, although future periodic maintenance will still be needed (DFID, 2005). It is however, important to strengthen pavements before they deteriorate to the extent that their structural integrity is lost.

2.6.5 Social Benefits of Road Investment

Economic justification for change in low-volume rural access road transport condition rest mainly on the impact of road investment on local economic development, manifesting itself in extra generated traffic (Archondo-Callao, 1999b). However, according to most authors (van de Walle, D. 2002; DFID, 2004 and DFID, 2005), there are problems with current appraisal methods for estimating and valuing generated traffic. As a result, the rate of return on low-volume rural roads is often insufficient, on a quantified economic basis, to justify expenditure compared to other public investments.

Studies (Belli, P. et al. 1998; van de Walle, D. 2002; Hine, J. 2003 and DFID, 2004) indicate that, social benefits are a wide range of multi-dimensional, interactive and complex non-economic benefits that arise from changes in transport conditions. These include such things as:

- Improved social networks and enhanced social capital that are acquired by maintaining links with family members outside of the immediate rural area;
- Improved health and education through easier access to services, particularly with regards to maternal mortality and girls education; and
- Improved services delivery by clinics and schools and associated staff attendance.

According to Hine (2003), providing access and mobility to a range of activities and opportunities, transport must inevitable have a social impact which is likely to be profound. Social movements cover trips to health centres, hospital, schools, government office and visit to friends and relations. They are important because they strengthen the social capital of the individual and may help in personal or community crisis (Hine, J. et al., 2002).

According to van de Walle (2002), social benefits arising from changes in rural transport conditions can be seen as:

- Improved social network and enhanced social capital from people finding it easier to maintain links with family members outside of the immediate rural area;

- Enhanced community development that may arise from the community working together to maintain or improve their own transport conditions;
- Increased confidence in an ability to travel to access services and opportunities; and
- Improved health and education through easier access to services;
- Reduced vulnerability to unexpected events and socks from crop failure, accidents and poor security;
- Greater reliability of clinics and schools in securing staff and easier maintenance of these services because drugs can be supplied and school supplies replenished; and
- Reduced time burdens from engaging in travel due to the improved environmental impact of roads (e.g. less dust) and increased transport services frequency.

The social benefits of changes in transport conditions are best measured with the use of proxy indicators. These indicators are based on participatory enquiry which seeks to estimate a community perspective of how transport influences their lives and livelihoods (Grootaert, 2002). Some of these indicators are presented in Table 2.5 below. In order to identify perceived and actual social benefits for individual cases and to undertake consultation and sensitization of local communities for defining and assessing road appraisal option, it is advised that a robust methodological approach be adopted for measurement of social impact (Hine, J. et al, 2000a).

Table 2.5: Indicators for Social Benefits

Social Benefit	**Indicator**
Increased access to education services	▪ Number of schools (primary and secondary) per 100 children in each settlement ▪ Enrolment to primary and secondary school (proportion of children) ▪ Actual attendance at school (frequency) ▪ Distance to primary and secondary schools and tertiary college ▪ Cost of attending school (transport and school fees) ▪ Literacy rate
Increased access and use of health services	▪ Distance to health facilities (health post, ;local clinic, hospital) ▪ Number of health facilities (health post, local clinic, hospital) per 100 in each settlement ▪ Attendance at health facility (frequency) ▪ Cost of attending health facility (transport and medical fees) ▪ Life expectancy
Greater access to income and marketing opportunities	▪ Proportion of expenditure on social/transport activities (well-connected compared to remote rural settlement) ▪ Economic growth measured by improved living standards and income/expenditure ▪ Access to/ownership of transport means by income group ▪ Acquisition of credit – proportion of trips and cost of journeys to community associations ▪ Unemployment rates
Improved transport and mobility services	▪ Transport fare per km ▪ Proportion of expenditure on transport ▪ Proportion of sample that commute to work and commuting time ▪ Improved mobility ▪ Distance to transport pickup point ▪ Passability during wet/dry season ▪ Transport fare per unit of goods ▪ Cost of fuel per litre
Enhanced social network and improved social capital	▪ Production of expenditure on social activities by income groups ▪ Distance to social activities ▪ Frequency of social trip-making ▪ Cost per km of social trip ▪ Number of places of worship per 100 people in each settlement ▪ Proportion of social visits undertaken by men/woman/boys/girls ▪ Access to/ownership of communications means, by income group ▪ Rate of migration to/from settlement.

Source: Overseas Road Note 5, "A Guide to Road Project Appraisal", Transport Research Laboratory, Overseas Development Administration, 2005, Pp. 111

2.7 SENSITIVITY AND UNCERTAINTY ANALYSIS

The economic analysis of projects is necessarily based on uncertain future events. The basic elements in the cost and benefits streams of road projects, such as inputs and output prices and quantities, seldom represent certain, or almost certain, events in the sense that they can be reasonably represented by single values (Gwilliam, 2000). Uncertainty and risk are present whenever a project has more than one possible outcome. The measurement of economic costs and benefits, therefore, inevitably involves explicit or implicit probability judgements (McMahon, 1997).

2.7.1 Contingency

DFID, (2005) has stated that, it is usual to include in the estimates of capital costs a separate allowance to cover contingencies. There are two types of contingency allowance namely:

(a) Expected Costs – This cover costs which have not been separately identified, but which experience indicates must inevitably occur during the construction period. A lump sum amount is normally used to cover a variety of items;

(b) Tolerances – This form of contingency allowance is an estimate, usually based on past experience, of the probability of unforeseen costs arising and their probable magnitude. Tolerance reflects the fact that costs may overrun due to physical contingencies, such as unexpected poor ground conditions or lack of finance which prolongs construction time.

According to DFID (2005), expected contingency allowance of up to about 25 percent of Construction cost is normal for road projects in developing countries. It is not necessary to make allowance in an economic appraisal due to inflation during the construction period provided that all prices are expressed in terms of constant base year values.

2.7.2 Sensitivity Analysis

Sensitivity analysis assesses risk by identifying the variable that most influence a project's net benefits and quantifying the extent of their influence. It is carried out by varying the magnitude of the more important variables, normally one at a time, while keeping the values of the remaining variables fixed (Belli, P. et al, 1998). By looking at higher and lower figures than those expected, it is possible to determine how sensitive the Net Present Value is to such changes. The variables that are chosen for testing is a matter of judgement but, for most road schemes, the following are normally considered: baseline and forecast traffic volumes, project costs, delay in implementation, generated traffic, time and accident savings, shadow prices, maintenance and special factors like implementation of other major development projects and natural occurrences which may affect the benefits of the road project (Belli, P. et al, 1998).

Sensitivity analysis, according to DFID (2005) has the following limitations:

- It does not take into account the probabilities of occurrence of the event;
- It does not take into account the correlations among the variables; and
- The practice of varying the values of sensitive variables by standard percentage does not necessarily bear any relation to the observed (or likely) variability of the underlying variables.

However, sensitivity analysis is appropriate for initial identification of sensitive inputs or parameters. One of the most preferred approaches to undertaking sensitivity analysis is "switching of values" (Belli, P. et al, 1998).

2.7.3 Risk Analysis

The Asian Development Bank (2002) defined risk as a "quantity subject to empirical measurement". Thus, in a risk situation, it is possible to indicate the likelihood of the realized value of a variable falling within stated limits – typically described by the fluctuations around the average of a probability calculus.

Risk analysis, in its simplest form, requires specifying the probability of an individual inputs variable attaining a range of value. Using this, the probability distribution of the Net Present Value and other output parameters can be determined. Risk analysis provides a better basis for judging the relative merits of alternative projects, but it does nothing to diminish the risk (Asian Development Bank, 2002).

Some risk identified by the sensitivity analysis can be reduced by carrying out further field investigations and redesign which may or may not be worthwhile depending on the cost of the investigation and the expected reduction in the risk. Risk may also be reduced by adopting more flexible approach to design and construction (Asian Development Bank, 2002).

2.7.4 Monte Carlo Simulation and Risk Analysis

Proper estimation of the expected NPV of a project normally requires the use of simulation techniques. Simulation is the only simple and generally applicable procedure for overcoming the limitations of sensitivity analysis, calculating the expected NPV, and analysing risk (Asian Development Bank, 2002). Simulation usually requires more information than sensitivity analysis, but the results in terms of improved project design are worth the effort (Asian Development Bank, 2002).

Proper estimation of the expected NPV requires three steps, namely:

- Specifying the probability distribution of the important uncertain components;
- Specifying the correlations between the components;
- Combining the information in the two above steps to generate the expected NPV as well as the underlying probability distribution of projects outcomes.

It is generally impossible to generate the underlying distribution and calculate the expected NPV through mathematical analysis and the analyst must rely on computer-generated simulations (Asian Development Bank, 2002).

2.8 SUMMARY

The general principles of project appraisal and various economic appraisals of road transport projects approaches were reviewed in this chapter. Specific issues highlighted includes general definition, objectives and processes of road project appraisal, economic evaluation criteria for selecting road candidates for investment and comparative analysis of economic and financial appraisal. Expected impact of road investment, economic appraisal techniques and computer based appraisal models were also reviewed. The other issues considered in this chapter were costs and benefit variables as they pertain to economic appraisal of road projects in general and sensitivity and uncertainty tests appropriate to economic appraisal of road project investment.

CHAPTER THREE – FEEDER ROADS PROJECT APPRAISAL

This chapter presents an overview of economic appraisal approaches with specific reference to feeder/rural road projects in developing countries.

3.1 FEEDER ROADS APPRAISAL METHODOLOGICAL ENHANCEMENT

Recently, two methods have been proposed to enhance feeder road appraisal techniques approach to 'social benefits'. These were: van de Walle (2002), and the United Kingdom's Department for International Development (DFID) funded study that designed and tested an appraisal technique in three locations in developing countries (DFID, 2004). A brief examination of these approaches is presented below:

van de Walle's methodology is an approach that has been developed in accordance with evaluating 'best practices' of prior rural road investigations by the World Bank (van de Walle, 2002). The methodology is defined as an attempt to aid selection of rural roads by developing an "operational approach that is grounded in a public economics framework in which efficiency and equity concerns are inseparable" (van de Walle, 2002).

The main tenets of this approach are as follows:

- the informational basis is grounded in key indicators. For example, school enrolment, income, and consumption;
- this data is to be collected at community level;
- the methodology is 'participatory' in that focus groups are held with Non-Government Organisations in consultation with local and international experts to assign weights to aid prioritisation of equity and efficiency indicators;
- money for upgrading rural roads is to be distributed amongst provinces based on defined criteria.

This study was initiated by van de Walle virtually simultaneously to develop the above methodology in Vietnam. The objective of this study was to expand knowledge of the impact of rural roads and aid the development of ex-ante evaluations and monitoring indicators (van de Walle, 2002).

The commune questionnaire designed for the Vietnam project resembles the World Banks Living Standards Measurement Survey design. The survey was divided into a number of different sections, such as, employment, living standards and, transport and infrastructure. Various dimensions of indicators were covered in these sections. For example, the 'economy' section covers economic indicators such as income earning opportunities, while the 'living conditions' section covers social aspects of wellbeing such as housing conditions and perceptions of change (van de Walle, 2001). The 'hybrid' method of assessment proposed by van de Walle would draw together a number of these dimensions in order to assess poverty in a broader amalgamated fashion than say looking purely at income (Porter, 2005).

According to Porter (2005), van de Walle's methodological 'bite' was more than a basic utilitarian approach of 'the greatest good to the greatest number'. She devises an approach where the instrumental freedoms that people enjoy in a commune can be judged comparatively and in reference to equity criteria. This could contribute positively to a more effective and equitable provision of roads. Especially commendable was the attempt to make explicit and transparent in assigning weights thereby helping to come to terms with the inherently political nature of the weighting process which can be hidden within coding formulas in some Cost Benefit Analysis (CBA) approaches (Alkire, 2002).

According to Porter (2005), the methodology still has three areas of shortcomings identified through a capability based examination in particular reference to Sen (1999). First the aggregation of results at commune levels leads to distributional indifference, that is, it is difficult to understand differences within the community. There were issues in comprehending the relative inequality within a certain commune in different dimensions of life if the 'sum total' is taken. People could be relatively rich in a number of dimensions, but totally impoverished in an important or valued area against which the weightings are biased. Further aggregated scores in an area of high inequality can upwardly shift averages and lead to analysis that is biased against the poor living side by side with extreme wealth, a not entirely unfamiliar scenario within the African continent.

Secondly, alternative valued freedoms and choices could be neglected in this approach. In van de Walle's methodology, information was excluded that could be of concern to people (Alkire, 2002). Though many instrumental freedoms were measured, certain substantive freedoms would not be registered in the community level survey. In Soviet Russia, for example, it could be imagined that a person was able to live in reasonable housing and have a job, and their children have access to schooling, but yet not have the freedom of worship. Instrumental freedoms measured by pre-set objective indicators do not tell us, necessarily, what a person values, and what choices they may make if they were able. Pre-set indicators can close off important areas of analysis and understanding (Porter, 2005).

Thirdly, exploration and enhancement of individual agency is not undertaken in this approach. van de Walle's appraisal does not investigate either the extent to which people's choices may have been enhanced, or the choices that they would make regarding an intervention. Free agency in rural road appraisal needs to be given space in order to examine the effectiveness of a development intervention. Proxies may point to instrumentally important areas of change, but it is not clear whether people value these areas, or would have chosen change in these areas (Porter, 2005).

In summary, peoples desired freedoms and achievements of well-being and agency aims in van de Walle's methodology cannot be fully appreciated. Inequality within and between different places was shrouded by aggregation (Porter, 2005).

The Department for International Development (DFID) of United Kingdom funded study, which developed the 'Overseas Road Note 22' makes use of a different informational basis to van de Walle's. The Overseas Road Note 22 document is one of the final deliverables in a Department for International Development funded research and knowledge project. The production of the 'Overseas Road Note 22' document followed a logical process: inception drew together a wide grouping of social scientists and engineers from across the developing and developed world to advise on the production of a methodology; testing of the methodology was implemented in three countries with a variety of social and topographic environments, Vietnam, Ethiopia, and Zambia; finally reporting produced the main bulk of documentation analysed in this study: the ‘Overseas Road Note 22’ methodology (DFID, 2004).

The **‘Overseas Road Note 22’** approach sought to investigate the impact of roads as a medium for the enhancement of social benefit. This was demonstrated by the three main objectives of the study:

- analysing the social benefits and costs of rural road improvements;
- examining the “differentiation in the experience of social benefit and cost;
- testing techniques for rapid appraisal of rural people’s perceptions and preferences vis-à-vis rural road development relative to other investments.

According to Bryceson *et al*, (2004), to realise these objectives would involved developing a range of techniques for differentiating and understanding the social impacts of roads. The implication of these objectives was that, in operation, they take into account a broader informational basis than van de Walle’s.

The ‘Overseas Road Note 22’ methodology was explicit on the need for individuals and groups in the local community to provide information beyond that sought in the household surveys of the project. A variety of local level informants were interviewed and focus groups sessions were undertaken with men, women and high school students from across wealth brackets defined by community leaders, being interviewed in different focus groups. These interviews were aimed at understanding the “community’s perceptions of social costs and benefits attributed to transport interventions” (Bryceson *et al*, 2004). The focus groups “were designed to be participatory not prescriptive”. The linking of focus groups with household surveys overcomes in part one of the criticism of van de Walle’s approach (Bryceson *et al*, 2004). Inter- and Intra-group inequality which impacts well-being can come to the fore in the ‘Overseas Road Note 22’s methodology. Experiences and inequalities, for example within gender and income, were disaggregated within the results.

Though the ‘Overseas Road Note 22’ study was framed in a manner that would seem attempts to be open in its informational basis - indeed in all three community survey tools opinions were sought expressly on the advantages and disadvantages of transport intervention in open-ended questions - three areas of concern arise. First, inequality in different spaces is still shrouded within results (Bryceson *et al*, 2004). The focus groups were designed to elicit information specifically on social movements and household surveys on various instrumental freedoms not on doings and beings important to participants. The pair-wise ranking procedure, for example, was an interesting and commendable method to help understand trade-offs between different ends, social and economic (Bryceson *et al*, 2004). However, participants again did not define what the trade-offs were. Instead 'indicators' were chosen a priori, avenues of discussion and important information were therefore closed off.

Second, and related to the first point, many of the focus group indicators are centred on understanding mobility and accessibility within the village, for example, nine of the ten questions in the focus group session are concerned to some degree with accessibility and mobility. The downstream influence of this was that the results reflect an '*N*' of social movements, a number of social excursions taken, rather than the value that is attached to the movement by participants (Bryceson *et al*, 2004).

Third, a more open pair-wise ranking scheme and focus group methodology would help to comprehend the trade-offs outside of the area of well-being. This would enhance understanding of the desired ends of the community, allowing them to state courses of action in which certain needs could be left unattended to. Helping assessors to comprehend how choices may have altered as a result of the intervention (Alkire, 2002).

Therefore, the 'bite' of the 'Overseas Road Note's informational basis does appear broader than van de Walle's, yet the methodology, based on the results from the field tests, suffers from much the same concerns (Porter, 2005). In the practical experience of Oxfam, it was found that output indicators can 'crowd out' impact indicators (Roche, 1999). The methodology tries to gather too much information on social movements, output indicators which were more easily quantified, and were analysed to the detriment of the open-ended questions on the valued and disvalued impacts of the rural road intervention (Roche, 1999).

In summary, both approaches were admirable in their attempts to gather a deeper understanding of the expansion and enhancement of knowledge in rural road appraisal. Van de Walle incorporates equity concerns with efficiency concerns, while the ‘Overseas Road Note 22’ starts to open up broader informational avenues of appraisal demonstrating a concern with community inequality and issues of movement and accessibility in the broader scope of transport changes.

3.2 APPROACHES TO APPRAISAL OF FEEDER ROADS PROJECT

The following is a discussion on various approaches to appraisal of schemes to upgrade low volume rural or feeder roads in developing countries. The schemes discussed below are not in any order of preference:

3.2.1 Economic Index and Trafficability Index

Ellis and Hine (1997) have identified two economic indices, one suitable for medium to high volume roads and a revised index for low volume roads. The economic index for medium volume roads is:-

$$\text{Economic Index} = \frac{\text{Traffic x Road Condition}}{\text{Cost}}$$

where,

Traffic	=	Average Daily Traffic (ADT)
Road condition	=	Roughness (1000 mm/km)
Cost	=	Cost/km of improvement in US$

This method for assessing priorities was considered not practical for low volume roads so the traffickability index was developed:-

$$\text{Traffic Index} = \frac{\text{ETW} \times [\{(\frac{\text{CST}}{10})\,\text{x}\,5\} + \text{CRC}]}{\text{CMI}}$$

Where,

ETW	=	Equivalent Traffic Weight (in person units)
CST	=	Change in Traffickability
CRC	=	Change in Road Condition
CMI	=	Cost of Maintenance Intervention

A notable point about this method was its use of an ETW, which recognises and measures all types of traffic which uses feeder roads. The weighting for each mode are shown in the Table 3.1 below.

Ellis and Hine (1997) used the traffic weight to reflect accurately the demand for transport on a road. According to Ellis and Hine (1997), the economic index can be enhanced by adding additional social dimension of 10 accessibility criteria all weighted as a percentage of the ETW. For example if the ETW for a road is 100, a hospital on the road has a 5% weighting, the revised ETW is 105. Calculations of the other variables are given in more detail in the paper by Ellis and Hine (1997). Road projects can then be ranked by the economic index score.

Table 3.1 Equivalent traffic weight for each Transport mode

Transport Mode	**Equivalent Traffic Weighting (ETW)**
Pedestrian	1
Bicycle	1.4
Motorcycle	1.7
Animal	5
4 x 4 and cars	10
Small Bus	17.5
Tractor	40
Truck	50
Large Bus	49

Source: Ellis and Hine, 1997

Advantages of this method are that (a) it recognises seasonal variations in trafficability, (b) outlines ways of calculating costs and (c) takes account of social activities that may be influenced by the road.

3.2.2 Robinson's Consumer Surplus Method with Ranking

Robinson (1999) has developed a method for incorporating the consumer surplus approach, a change in transport mode, economic and social benefits and a ranking procedure to prioritise road improvement projects.

Vehicle operating costs were calculated using measures of road roughness. Benefits from changes in transport mode (from walking to using motorised means) were assessed by calculating the changes in costs and benefits between the modes. Social factors were converted into the same units as vehicle operating cost savings based on population size. However, subjective judgements were still required to assess the relative worth of the social benefits.

Once the benefits of each project have been assessed, a simple ranking procedure was used to determine priorities based on the first year rate of return. This is the sum of the benefits in the first year after project completion divided by the present project cost. Robinson (1999) argued that using the first year rate of return method, discounting and inflation effects do not need to be considered.

This method of appraisal appears fairly comprehensive tapping into a number of different techniques. However, little is said about the process of local consultation and on the ground data collection.

3.2.3 Socio-economic Evaluation and Upgrading of Rural Roads in Ecuador

Work by Greenstein and Bonjack (1983) concluded that evaluation of rural roads was best executed in two stages. Firstly, a threshold analysis, a screening process based on the traffic volume in vehicles per day. A fairly detailed economic analysis is then conducted of each scheme to give measures of Net Present Value (NPV), Internal Rate of Return (IRR) and First Year Benefit Rate (FYBR). These economic indicators were then analysed together with social factors. This study only analysed population density and rate of illiteracy, arguing that the higher the population density, the greater the social benefits that will be achieved by a road scheme.

3.2.4 IT Transport's Prioritisation Procedure for Low Volume Roads

Airey and Taylor (1999) of IT Transport have produced a screening and ranking prioritisation procedure for low volume roads that is still economic in it's approach but moves away from the traditional consumer surplus and cost-benefit appraisal methods. It is aimed at appraising and prioritising road schemes for very low volume roads carrying an average of less than 25 vehicles per day. The methodology begins with a preliminary screening process to identify low volume roads projects that are likely to provide the greatest benefits. The identified roads were divided into two groups, impassable and passable. Improvement schemes for impassable roads were ranked according to cost per head using the formula:

$$\text{Cost/head} = \frac{\text{Estimated Cost of Min Improvement Wks}}{\text{Population Served by Improved Wks}}$$

Improvement schemes for passable roads with less than 25 vehicles per day the following prioritisation index was used:

$$\text{Prioritisation Index} = \frac{[\text{Dist. Trips} + \text{Fisheries Trip} + \text{Agric Trip}] \times \text{Access Change}}{\text{Rehabilitation (Spot Improvement) Cost}}$$

where trip values were allocated for motor vehicle traffic generated by the following activities:

District trips	=	those generated by district services
Fisheries trips	=	those generated by all fishery activities
Agricultural trips	=	an index calculated by: Number of households x marketed production per household x round trips per tonne of marketed production
Access Change	=	on a grading of 0 (very poor) to 5 (good) After rating – before rating.
Rehabilitation Cost	=	improvement costs as estimated to be charged by contractors in ,000 US$/km.

The figures for the index were generally based on estimates. If more time was allowed for projects, actual traffic counts could be made. Those roads showing a high prioritisation index were given the highest priority.

Using calculations of internal rates of return, it is claimed that the prioritisation index can be related to conventional economic analysis. However, a number of assumptions have to be made.

Advantages of this method are that its application was relatively simple and transparent and it allowed limited local level involvement by allowing political debate. A great advantage is that it is claimed that it can be used in most situations in the developing world and is not specific to one area.

The main disadvantages relate to the subjectivity of the definitions within the prioritisation index and the number of assumptions made when relating the index to conventional economic analysis. There is an argument that obtaining population data at the level of the "zone of influence" may prove difficult. Researchers in Ghana have found that small rural settlements do not appear on maps and census data is often out of date (Hine et al., 2001)

3.2.5 Zambian Assessment Framework for Feeder Roads

This approach to feeder road assessment, developed by the Zambia National Road Board (1998), considers three main areas, namely network considerations, social factors and economic factors. The initial screening process examines the road network in each district. Roads to be included for upgrade consideration must satisfy basic network criteria, including links with national roads, non-duplication, and access to large populations. The social and economic factors are summarised in Table 3.1 and Table 3.2 respectively.

Table 3.2. Social Factors and data Requirements

Social Factors	**Data Requirements**	**Measurement Unit**
Population served by road	Population per km of road Area influenced by road	Number of people Road distance Size of area
Presence and intensity of social infrastructure	Types of facilities Number of facilities	Description Number
Potential increase in traffic volume and mobility of people	Existing type and traffic volumes Potential and type of traffic volume	Numbers of current vehicles on road segment Potential number and type of vehicles
Employment creation potential	Number of both direct and indirect jobs to be created Potential wages and incomes	

Source: Republic of Zambia National Road Board (1998)

Table 3.3. Economic factors and data requirements

Economic Variables	**Data Requirements**	**Measurement Unit**
Historical and current agricultural production	Value of marketed products	Current production levels (marked quantity x price)
Potential agricultural production	Arable agricultural area (ha) Area under cultivation (ha)	Potential tonnage of crops Potential livestock tonnage
Production facilities and services	Storage depots Extension centres/camps Retail trade services	Number of facilities Capacity of facilities Presence of centres
Planned future development activities	Type of planned future developments	Number of ongoing projects

Source: Republic of Zambia National Road Board (1998)

Road projects are ranked by their score on the Social Economic Justification Index (SEJI), the higher the score the greater the justification.

The Social Economic Justification Index (SEJI) is derived as follows:-

Each social and economic factor is given a corresponding rating:-

0 – 2.0 (low)

2.1 – 6.0 (medium)

6.1 – 10.0 (high)

An average rating is then calculated for the social factors (Social Dimension Index, SDI) and for the economic factors (Economic Dimension Index, EDI). The SEJI is the average of the sum of the SDI and the EDI.

$$\text{SEJI} = \frac{(\text{SDI} + \text{EDI})}{2}$$

The transfer of actual numbers of facilities, tonnage of output, etc., into the qualitative bands is somewhat subjective as it is up to the discretion of the researcher. Local consultation with stakeholders is suggested to identify if any weightings should be applied to the indices. Again this adds a subjective element into the analysis.

A problem with this method is how to measure and predict the potential output/increases in variables due to the upgraded road. However, a good coverage of the social factors and units in which they are measured and the flexibility to weight indices according to information gained through local consultation help align this method to the criteria requested for the development of a prioritisation methodology.

3.2.6 Contingent Valuation Method (CVM)

This is a quantitative method using a survey to determine the communities' willingness to pay (WTP) for a new amenity such as a new or upgraded road. The study conducted by Nahem (1996) cited by Hine et al., (2000b) used a hypothetical scenario that requested villagers in Laos to disclose how much they would be willing to pay for an upgrade of their existing dirt road to an all-weather gravel road. Surrounding questions on lifestyle, travel patterns and perceived benefits of the road were also asked. The mean value of the WTP from the total number of people sampled can be determined and aggregated to the total population. A Tobit Regression Model was used to determine what variables are important in explaining why people are willing to pay for an improved road.

Advantages of using CVM in the feeder roads context is that it determines the value that local people put on the provision of a road having identified perceived benefits. The result is quantifiable in monetary terms which allow comparison with other schemes. The CVM is also flexible as it allows hypothetical scenarios to be put to people and tested to determine preferences.

The main disadvantage of the CVM is similar to MCDA in the logistics of reaching and interviewing in detail residents of the relevant villages and/or towns and the related costs and time involved. Communication problems may exist which may amplify various survey biases and working through an interpreter may result in lost or impeded information (Hine et al., 2000b). Areas of bias include strategic bias, compliance bias, starting point bias, income constraint and information bias. The 'free-rider' problem, if the respondent believes that the road will be built anyway and fearing they may be asked to pay the price they state, therefore they state a low price. However this can be overcome by ensuring respondent anonymity. Another problem with CVM accounting in monetary terms is that in rural areas of developing countries wealth is determined by factors such as land and livestock, rather than in monetary units. The method is also based on notion of individualist culture, as in Western Europe, whereas in developing countries a more collective society exists. This leads to suggest that one questionnaire per village given to the village leader as a representative of the collective will suffice.

A CVM does meet the requirement of involving local people in determining the value of improving low volume feeder roads although its accuracy at assessing the benefits based on the willingness to pay method has to be questioned given the potential for bias.

3.2.7 Community Access Road Needs Study (CARNS)

Developed from a procedure used in KwaZulu Natal the "Moving South Africa" project used the CARNS methodology in determining priorities for rural road upgrades in the Eastern Cape Province of South Africa, reported by Lipman (1999). The aim of the CARNS was to identify the probable usage of an upgraded road. Points were awarded for the size of the community and facilities along the road such as health, social, educational, religious, agricultural and business. The total points are divided by the length of the road to give a rating value per kilometre. This system of point allocation was undertaken using data from desk research, and then using data provided by district level government and community members having being trained on simple data collection methods.

Any differences between the two results were discussed with the community, however the review of this method does not indicate how the differences were resolved (Hine J. et al., 2001).

A merit of this methodology is that it compares objective desk research data with possibly more subjective data provided by local communities and allows the possibility of reaching a solution acceptable across the board. However in some countries, recorded data may be very limited and therefore more reliance will have to be placed on that provided by the communities. The cost, time and logistics of training and helping the district governments and communities in data collection methods may be a disadvantage of this method.

3.2.8 A Do-it-Yourself Screening Method Based on Benefit-Cost Ratio.

Weatherell (1984) suggests a simple objective method of ranking rural road projects based on the comparison of the value added benefit from crop planting with the cost of improving and maintaining the road. Rates for each benefit are predetermined and a double sided worksheet is used on which data is entered and calculations made. A graph is used to show the results comparing the minimum planting that can justify road development with the number of households in the area. Thus a priority rating is obtained.

Advantages of this method are its simplicity, allowing local project staff to carry out the appraisals, and speed of assessment. However, limitations include the basis that benefits are determined by new or intensified agricultural activity rather than overall social benefit, and the assumptions of uniformity of construction costs and of terrain, soil type and climate and economic response per capita. The objectivity of the approach is advantageous as it avoids subjective judgements and political involvement, however this results in rigidity and a lack of community involvement in the decision making process.

One element of Weatherell’s method worth further investigation is the costing procedure used. This is dependent on the setting of minimum standards for drains, earthworks, gravel and bridges, and then assessing the road by recording the proportion (expressed as a %) that fall below the required standard. The deficiencies were assessed every half mile.

3.2.9 Ranking Procedure used in Thailand

Bovill (1978) cited by Hine J. et al, (2001b) identifies a ranking procedure used by the Thailand Highway Department. Roads were categorised into two groups, those with flow more than 100 vehicles per day and those with less. Over ten criterion points were assigned (totalling 100, but no maximum per criterion). The criteria being:

- Population density in area either side of road;
- Percentage of fertile land cultivated;
- Potential for diversification and intensification of agricultural activities Percentage of land forested;
- Percentage of land designated for mining or industry;
- Tourism;
- Administration/degree of political pressure;
- Military and strategic;
- Traffic; and
- Other benefits.

An advantage with this method was the recognition of political and social benefits; however the definitions and weightings put on some of the criteria were very subjective and could be open to argument.

3.2.10 Socio-Economic Appraisal (Bovill)

Building on the Thailand ranking procedure mentioned above, Bovill (1978) has developed a preliminary screening and selection process for rural roads incorporating social service and economic welfare benefits. The schemes were appraised using a number of factors under the three criteria of economic activity, social service and social and economic welfare. These factors were objectively measured using specific units and then transferred to a rating scale of 1-100. Predetermined weights were given to each factor and the resulting total score then allows each scheme to be ranked.

The advantages of this method were similar to those of the Thailand model. The recognised drawbacks with this approach were that double counting may occur across the factors, and there may be dispute on the ratings used and the weights assigned to each factor.

3.2.11 World Bank Ranking Procedure for Access

The World Bank (1998) recommends two types of ranking approach. The one appropriate for low volume feeder roads is a least cost approach with the aim of providing a desired level of service, being “full access”, “partial access” or “basic access”. Taking the population into account, costs can be considered as “cost per person provided with access”. However a difficulty may arise when the objective is to improve a road in trying to quantify the benefits of improved access.

3.2.12 Road Prioritisation Methodology (RPM) in Ghana

This methodology was developed by the Department for International Development (DFID), United Kingdom in conjunction with the Department of Feeder Road (DFR), Ghana, as part of the former’s programme to support rehabilitation of about 600 – 700km of feeder roads in nine district of North Eastern Ghana. The RPM was piloted between 2000 and 2004.

The RPM produced a prioritisation Index which allows a consistent assessment of road improvement across Ghana according to engineering, economic and social criteria by providing a systematic basis for ranking road investment (Hine J. et al., 2000b). In this case, investment covers both full rehabilitation and accessibility improvement. The prioritisation index calculates a Benefit/Cost ratio for the standard road improvement for any feeder road. It enables the user to prioritise feeder roads list submitted by a District Assemblies and to decide on the most appropriate improvement standard for the selected roads. The Prioritisation Index is expressed as:

$$\text{Prioritisation Index} = \frac{\text{Benefits of Improvement}}{\text{Costs of Improvement}}$$

The prioritisation procedure starts with a process of consultation at the Unit, Area and District levels in order to define candidate road for improvement. Once a candidate list of roads has been proposed, engineering, traffic and population data are collected and technical analysis undertaken to derive a prioritisation. This index is then used to rank alternative road investment in different district. The road candidates with the highest index are recommended for improvement. A final public hearing is undertaken to confirm the acceptability of the results and if necessary, final modifications are made before construction activities begins.

Hine (2003) indicated that in the case of Ghana Feeder Road Prioritisation, social access benefits were perceived to be a function of population and the predicted change in unit transport costs. Under the prioritisation procedure, social benefits were calculated from the reduced transport costs of every person in the area of influence of the road making five return trips per year of a given length. The implication is that the greater the change in unit transport costs and the larger the population affected, the greater the rural access benefit. These benefits were then added to total benefits within the prioritisation procedure.

The prioritisation index gives a benefit cost ratio that is similar to other benefit cost ratios (e.g. NPV/C) that are used to determine priorities where budgets are constrained. Where there are mutually exclusive alternatives (as is the case when full rehabilitation is tested against accessibility improvements) a form of incremental analysis is applied to the benefit cost ratio with the budget constraint to determine priorities.

Where traffic volumes are high the “Full Rehabilitation” option may be tested against the “Accessibility Improvements” approach by comparing the incremental benefit cost ratio (i.e. the difference in benefits divided by the difference in costs) with the established cut off benefit cost ratio of the whole programme. If the incremental benefit cost ratio is greater than the programme cut off ratio then the higher cost intervention (i.e. Full Rehabilitation) should be undertaken. If it is less than the cut off ratio then the lower cost project (i.e. the Accessibility Improvements) should be undertaken.

The index was however not designed to cover routine maintenance activities like grading, grass cutting, ditch and culvert cleaning, etc. The Prioritisation Index also does not involved a full time profile analysis over the life of the investment, as a result projects with a large proportion of drainage structures would unfairly loose out to road investment without structure that lasted for a shorter period. To overcome this limitation, it is important to distinguish between the cost of drainage structures and the cost of other road works to compute adjusted benefit cost ratio.

CHAPTER FOUR - RESEARCH DESIGN AND METHODS

4.1 INTRODUCTION

Chapters two and three gave an overview of procedures for appraising road projects investment and approaches to appraisal of schemes to upgrade low volume rural roads and/or feeder roads in developing countries respectively. The overview led to the proposition of the key research questions, namely:

- How was investment in feeder road projects analysed and prioritised in Ghana?
- What significant variables were included in economic analysis and prioritisation of feeder roads in Ghana?

The aims of the research were therefore to identify significant variables in economic appraisal process of feeder roads in Ghana and develop an outline for analysing and prioritising feeder road projects in Ghana. Subsequently, the research objectives were developed to achieve the above mentioned aims. This chapter explains the methods and procedures adopted for the study.

4.2 RESEARCH DESIGN AND METHOD

A quantitative strategy was adopted in this research due to the fact that quantitative research follows a deductive approach in relation to theory and is concerned with the design measurement and sampling (Naoum, 2002).

The study sought to identify appropriate techniques for appraising feeder roads investment in Ghana, identify significant cost and benefit variables included in economic appraisal process in Ghana, identify conditions under which inclusion of social benefit in the appraisal process become significant and identify significant sensitive and uncertain variables in feeder roads appraisal from the perspective of local consultancy firms in the road sector, road agencies and donor/development partners with offices in Ghana.

The study also:

- Determined if there was significant and high agreement (i.e. 0.7 or above) among respondents within each category (i.e. agency and consultancy) on the importance of the variables;
- Determined relative importance of variables with significant and high agreement;
- Determined variables of high relative importance across both categories; and
- Determined variables that discriminate between the categories (i.e. where level of agreement was weak between the road agencies and local consultancy firms in road sector).

The research was carried out in three phases, firstly, a review of literature from academic and professional journals, conference papers/reports, technical papers, working papers and the internet.

Secondly, a questionnaire was designed and administered to staff of the Ministry of Roads and Highways and its agencies, local consultancy firms in the road sector and Country offices of donor agencies in a survey that sought to provide data and opinion relating to the research objectives.

Thirdly, the results of the questionnaire were analysed statistically and the results used as a basis to develop an outline for conducting economic appraisal of feeder road investment in Ghana.

4.3 SAMPLE DESIGN PROCESS

The purpose of the sample was to obtain information about the population by observing only a small proportion of the population (i.e. sample size).

4.3.1 Population Definition

The selection of the respondents was limited to staffs of the road agencies, local consultancy firms in the road sector, and Country offices of donor partners to the road sub-sector.

The road agencies were made up of the Ministry of Roads and Highways in Accra, Ghana Highway Authority, Department of Feeder Roads and Department of Urban Roads, at the Headquarters in Accra and regional offices in Kumasi.

The local consultancy firms in the road sector comprised registered corporate members of Ghana Institution of Engineers and Ghana Association of Consultants (Planning category) located in Greater Accra and Ashanti regions. Other state consultancy institutions such as Building and Road Research Institute (BRRI) in Kumasi and Architectural and Engineering Services Limited (AESL) in Accra were also sampled.

The list of donor institutions was obtained from the Ministry of Road and Highways and Department of Feeder Roads. The donor institutions were Ghana Cocoa Board and development partners with Country offices in Accra.

The decision to focus on these two regions was influenced by the fact that most of the targeted respondent institutions were located in Accra and Kumasi. According to the membership directory of Ghana Institution of Engineers, approximately 93.69% of registered members are located in Accra and Kumasi. In addition, all the headquarters of the road agencies and country offices of the donor institutions are located in Accra. Secondly, the latest Road Survey conducted by the Ministry of Roads and Highways indicates that Ashanti regional office of the Department of Feeder Roads controls a significant proportion of feeder road network in Ghana (Approx. 13.1% of total feeder road network in Ghana). Greater Accra and Ashanti regions therefore provided the proximate and reduced travel distance. In addition, the limited time available for the study and financial constraints did not allow the researcher to travel to the other regions.

4.3.2 Sampling Technique

Both probability and non-probability sampling techniques were employed in this study. Purposive sampling, which is an example of non-probability sampling technique, was adopted in identifying key respondent institutions, namely road agencies, donors and local consultancy firms in road development. This was because the researcher required certain categories of respondents who had been involved in road investment appraisal or were knowledgeable in the economic appraisal process of road investment in general and rural transport infrastructure in particular to answer the questionnaire.

Purposive sampling was further used in the selection of local consultancy firms in road sector for the study. This resulted in selecting only corporate members of Ghana Institution of Engineers and Ghana Association of Consultants categorized into civil and highway engineering, urban and rural development, environmental engineering, project management, procurement, planning and development since the researcher believed that they were representative of the population of interest and could give accurate and practical responses. A random sampling technique, as a means of selection was then applied to the targeted population to obtain the sample size for the local consultancy firms in the road sector. Snowball sampling technique (i.e. non-probability sampling technique) was used to obtain the number of other road consultants, who were not registered with the Ghana Institution of Engineers and Ghana Association of Consultants for the study due to the diverse nature of road development consultants. By the snowball sampling technique, the road agencies were first contacted and requested to suggest names of persons or organization that had provided consultancy services for them in the research area. The companies were then contacted via phone to collect their location address.

The respondents from the road agencies were purposively sampled randomly from the following divisions or sections; planning and development, safety and environment, procurement unit, contracts, bridges and quality management.

Human Resource Managers and/or Front Desk Officers of the donor institutions identified their respondents for the study. In some cases, the researcher was not allowed to go beyond the front desk even after showing student's ID and introductory letter from the university.

4.3.3 Sample Size Determination

Israel (1992) identified three methods for determining sample size. These include using census for small population, replicating a sample size of similar studies using published tables and using published formula to calculate a sample size. In this regards, sampling framework was developed for each of the three categories of respondents by adopting the first and latter approaches.

a. Road Agencies [Category A]

The population size for the road agencies (Category A) was determined following preliminary enquires at the road agencies on the possible number of staff with the requisite knowledge and experience in the research area who would be available to respond to the questionnaire. Consequently, the population size (N) for the road agencies was estimated at thirty staffs (i.e. N = 30). Since the population size was determined to be small, the Census Approach identified by Israel (1992) for small population was adopted to obtain the sample size of **(n = 30)** for the road agencies. Refer to Appendix B for breakdown of population size for the road agencies.

b. Local Consultancy Firms in Road Sector [Category B]

The population size as determined from the registry of Ghana Institution of Engineers, Ghana Association of Consultants and list of other development consultants from the road agencies in Ghana was estimated at forty eight (N = 48) firms. Refer to Appendix B for details.

The sample size (n) was determined using the Kish formula (Kish, 1965) as follows;

$$n = \frac{n^1}{\left(\frac{n}{N}^1 + 1\right)}$$

where; n = sample size

n^1 = s^2/v^2, $s^2 = p(1 - p)$

N = total population (**N = 48**)

s = the maximum standard deviation of the population elements (total error = 0.1 at a confidence level of 95%)

v = the standard error of sampling distribution (i.e. $v = 0.05$)

p = the proportion of the population elements that belong to the defined category (i.e. ρ = 0.5, 95% confidence level)

Thus, $s^2 = p(1 - p) = 0.5\,(0.5) = 0.25$

$v^2 = (0.05)^2 = 0.0025$

$n^1 = 0.25 / 0.0025 = 100$

n = 100/(1 + 100/48) = 32.43, use **n = 33**

The above formula provide for the minimum number of responses to be achieved. However, from previous work done by other researchers (Israel, 1992; Walpole et al., 2007), ten percent was commonly added to the sample size to compensate for persons the researcher is unable to reach and a thirty percent increase in the sample size to compensate for non-responses. The sample size for the road development consultants was therefore determined by adding 40% to the actual size to obtain the adjusted sample size of 46 (i.e. 140/100 x 33 = **46**)

Thus the adjusted sample size and the actual sample size calculated were 46 and 33 respectively. It was therefore imperative to reach all the targeted population. A total of forty-eight **(48)** questionnaires were administered. This number was sent out in order to allow a larger than required sample size (n = 46) to achieve the desired level of confidence. In addition, the difference between the population size **(N = 48)** and the adjusted sample size (**n = 46)** was not significantly large.

c. Donor Institutions [Category C]

A total of fifteen (15) donor institutions were obtained from the Ministry of Roads Highways and the Department of Feeder Roads. The population size (N) for the donor institution targeted was 15. As a result, the Census Approach for small population was adopted to obtain the sample size of **(n = 15)** for the donor institutions.

This Census Approach according to Israel [1992] eliminates sampling error and provides data on all individuals in the population. In addition, the approach allows virtually the entire population to be sampled in small population to achieve level of precision. In summary, the sample sizes targeted for the study were **30, 48** and **15** for road agencies; local consultancy firms in the road sector and donor institutions respectively, making the total sample size of **93**.

4.4 QUESTIONNAIRE DESIGN

To achieve the objective of the study, the questionnaire was structured into four parts. Part I contained questions that sought to identify the profile of the respondents. The second part of the questionnaire contained questions that sought to identify economic appraisal techniques for appraising feeder road projects in Ghana. In the third part, respondents were asked to rank cost and benefit factors associated with road investment. The fourth part of the questionnaire sort to identify significant variables included in sensitivity and uncertainty testing in the road project economic appraisal process in Ghana. This part also contained questions to identify appropriate economic evaluation criteria for selecting road candidates for investment.

Generally, five point likert scale was employed in the questionnaire either to indicate the level of appropriateness, significance or suitability of variables, where "1" represented least appropriate, least significant or least suitable and "5" represented most appropriate, very significant or most suitable.

4.5 ADMINISTRATION OF QUESTIONNAIRE

The questionnaires were administered to staff of the targeted respondent institutions. Ample time was allowed to collect responses. A total of **93** questionnaires were administered to respondents in Accra and Kumasi, of which **69** out of **70** responses received were considered to be responsive, representing 74.19% overall response rate. Table 4.1 is a summary of questionnaire issued and their response rates.

Table 4.1: Summary of Questionnaire Administered and Response Rate

Category	Nomenclature	Questionnaire			Response Rate
		Issued	Received	Responsive	
A	Road Agencies	30	26	26	86.67%
B	Road Consultants	48	43	43	89.58%
C	Donor Institutions	15	1	0	0.0%
	Total	**93**	**70**	**69**	**74.19%**

The single response received from Category C – Donor Institutions was ignored in the analysis since it was statistically insignificant.

4.6 DATA ANALYSIS TOOLS

Analytical tools used in analyzing the responses from the survey include: Relative Importance Index (RII); Weighted Average; Kappa Statistic for multiple raters using categorical classification; and Discriminant Analysis (DA).

4.6.1 Relative Importance Index (RII)

This was used to evaluate the relative importance index for the cost and benefit variables, economic appraisal techniques, economic evaluation criteria and conditions necessary for inclusion of social benefit in feeder roads investment appraisal process in Ghana. This method was adopted because it yields a final number (index), which is an overall estimate of the relative importance of the variable. Using this index, the relative importance of different variables can be compared with each other. Relative Importance Index (RII) is given as:

$$RII = \frac{\sum_{j=1}^{i=5} W}{AxN}, \quad 0 \leq INDEX \leq 1$$

where :

W	=	the weighting given to each factor by respondent, ranges from 1 to 5 where "1" is least significant and "5" is very significant.
A	=	the highest weight (i.e. 5 in the study)
N	=	the total number of respondents

4.6.2 The Weighted Average

To select the variables that were significant or important in all the categories, a Weighted Average of the Relative Importance Index (RII) was calculated for each variable by adding the products of

- the relative importance index for each group and
- the proportion of the total respondents for each factor

$$\text{Weighted Average} = \frac{n_a}{N} RII_a + \frac{n_b}{N} RII_b$$

Where;

n_a	=	number of respondents for category A (i.e. road agencies)
n_b	=	number of respondents for category B (i.e. road consultants)
N	=	total number of respondents
RII_a	=	the relative importance index for Category A
RII_b	=	the relative importance index for Category B

4.6.3 Inter-Raters Agreement

Kappa statistic for multiple raters using categorical classifications was employed to determine inter-raters agreement between the two categories of responses. The coefficient indicates whether there was a trend of agreement among the respondents.

According to Green (1996), since the kappa statistic ($\hat{k}$) was first proposed by Cohen in 1960, variants have been proposed by others, including Scott (1955), Maxwell and Pilliner (1968), and Bangdiiwala (1987). According to Fleiss (1993) as cited by Green (1996), there is a natural means of correcting for chance using indices of agreement; Kappa is based on such indices. If there is complete agreement, $\hat{k}$ = 1. If the observe agreement is greater than or equal to chance, $\hat{k} \geq 0$, and if the observe agreement is less than or equal to chance agreement, $\hat{k} \leq 0$.

The determination of Kappa Statistic ($\hat{k}$) is demonstrated as follows:

$$m = \sum_{j=1}^{k} x_{ij} \qquad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \qquad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m}$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times \bar{m}} \qquad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\,\bar{p}_j \bar{q}_j} \qquad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \dfrac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

Where;

m	=	number of different raters
x_{ij}	=	number of ratings on a subject
n	=	number of subjects
j	=	category of rating
k	=	number of ratings per subject
$\bar{m}$	=	mean number of ratings per subject
$\bar{p}$	=	overall proportion of ratings
$\bar{q}_j$	=	overall proportion of non-ratings
$\hat{k}_j$	=	kappa value per category
$\hat{k}$	=	overall kappa value

According to Green (1996), there is general consensus in the interpretation of Kappa, namely Kappa values greater than 0.75 are considered to have a higher degree of agreement beyond chance. Values below 0.40 have a low degree of agreement and values between 0.40 and 0.75 represent a fair to good level of agreement beyond chance alone.

4.6.4 Discriminant Analysis

A two-group Discriminate Analysis was employed to explained difference in the ranking among the two categories of respondents. This multivariate technique was used to classify the total sample into mutually exclusive and exhaustive groups on the basis of predictor variables established in the questionnaire. The objectives of the two-group Discriminant Analysis under the study include:

i. Finding linear composites of the predictor variables that enable the analyst to separate the groups by maximizing among groups to within-group variation;
ii. Testing whether significant difference exist between the predictor variable profiles of the two groups;
iii. Determining which variables account most for intergroup differences in mean profiles (i.e. to determine what variables discriminate well between groups).

These objectives were underpinned by the following key assumptions:

i. That, the predictors are not highly correlated with each other;
ii. That, the mean and variance of a given predictor are not correlated;
iii. That, the correlation between two predictors is constant across groups;
iv. That, the values of each predictor have a normal distribution.

A computer program (Appendix G) in SPSS package was used to perform the Discriminant Analysis (DA). The SPSS program produces numerous outputs that were useful in identifying the difference between the two groups. Some of the important outputs are discussed below:

- **Canonical Correlation Coefficients**: - This is a measure of the association between the Discriminant scores and the groups. It summaries the degree of relatedness between the groups and the discriminant function. A value of zero denotes no relationship at all; while a higher value (near 1) shows that the function discriminates well.

- **Eigen Value**: - The Eigen Value is a constant produced by the Discriminant Analysis (DA) to help in determining which of the functions are important for explaining the differences between the groups. The function with the largest Eigen Value is the most important function. For a two-group analysis, only one function is needed to discriminate, thus one Eigen Value (which will explain 100% of the variance) is given.

- **Wilk's Lambda**: - This shows the proportion of the total variance in the discriminant score not explained by difference among groups. A small Lambda value (near 0) indicates that the group's mean discriminant score differ. The significance ($p < 0.05$) is for the Chi-square test which indicates that there is a highly significant difference between the groups' centroid. The Eigen Value and Wilk's Lambda give an indication on how discriminating the Discriminant Analysis model is but provides little information regarding the accuracy of the model.
- **Standardised Canonical Coefficient**:- These coefficients are used to determine the factors which have the highest contribution to the determination of the discriminant function scores (i.e. it shows the impact of each variable on the discriminant function after "standardizing" – putting each variable on the same platform since each variable may have different units). This is done by examining the magnitude of the standardized coefficient. The factors with the largest coefficient (in absolute terms) are the significant contributors to the discriminant functions.

- **Tests of Equality of Group Means**: - This test or identify which variable is statistically different between the two groups.

CHAPTER FIVE - ANALYSIS OF RESULTS AND DISCUSSIONS

The aims of the research were to identify significant variables in economic appraisal of feeder roads in Ghana and develop an outline for economic appraisal and prioritization of investment in feeder roads in Ghana. In order to achieve this, a three phase research method, consisting of a review of literature, field questionnaire survey and data analysis was designed and data collected from three categories of respondents namely staff from Ministry of Roads and Highways and her agencies, local consultancy firms in the road sector and donor partners to Ghana's road sector. This chapter presents the survey results and explains the findings.

5.1 ANALYSIS OF RESPONSE

A total of ninety-three (93) questionnaires were sent to three categories of respondents of which seventy (70) were received. However, only one response was received from the development/donor partners to Ghana's road sector (i.e. category C). As a result, the response from this category was ignored in the analysis since it was considered insignificant, hence sixty nine (69) questionnaire received were considered responsive for analysis. The overall response rate was therefore 74.19%. Table 5.1 shows the response rate for the three categories of respondents

Table 5.1: The Survey Response

Category	Nomenclature	Questionnaire Issued	Questionnaire Received	Questionnaire Responsive	Response Rate
A	Road Agencies	30	26	26	86.67%
B	Road Consultants	48	43	43	89.58%
C	Donor Institutions	15	1	0	0.0%
	Total	**93**	**70**	**69**	**74.19%**

From Table 5.1, a response rate of 86.67% was achieved for the road agencies. This was due to the fact that all the relevant road agency institutions were all located within a common geographic area, which made it easy to follow-up on respondents. Similarly, among the local consultancy firms in the road sector, majority of potential respondents who felt unable to respond to the survey either due to time and/or technical constraints refused to accept the questionnaire but rather preferred recommending other consultants they felt were more competent in the research area, hence the relatively higher response rate of 89.58%. On the other hand, a single response was received from donor institutions. Copy of the questionnaire has been reproduced in Appendix A.

From Table 5.2, a total of 63 respondents answered question 3. Out of this, only 1.62% of valid respondents had less than two (2) years working experience in their current capacity. Table 5.2 shows summary of responses to question 3 of the questionnaire.

Table 5.2 –Experience in Official Position Held by Respondents

Qu.3	Working Experience	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2 yrs	1	1.4	1.6	1.6
	2yrs to < 5yrs	23	33.3	36.5	38.1
	5yrs to <10yrs	31	44.9	49.2	87.3
	Exceeding 10yrs	6	8.7	9.5	96.8
	Others	2	2.9	3.2	100.0
	Total	63	91.3	100.0	
Missing	No response	6	8.7		
Total		**69**	**100.0**		

From Table 5.3 below, 74.6% of valid respondents have conducted economic appraisal of road projects in Ghana within the last five (5) years. It can be deduced that respondents were up to date with current practices and trends in the economic appraisal process in Ghana. Table 5.3 shows summary of responses to question 4 of the questionnaire.

Table 5.3 –Experience of Respondents in Economic Appraisal Process

	Years of Experience	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 2 yrs	10	14.5	15.9	15.9
	2yrs to < 5yrs	37	53.6	58.7	74.6
	5yrs to <10yrs	16	23.2	25.4	100.0
	Total	63	91.3	100.0	
Missing	No response	6	8.7		
Total		**69**	**100.0**		

From Table 5.4, approximately 91.3% of respondents have had experience of appraising at least one or more of classified roads project in Ghana. The economic appraisal experience of respondents with specific reference to functional classification of road type appraised is presented in Table 5.4.

Table 5.4 – Road Classification Appraised by Respondents

Category		Functional Road Classification (i5)							Total
		Trunk Roads	Feeder Roads	Urban Roads	Trunk & Feeder Roads	Trunk & Urban Roads	Feeder & Urban Roads	Trunk, Feeder & Urban	
Agencies	i4 Less than 2 yrs	1	2	0	0	0	0		3
	2yrs to < 5yrs	0	11	3	1	1	1		17
	5yrs to <= 10yrs	0	2	3	0	0	0		5
	Total	1	15	6	1	1	1		**25**
Consultants	i4 Less than 2 yrs	0	4	0	0	0	0	3	7
	2yrs to < 5yrs	3	4	1	7	0	4	1	20
	5yrs to <= 10yrs	4	1	2	2	1	1	0	11
	Total	7	9	3	9	1	5	4	**38**

5.2 SURVEY FINDINGS AND DISCUSSIONS

5.2.1 Survey Findings and Discussions on Economic Appraisal Techniques

Responses to Question 6 were analysed in order to determine a suitable economic appraisal technique for investment in feeder roads in Ghana. Table C1 of Appendix C shows the relative importance indices of the ranking of eight (8) economic appraisal techniques by road agencies. It was observed that respondents from road agencies ranked the following in descending order as suitable appraisal techniques for feeder roads in Ghana:

1. Prioritisation/ranking procedure (PI);
2. Multi-criteria analysis (MCA);
3. Cost-benefit analysis (CBA);
4. Cost-effectiveness analysis (CEA);
5. Maintenance performance budgeting system (MPBS);
6. Framework analysis;
7. Pavement maintenance and management systems (PMMP);
8. Fiscal impact analysis.

Table D1 of Appendix D also shows the relative importance indices of the ranking of eight (8) economic appraisal techniques by local consultancy firms in the road sector. It was clear from Table D1 of Appendix D that local consultancy firms in the road sector ranked the following as suitable techniques for appraising feeder roads in Ghana:

1. Cost-benefit analysis (CBA);
2. Cost-effectiveness analysis (CEA);
3. Multi-criteria analysis (MCA);
4. Prioritisation/ranking procedure (PI);
5. Framework analysis (FWA);
6. Maintenance and performance budgeting system (MPBS);
7. Fiscal impact analysis (FIA);
8. Pavement maintenance and management system (PMMP).

To determine the economic appraisal technique that was suitable in the two categories, a weighted average of the relative importance indices was calculated. Using the weighted averages, the eight techniques were ranked as shown in Table E1 of Appendix E. The rankings were as follows in descending order:

1. Cost-benefit analysis;
2. Prioritisation/ranking procedure;
3. Multi-criteria analysis;
4. Cost-effectiveness analysis;
5. Maintenance performance budgeting system;
6. Fiscal impact analysis;
7. Framework analysis; and
8. Pavement maintenance and management system.

After the ranking exercise, Kappa Statistic for multiple raters was employed to determine inter-raters agreement between respondents from road agencies and local consultancy firms in the road sector.

From Table F1 of Appendix F, the agreement among respondents on suitable economic appraisal techniques for feeder roads in Ghana was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 552 \qquad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \qquad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 552$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times m} \qquad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\,\bar{p}_j \bar{q}_j} \qquad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \dfrac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From Table F1 of Appendix F,

$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.681$ and $\sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.875$

$$\hat{k} = \frac{0.681}{0.875} = \mathbf{0.779}$$

From the results obtained, $\hat{k} > 0.75$. It can be interpreted that there exists a high degree of agreement beyond chance among raters on the suitability of Cost-Benefit Analysis (CBA) technique for appraising feeder roads in Ghana.

The finding collaborates with earlier work in Ecuador by Greenstein and Bonjack (1983), who concluded that evaluation of rural roads were best executed in two stages with initial screening process prior to detailed economic analysis which generates a measure of Net Present Value (NPV), Internal Rate of Return (IRR) and First Year Benefit Rate (FYBR) within a modified Cost-Benefit Analysis framework.

However, many researchers have argued that traditional Cost-Benefit Analysis (CBA) and Consumer Surplus methods of appraisal were not appropriate for low volume feeder roads (Airey and Taylor, 1999; Lipman 1999; Schelling and Liu, 2000 and van de Walle, D. 2002).

van de Walle (2002) further argued that by using traditional Cost-Benefit Analysis methods with small volumes of traffic, little investment would be justified because traditional Cost-Benefit Analysis have been based on benefit indicators derived from consumer surplus calculations of road user savings, comprising vehicle operating cost savings and travel time savings which do not account for many of the benefits of Rural Transport Infrastructure investment.

In the World Bank Infrastructure Notes, Liu (2000), working in Andhra Pradesh, India, tries to aggregate savings in vehicle operating costs and rural road user travel time (TTS), even as the author admits the unsuitability of the methodology due to low traffic volumes associated with rural access roads. Thus Schelling and Lebo (2000) suggest complimenting the analysis with a participatory Cost-Effectiveness Analysis approach.

To overcome these shortcomings, Lebo and Schelling (2001) has proposed enhancement to the traditional Cost-Benefit Analysis (CBA) technique with the aim of finding broader measures of economic benefits and costs applicable to Rural Transport Infrastructure (RTI). That is, while the principles of analysis were the same, the special feathers of RTI call for special methods of analysis.

According to Lebo and Schelling (2001), possible enhancement of traditional Cost-Benefit Analysis (CBA) may include:

- Better assessment of the costs of interrupted access;
- Estimating operating cost savings of Non-motorized Means of Transport (NMT);
- Savings due to mode changes (from NTM to motorized transport);
- Improved valuation of time savings; and
- Valuation of social benefits from improved access to school and health centres.

To this end, Ojukwu (2000) has demonstrated that it was possible to incorporate vehicle operating costs, passenger time and producer surplus transport costs savings within CBA framework. The particular project was the implementation of an Area-based Agricultural Modernisation Programme (AAMP) in the Southwestern Uganda. The objective of the programme was to raise the income of more than 300,000 households living in the ten districts comprising the Southwestern region of Uganda, through a process of agricultural modernisation, community mobilisation and rural infrastructure development. According to Ojukwu (2000), the extended Cost Benefit Analysis approach achieved Economic Internal Rate of Return (EIRR) of 14% to 54% for individual candidate roads under the AAMP.

The ranking of Cost Benefit Analysis as the preferred method for appraising feeder roads in Ghana was therefore consistent with previous studies delineated above. It is therefore feasible to adopt the extended Cost-Benefit Analysis techniques for appraising feeder roads in Ghana.

5.2.2 Survey Findings and Discussions on Cost Variables

Responses to Question 7 were analysed to determine the significant cost variables in appraising feeder roads in Ghana.

Table C2 of Appendix C shows the relative importance indices of the ranking of thirteen (13) cost variables by road agencies. It was observed that respondents ranked the following in descending order as significant cost variables in appraising feeder roads in Ghana:

1. Routine annual maintenance cost;
2. Initial construction/rehabilitation cost;
3. Major maintenance cost;
4. Environmental mitigation works that are not included in the construction cost;
5. Construction supervision cost;
6. Compensation;
7. Land acquisition and right of way;
8. Engineering studies and design cost;

9. Value added tax and other taxes;
10. Resettlement;
11. Residual capital value;
12. An allowance for contingencies;
13. Fiscal impact cost;

Table D2 of Appendix D shows that local consultancy firms in the road sector ranked the following in descending order as significant cost variables in appraising feeder roads in Ghana:

1. Initial construction/rehabilitation cost;
2. Major maintenance cost;
3. Compensation cost;
4. Land acquisition and right of way cost;
5. Resettlement cost;
6. Construction supervision cost;
7. Engineering studies and design cost;
8. Routine annual maintenance cost;
9. Environmental mitigation works that are not included in the construction works;
10. Fiscal impact;
11. Residual capital value;
12. An allowance for contingencies;
13. Value added tax and other taxes;

To determine the cost variables that were significant in the two categories, a weighted average of the relative importance indices was calculated. Using the weighted averages, the thirteen cost variables were ranked as shown in Table E2 of Appendix E. The rankings of the significant cost variables, in descending order, were as follows:

1. Initial construction/rehabilitation cost;
2. Major maintenance cost;
3. Routine annual maintenance cost;

4. Environmental mitigation works that are not included in the construction cost;
5. Compensation cost;
6. Construction supervision cost;
7. Land acquisition and right of way;
8. Engineering studies and design cost;
9. Resettlement;
10. Residual capital value;
11. Value added tax and other taxes;
12. Fiscal impact;
13. An allowance for Contingencies;

To determine inter-raters agreement between respondents from road agencies and local consultancy firms in the road sector, Kappa Statistic for multiple raters was employed. From Table F2 of Appendix F, the agreement among respondents on cost variables in appraising feeder roads was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 897 \quad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \quad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 897$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times m} \quad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\,\bar{p}_j\bar{q}_j} \quad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \dfrac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From table F2 of Appendix F,

$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.727$ and $\sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.923$

$$\hat{k} = \frac{0.727}{0.923} = \mathbf{0.788}$$

From the results obtained, $\hat{k}$ > 0.75. It can therefore be interpreted that there exists a high degree of agreement beyond chance among respondents on the selection of significant cost variables in the economic appraisal of feeder roads in Ghana.

Generally, the first three ranking of the thirteen cost variables collaborates with the cost variables put forward by the Minnesota State Department of Transport (2005). However, respondents did not agree with the level of significance of the fourth variable proposed by the same researcher as "Residual capital value" was ranked 10^{th} by respondents.

In addition, the first five ranked cost variables have been recommended by DFID (2005) in its guide on methods of conducting feasibility studies for road projects in developing countries. It can be deduced that, the first five ranked cost variables could be considered as the significant cost variable in economic appraisal of feeder roads in Ghana.

5.2.3 Survey Findings and Discussions on Benefit Variables

Responses to Question 8 were analysed in order to determine the significant benefit variables in appraising feeder roads in Ghana. Table C3 of Appendix C shows the relative importance indices of the ranking of fourteen (14) benefit variables by road agencies. The respondents ranked the following in descending order as significant benefit factors in appraising feeder roads in Ghana:

1. Savings in vehicle operation cost (VOC);
2. Implicit benefit associated with switching from non-motorized modes to motorized vehicle traffic;
3. Increase in reliability of transport service;
4. Improvement in social mobility and network;
5. Stimulation of economic development in road zone of influence;
6. Environmental improvement;

7. Changes in transport cost associated with seasonal improvement in road trafficability;
8. Travel time savings by passengers and freight (TTS);
9. Increase in travel convenience (i.e. headway);
10. Weighting to cover isolation from social services identified as being of greatest importance to communities;
11. Changes in transport cost associated with eliminating vehicle impassibility;
12. Economies in road maintenance;
13. Increase in travel comfort (i.e. riding quality);
14. Savings in road accidents.

Table D3 of Appendix D shows that local consultancy firms in road sector ranked the following in descending order as significant benefit variables in appraising feeder roads in Ghana:

1. Travel time savings by passenger and freight (TTS);
2. Increase in reliability of transport service;
3. Stimulation of economic development in road zone of influence;
4. Savings in vehicle operating cost (VOC);
5. Improvement in social mobility and network;
6. Changes in transport cost associated with eliminating vehicle impassibility;
7. Changes in transport cost associated with seasonal improvement in road trafficability;
8. Savings in road accident costs;
9. Increased in travel comfort (i.e. riding quality);
10. Increased in travel convenience (i.e. headway);
11. Economies in road maintenance;
12. Environmental improvement;
13. Implicit benefit associated with switching from non-motorized modes to motorized vehicle traffic;
14. Weighting to cover isolation from social services identified as being of greatest importance to communities.

To determine the benefit variables that were significant in the two categories of respondents, a weighted average of the relative importance indices was calculated. Using the weighted averages, the fourteen benefit variables were ranked as shown in Table E3 of Appendix E. The rankings of the significant benefit variables were as follows in descending order:

1. Travel time savings by passengers and freight (TTS);
2. Increased in reliability of transport service;
3. Stimulation of economic development in road zone of influence;
4. Savings in vehicle operating cost (VOC);
5. Improvement in social mobility and network;
6. Changes in transport cost associated with seasonal improvement in road trafficability;
7. Changes in transport cost associated with eliminating vehicle impassibility;
8. Implicit benefit associated with switching from non-motorized modes to motorized vehicle traffic;
9. Increase in travel convenience (i.e. headway);
10. Environmental improvement;
11. Increased in travel comfort (i.e. riding quality);
12. Economies in road maintenance;
13. Weighting to cover isolation from social services identified as being of greatest importance to communities;
14. Savings in road accident costs.

After the ranking exercise, Kappa Statistic for multiple raters using categorical classifications was employed to determine inter-raters agreement between respondents. From Table F3 of Appendix F, the agreement among respondents on benefit variables significant for appraising feeder roads was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 966 \quad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \quad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 966$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times m} \quad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\bar{p}_j\bar{q}_j} \quad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \frac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From Table F3 of Appendix F,

$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.732$ and $\sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.929$

$$\hat{k} = \frac{0.732}{0.929} = \mathbf{0.789}$$

From the results obtained, $\hat{k} > 0.75$. It can therefore be inferred that there exists a high degree of agreement beyond chance in the rankings of benefit variables that were significant in economic appraisal of feeder roads in Ghana.

From the ranking of benefit variables by both categories of respondents, it can be seen that, only two of the primary benefits of road investments [i.e. Travel time savings (TTS) and Savings in vehicle operating cost (VOC)] were included in the first ten rankings. This finding underscores the importance of including social or secondary benefits in appraisal of feeder roads in developing countries.

The ranking of "Increased in reliability of transport services" as the second significant benefit variable in economic appraisal of feeder roads in Ghana collaborates with previous researchers. For example, Hine (2003) in his study in Ethiopia reported that, from the point of view of feeling of personal security and the need for vehicle access in a medical emergency, there was an important psychological benefit of all year round vehicle access, even if emergency trips were rarely made.

Hine (2003) and DFID (2004) further argued that where only access to remote community is liable to be severed or disrupted, possibly for several months of the year, vehicle movement may be prevented and mobility constrained and the following issues may arise:

- It is likely that normal marketing activities in the area will either cease or be severally curtained. Longer, more circuitous walking trips can be expected;
- While government services and external agencies remain crucial to the development of an area, there are strong arguments for reasonable all year round vehicle access to major centres within each local district; and
- Any external institution (Commercial, Government or Non-Government Organisation, etc) planning to locate staff and facilities in a remote location will think twice if vehicle access is very poor and cannot be guaranteed throughout the year.

According to DFID (2004), new road investment in rural areas of developing countries was often seen as the precursor of many other interventions including schools, clinics, water supply, Government offices, NGO activities and commercial investment. The ranking of "Stimulation of economic development in road zone of influence" as the third significant benefit variable in feeder roads investment in Ghana cannot therefore be out of place.

In addition, the first five ranked benefit variables which include both economic (primary) benefits and social (secondary) benefits factors also collaborate with the appraisal scheme developed by Robinson (1999) for developing countries which uses a mixture of four groups of benefits including consumer surplus, a change in transport mode, economic and social benefits. In an earlier report by the Zambian National Road Board, social factors such as population served by road, presence and intensity of social infrastructure, potential increase in traffic volume, mobility of people and employment creation were combined with economic factors such as agricultural production, potential agricultural production, production facilities and services and planned future development activities to develop an assessment frameworks for feeder roads.

5.2.4 Survey Findings and Discussions on Inclusion of Social Benefits

Responses to Question 9 were analysed in order to determine conditions under which social benefits become significant in economic appraisal of feeder roads in Ghana.

Table C4 of Appendix C shows the relative importance indices of the ranking of eight (8) conditions for inclusion of social benefits by road agencies. The respondents ranked the following in descending order as conditions under which inclusion of social benefits in appraising feeder road projects become significant;

1. Where there are under employed resources in the affected community;
2. Where investment can provide significant improvement in vehicle access as in situations where there is no existing rural access at all or the access is at risk of being cut;
3. For remote new rural transport infrastructure investment;
4. Where relatively large changes in transport cost are anticipated;
5. Where existing traffic volumes are very low;
6. Where the local economy is perceived to be uncompetitive and weak;
7. Where the population is very remote;
8. Where there is a desire to weight conventional traffic benefits to different classes of existing users (e.g. provide higher weighting to the poor).

Table D4 of Appendix D shows that local consultancy firms in the road sector ranked the following as conditions under which social benefits are significant in appraising feeder roads in Ghana:

1. Where investment can provide significant improvement in vehicle access as in situation where there is no existing rural access at all or the access is at risk of being cut;
2. For remote new rural transport infrastructure investment;
3. Where the population is very remote;
4. Where relatively large changes in transport cost are anticipated;
5. Where there are under employed resources in the affected community;
6. Where there is a desire to weight conventional traffic benefits to different classes of existing users (e.g. provide higher weighting to the poor);
7. Where existing traffic volumes are very low; and

8. Where the local economy is perceived to be uncompetitive and weak.

To determine the conditions that were significant in the two categories, a weighted average of the relative importance indices was calculated. Using the weighted averages, the eight conditions were ranked as shown in Table E4 of Appendix E. The ranking of the significant conditions for inclusion of social benefits in appraisal of feeder roads were as follows:

1. Where investment can provide significant improvement in vehicle access as in situation where there is no existing rural access at all or the access is at risk of being cut;
2. For remote new rural transport infrastructure investment;
3. Where there are under employed resources in the affected community;
4. Where a relatively large changes in transport cost are anticipated;
5. Where the population is very remote;
6. Where existing traffic volumes are very low;
7. Where local economy is perceived to be uncompetitive and weak;
8. Where there is a desire to weight conventional traffic benefits to different classes of existing users (e.g. provide higher weighting to the poor).

After the ranking exercise, Kappa Statistic for multiple raters was employed to determine inter-raters agreement between respondents from road agencies and local consultancy firms in the road sector. From Table F4 of Appendix F, the agreement among responses on conditions under which inclusion of social benefits become significant in appraisal of feeder roads in Ghana was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 552 \quad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \quad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 552$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times \bar{m}} \qquad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij} (m - x_{ij})}{nm(m-1)\, \bar{p}_j \bar{q}_j} \qquad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \dfrac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From Table F4 of Appendix F,

$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.682$ and $\sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.875$

$$\hat{k} = \frac{0.682}{0.875} = \mathbf{0.779}$$

From the results obtained, $\hat{k} > 0.75$. It can therefore be interpreted that there exists a high degree of agreement beyond chance. It can be deduced that, respondents from both category believed that the inclusion of social benefits in the appraisal of feeder roads in Ghana was significant where investment could led to significant improvement in vehicle access, particularly in situations where there was no existing access at all or the access was at a risk of being cut-off for a considerable period of the year.

It was evidently clear from the ranking of conditions under which inclusion of social benefits become significant in the economic appraisal of feeder roads in Ghana that, respondents were more inclined towards the conditions suggested by Hine (2003), DFID (2004) and DFID (2005). This was however not surprising since the conditions put forward by these cited references were as a result of studies conducted simultaneously in three developing countries of Vietnam, Zambia and Ethiopia.

5.2.5 Survey Findings and Discussions on Appraisal of Costs and Benefits

Questions 10, 11, 12, 13, 14 and 15 of Section IV of the Questionnaire were analysed one after the other and discussed in order to ascertain how cost and benefits variables were evaluated within the economic appraisal framework. Table 5.5 is the summary of statistics for responses for question 10 to question 14.

Table 5.5 Summary of Statistics

	Qu.10	Qu.11	Qu.12e	Qu.12f	Qu.13	Qu.14
N Valid	66	65	65	61	67	65
Missing	3	4	4	8	2	4
Mean	2.27	2.31	2.29	3.07	2.40	2.40
Std. Deviation	1.184	1.368	0.678	0.814	0.922	1.247

Table 5.6 below shows the analysis of responses to question 10. This question was analysed to help determine a suitable option for selecting discount rate for economic appraisal of Rural Transport Infrastructure (RTI) in Ghana.

Table 5.6 Economic Discount Rate Options

	Discount Options	Frequency	Percent (%)	Valid Percent	Cumulative Percent
Valid	Prevailing Market Rate	20	29.0	30.3	30.3
	Official Country Rate for Public Sector Projects	27	39.1	40.9	71.2
	Int. Devt. Partners Discount Rate	19	27.5	28.8	100.0
	Total	66	95.7	100.0	
	Missing	3	4.3		
Total		69	100.0		

From Table 5.6, it can be deduced that the choice of discount rate for appraising road projects investment in Ghana was dependent on the source of funding for the particular project since none of the variables scored more than 50%.

According to Gwilliam (2000) and Belli et al, (1998) any World Bank funded infrastructural project must pass the conventional 10 - 12% minimum Internal Rate of Return Test. In addition, discussions with some of the local consultancy firms indicated that, the feeder roads improvement component of Millennium Challenge Account Program requires all candidate roads selected for improvement under the Program to yield a minimum internal rate of return of 8%. On the other hand, officials of the Ministry of Roads and Highways informed the researcher that, the Ministry of Finance and Economic Planning have been providing official discount rate for evaluation of most public sector capital investments in Ghana.

Table 5.7 shows analysis of responses to question 11. This question was analysed to help determine a suitable option for selecting discount rate for financial appraisal of Rural Transport Infrastructure to test their financial viability.

Table 5.7 – Financial Discount Rate Options

	Discount Options	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Prevailing Market Rate	27	39.1	41.5	41.5
	Official Country Rate	13	18.8	20.0	61.5
	Institutional Planning Rate	7	10.1	10.8	72.3
	IDP Discount Rate	14	20.3	21.5	93.8
	Others	4	5.8	6.2	100.0
	Total	65	94.2	100.0	
Missing	Missing	4	5.8		
Total		69	100.0		

From the survey, prevailing market rate scored 41.5% of valid responses as the preferred option for selecting discount rate for appraising capital investment to determine their financial viability.

As a follow-up question, respondents were asked to indicate the levels of discount rate they have previously used (Question 12).

Table 5.8a – Discount Rate for Economic Appraisal

	Discount Rates	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	< 10%	2	2.9	3.1	3.1
	10% to <= 15%	46	66.7	70.8	73.8
	15% to <= 20%	15	21.7	23.1	96.9
	> 25%	2	2.9	3.1	100.0
	Total	65	94.2	100.0	
Missing	Missing	4	5.8		
Total		69	100.0		

From the survey, 70.8% and 44.3% of valid responses indicated 10% to less than 15% and 15% to less than 20% as discount rate for economic appraisal and financial appraisal respectively. Table 5.8a and Table 5.8b show the levels of discount rates used for economic and financial appraisal of feeder roads and other rural infrastructure projects.

Table 5.8b – Discount Rate for Financial Appraisal

	Discount Rates	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10% to <= 15%	16	23.2	26.2	26.2
	15% to <= 20%	27	39.1	44.3	70.5
	20% to <= 25%	16	23.2	26.2	96.7
	> 25%	2	2.9	3.3	100.0
	Total	61	88.4	100.0	
Missing	Missing	7	10.1		
	System	1	1.4		
	Total	8	11.6		
Total		69	100.0		

Table 5.9 below shows the response for question 13 of the questionnaire. This question was analysed to help determine the appropriate economic life of feeder roads in Ghana.

Table 5.9 – Economic Life for Feeder Road Projects

	Economic Life of Project	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5yrs	10	14.5	14.9	14.9
	5yrs to Less than 10yrs	30	43.5	44.8	59.7
	10yrs to less than 20yrs	17	24.6	25.4	85.1
	20yrs to less than 25yrs	10	14.5	14.9	100.0
	Total	67	97.1	100.0	
Missing		2	2.9		
Total		69	100.0		

From the survey, 44.8% of valid respondents adopted economic life of ‘5 years to < 10 years’ in appraising feeder roads projects.

Table 5.10 below shows the response for question 14 of the questionnaire. This question was analysed to help determine road corridor/zone of influence to be affected by investment in feeder roads in Ghana.

Table 10 – Determination of Zone of Influence

	Method of Determination	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Perpendicular Distance to Road	21	30.4	32.3	32.3
	Parallel Distance to Road	15	21.7	23.1	55.4
	Proximity of Road Network	14	20.3	21.5	76.9
	Accessibility of Area	12	17.4	18.5	95.4
	Others	3	4.3	4.6	100.0
	Total	65	94.2	100.0	
Missing	Missing	4	5.8		
Total		69	100.0		

From the survey, 32.3% of valid respondents adopted perpendicular distance along road project to determine its zone of influence.

Responses to Question 15 were analysed to determine a suitable economic evaluation criteria for selecting or prioritising feeder roads for intervention in Ghana.

Table C5 of Appendix C shows the relative importance indices of the ranking of six (6) economic evaluation criteria by road agencies. The rank by road agencies respondents in descending order were as follows:

1. Prioritization Index (PI);
2. Benefit/cost ratio (B/C);
3. Net present value/Cost ratio (NPV/C);
4. Net present value (NPV);
5. Internal rate of return (IRR);
6. First year rate of return (FYRR).

Table D5 of Appendix D shows that local consultancy firms in the road sector ranked the six economic evaluation criteria for selecting feeder roads for intervention as follows:

1. Benefit/cost ratio (B/C);
2. Net present value (NPV);
3. Prioritization index (PI);
4. Internal rate of return;

5. Net present value/cost ratio (NPV/Cost);
6. First year rate of return (FYRR).

To determine the most suitable economic evaluation criteria for selecting feeder roads for intervention by the two categories, a weighted average of the relative importance indices was calculated. Using the weighted averages, the six economic evaluation criteria were ranked as shown in Table E5 of Appendix E. The rankings of the suitable criteria in descending order were as follows:

1. Prioritization index (PI);
2. Benefit/cost ratio (B/C);
3. Net present value (NPV);
4. Net present value/cost ratio (NPV/Cost);
5. Internal rate of return (IRR);
6. First year rate of return (FYRR).

After the ranking exercise, Kappa statistic for multiple raters was employed to determine the inter-raters agreement between respondents from road agencies and local consultancy firms in road sector. From Table F5 of Appendix F, the agreement among respondents on suitable economic evaluation criteria for selecting candidate road for intervention was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 414 \quad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \quad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 414$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times \bar{m}} \quad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\,\bar{p}_j \bar{q}_j} \quad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \frac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From Table F5 of Appendix F,

$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.644$ and $\sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.833$

$$\hat{k} = \frac{0.644}{0.833} = \mathbf{0.772}$$

From the results obtained, $\hat{k} > 0.75$. It can therefore be inferred that there exists a high degree of agreement beyond chance among raters. This means that majority of respondents agrees on the suitability of Prioritisation Index (PI) as the suitable economic evaluation criteria for selecting feeder roads for intervention in Ghana.

However, this finding was found to be inconsistent with the earlier ranking of Cost-Benefit Analysis as the suitable economic appraisal technique for feeder roads in Ghana since conventional Cost-Benefit Analysis relies heavily on Internal Rate of Return (IRR), Net Present Value (NPV) and Net Present Value/Cost ratio to prioritise investments in road projects

In order to identify the variable which contributed most to the inconsistency in the rankings of economic evaluation criteria for selecting feeder road projects in Ghana by local consultancy firms in road sector and road agencies, Discriminant Analysis was used.

In the Discriminant Analysis, it was assumed that, the means of the two categories were equal at 95% level of significance. The outputs in SPSS on question 15 are presented in Appendix G. Some of the important outputs are discussed below.

From Table G5.17 of Appendix G5, 75.6% of selected original grouped cases were correctly classified, 81.8% of unselected original grouped cases were correctly classified and 62.2% of selected cross-validated grouped cases were correctly classified.

From Table G5.2 of Appendix G5, it can be observed that the mean and variance of evaluation criteria iv155 and iv156 do not correlate. From Table G5.4 of Appendix G5, evaluation criteria iv155 and iv156 are not highly correlated with each other, hence could be considered as possible variables to discriminating between the two categories.

A careful study of the canonical coefficient in Table 5.11 below shows that the evaluation criteria iv156 with corresponding coefficients 0.911 was the primary variables with relatively large coefficient. The primary variable will then be considered as the most important variable for the discrimination. Table 5.11 shows the Structure Matrix of the discriminant function.

Table 5.11 Structure Matrix – Criteria

ID Evaluation Criteria	Function
	1
iv156 – Prioritisation Indices (PI)	.911
iv153 – Benefit/Cost Ratio	.196
iv154 – NPV/Cost Ratio	.163
iv151 – Net Present Value (NPV)	.135
iv155 – First Year Rate of Return (FYRR)	-.131
iv152 – Internal Rate of Return (IRR)	.055

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions. Variables ordered by absolute size of correlation within function.

The standardized canonical discriminant function coefficients in Table 5.12 below were used to determine the variable with the highest contribution to the determination of discriminant function score by examining the magnitude of the standardized canonical coefficients. The variables with the largest coefficients (in absolute terms) were the significant contributors to the discriminant function.

Table 5.12 Standardized Canonical Discriminant Function Coefficients

Evaluation Criteria	Function
	1
iv151 – Net Present Value (NPV)	.352
iv152 – Internal Rate of Return (IRR)	-.060
iv153 – Benefit/Cost Ratio	.139
iv154 – NPV/Cost Ratio	-.202
iv155 – First Year Rate of Return (FYRR)	-.295
iv156 - Prioritisation Indices (PI)	1.013

From Table 5.12 above, evaluation criteria iv156 with coefficient 1.013 was not redundant variable in the discriminant function.

From Table 5.13 below, the grouped mean of evaluation criteria iv156 was not equal at 95% level of significance. This shows that the local consultancy firms and road agencies vary in their assessment of evaluation criteria iv156 (i.e. Prioritisation Index).

Table 5.13 Tests of Equality of Group Means - Criteria

Evaluation Criteria	Wilks' Lambda	F	df1	df2	Sig.
iv151 – Net Present Value (NPV)	.994	.247	1	43	.622
iv152 – Internal Rate of Return (IRR)	.999	.041	1	43	.841
iv153 – Benefit/Cost Ratio	.988	.524	1	43	.473
iv154 – NPV/Cost Ratio	.992	.362	1	43	.550
iv155 – First Year Rate of Return (FYRR)	.995	.234	1	43	.631
iv156 - Prioritisation Index (PI)	.792	11.316	1	43	.002

We can therefore conclude that the views of respondents on economic evaluation criteria iv156 (i.e. Prioritisation Index) were indifferent. It should be noted that the highest absolute values of Canonical structure and Standardized canonical coefficients and Test of equality of grouped means were used to determine the variables with significant contribution to the discrimination.

The evaluation criterion that contributed substantially to the discrimination between the road agencies and local consultancy firms in the road sector was Prioritisation Index (PI). This imply that, any policy on the adoption of Prioritisation Index as evaluation criterion for selecting feeder road projects in Ghana must be done with caution since respondents were different on its suitability.

However, in a study in Tanzania, Ellis and Hine (1997) identified Economic index and Trafficability index for assessing medium to high volume roads and low volume roads respectively. In another study in Uganda, Airey and Taylor (1999) produced a screening method and prioritisation index for ranking low volume feeder roads. The aim of this index was to appraise and prioritise road schemes for very low volume roads carrying an average of less than twenty-five (25) vehicles per day. Airey and Taylor (1999) argued that by using calculations of internal rate of returns, the prioritisation index can be related to conventional economic analysis. With necessary modification, it may be possible to adopt this index for use in Ghana.

The Republic of Zambia National Roads Board (1998) has also developed Assessment Framework for Feeder Roads which adopt another prioritisation methodology called Social Economic Justification Index (SEJI) to assess upgrade of rural feeder roads based on network considerations, social factors and economic factors. It combines Social Dimension Index (SDI), Economic Dimension Index (EDI) and Network considerations to rank road projects by their scores on the SEJI. The problem with adopting this methodology in Ghana will be how to measure and predict the potential output/increases in variables due to the upgraded roads. However, a good coverage of the social factors in units which they are measured and the flexibility to weigh indices according to information gained through local consultation will help enhance this method.

Another prioritisation methodology is the Community Access Road Needs Study (CARNS) which was used to determine prioritises for rural roads upgrades in Eastern Cape Province of South Africa. According to Lipman (1999), the aim of the CARNS was to identify the probable usage of an upgraded road. A merit of this methodology was that it compares objective desk research data with possibly more subjective data provided by local communities and allows the possibility of reaching a solution acceptable across the board. However in Ghana, recorded data may be very limited and therefore more reliance will have to be placed on the data provided by the communities. The cost, time and logistics of training and helping the Local Authorities and the Communities in data collection methods may be a disadvantage of this method.

Finally, the ranking of Prioritisation Index (PI) as the suitable economic criteria for selecting feeder roads for intervention in Ghana well collaborates with the outcome of the Department for International Development (DFID) funded study which produced Ghana's Feeder Road Prioritisation Methodology (RPM).

From the above references, it can be deduced that prioritisation/ranking methods of appraisal were becoming popular for appraisal of low volume feeder roads as they overcome the disadvantages of traditional economic appraisal methods.

5.2.6 Survey Findings and Discussions on Sensitive and Uncertain Variables

Responses to Question 16 were analysed to determine the significant sensitive and uncertain variables when appraising feeder roads in Ghana.

Table C6 of Appendix C shows the relative importance indices of the ranking of sixteen (16) variables by road agencies. It was observed that respondents ranked the following in descending order as the significant sensitive and uncertain variables when appraising feeder roads in Ghana:

1. Project investment cost;
2. Delay in construction period;
3. Other development in the project area;
4. Discounting rate;
5. Economic life estimates;
6. Discounting/evaluation period;
7. International roughness index (IRI) level;
8. Baseline traffic flows;
9. Generated traffic estimates;
10. Year of project implementation;
11. Accident savings estimates;
12. Time saving estimates;
13. Traffic growth forecast;
14. Normal traffic growth rate;
15. Induce traffic estimates; and
16. Shadow prices estimates.

Table D6 of Appendix D shows that local consultancy firms in the road sector ranked the following in descending order as the significant sensitive and uncertain variables in appraising feeder roads in Ghana:

1. Project investment costs;
2. Discounting/evaluation period;
3. Delays in construction period;
4. Baseline traffic flow estimates;
5. Traffic growth forecast;
6. Time savings estimates;

7. Other development in the project area of influence;
8. Generated traffic estimates;
9. Discounting rate;
10. International roughness index (IRI) level;
11. Economic life estimates;
12. Normal traffic growth rate;
13. Accidents savings estimates;
14. Induce traffic estimate;
15. Year of project implementation;
16. Shadow prices estimates.

To determine the sensitive and uncertain variable factors that were significant in the two categories, a weighted average of the relative importance indices was calculated. Using the weighted averages, the sixteen factors were ranked as shown in Table E6 of Appendix E. The ranking of the significant variables in respect of sensitivity and uncertainty testing were as follows:

1. Project investment costs;
2. Delays in construction period;
3. Discounting/evaluation period;
4. Baseline traffic flow estimates;
5. Other development in the project area;
6. Discounting rate;
7. Traffic growth forecast;
8. Generated traffic estimate;
9. Economic life estimates;
10. International roughness index (IRI) level;
11. Time savings estimates;
12. Normal traffic growth rate;
13. Accident savings estimates;
14. Year of project implementation;
15. Induce traffic estimate;
16. Shadow prices estimates.

After the ranking exercise, Kappa statistics for multiple raters was employed to test the level of agreement among road agencies and local consultancy firms in road sector respondents. From Table F6 of Appendix F, the agreement among responses on sensitivity and uncertainty test variables within appraisal framework was tested as follows:

$$m = \sum_{j=1}^{k} x_{ij} = 1104 \qquad (1)$$

$$\bar{m} = \frac{\sum_{i=1}^{n} m_i}{n} \qquad (2)$$

$$\Rightarrow \quad \sum_{i=1}^{n} m_i = n \times \bar{m} = 1104$$

$$\bar{P}_j = \frac{\sum_{i=1}^{n} x_I}{n \times \bar{m}} \qquad (3)$$

$$\hat{k}_j = 1 - \frac{\sum_{i=1}^{n} x_{ij}(m - x_{ij})}{nm(m-1)\,\bar{p}_j \bar{q}_j} \qquad (4)$$

where $\bar{q}_j = 1 - \bar{p}_j$

Hence the overall kappa value for occurrence = $\hat{k} = \dfrac{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j}{\sum_{j=1}^{k} \bar{p}_j \bar{q}_j}$ (5)

From Table F6 of Appendix F,

$$\sum_{j=1}^{k} \bar{p}_j \bar{q}_j \hat{k}_j = 0.741 \quad \text{and} \quad \sum_{j=1}^{k} \bar{p}_j \bar{q}_j = 0.938$$

$$\hat{k} = \frac{0.741}{0.938} = \mathbf{0.791}$$

From the results obtained, $\hat{k} > 0.75$. It can therefore be inferred that there exists a high degree of agreement beyond chance among raters in the ranking of uncertainty and sensitivity test variables.

5.3 OTHER ISSUES FROM THE QUESTIONNAIRE

a. Identification of Additional Costs Variables of Road Investment

Other cost variables that were named by respondents but not mentioned in the questionnaire were:

- Labour standard costs
- Value for money (i.e. Initial construction cost plus Annual maintenance cost)
- Social impact cost

b. Conditions for inclusion of Social Benefits in Appraisal Framework

Other conditions under which social benefits become significant in economic appraisal of feeder road projects in Ghana were:

- Where economic benefits are slightly below the pre-determined threshold.
- When roads become impassable to motorized traffic.

c. Selection of Discount Rate

The following practical solutions not mentioned in the questionnaire were given by respondents as other means of selecting discount rate for economic appraisal of rural transport infrastructure in Ghana:

- Agriculture growth rate
- Net economic discount rate (i.e. Market rate minus Inflation rate)
- Prevailing rate of inflation

d. Determination of Project's Area of Influence

Other methods of determining a project area of influence mentioned by respondents were:

- Use distance of 2km from the start, end and both sides of candidate road;;
- By using a radius of 5km distance radius around the road for intervention;
- By using a walking distance of one hour from the candidate road project.

e. Economic Evaluation Criteria for Selection Road for Intervention

Other evaluation criteria mentioned by respondents but not included in the questionnaire was:

- Transport Economic Efficiency Model/Table (i.e. T-Tables)

5.4 PROPOSED APPRAISAL AND PRIORITISATION PROCEDURE

The flowchart in Fig 5.1 is a proposed appraisal and prioritisation procedure for feeder roads projects in Ghana. The proposed prioritisation procedure evolved out of consultations with some of the respondents during the field survey and a review of literature. It was proposed that the appraisal and prioritisation procedure for feeder roads in Ghana should start with a process of consultation at the local level in order to define candidate roads for intervention.

The other process may include:

- An initial screening and ranking of candidates roads by community groups;
- A detailed survey and technical analysis of the highest community ranked roads by the Department of Feeder Roads or the Works Department of the Local Authorities;
- A participatory review of the proposed network by the Department of Feeder Roads; and
- A revision of the investment decision to take into account the concerns of the community from public review.

It was further proposed that the budget allocation and selection procedure proposed by Hine et al (2000a) be adopted.

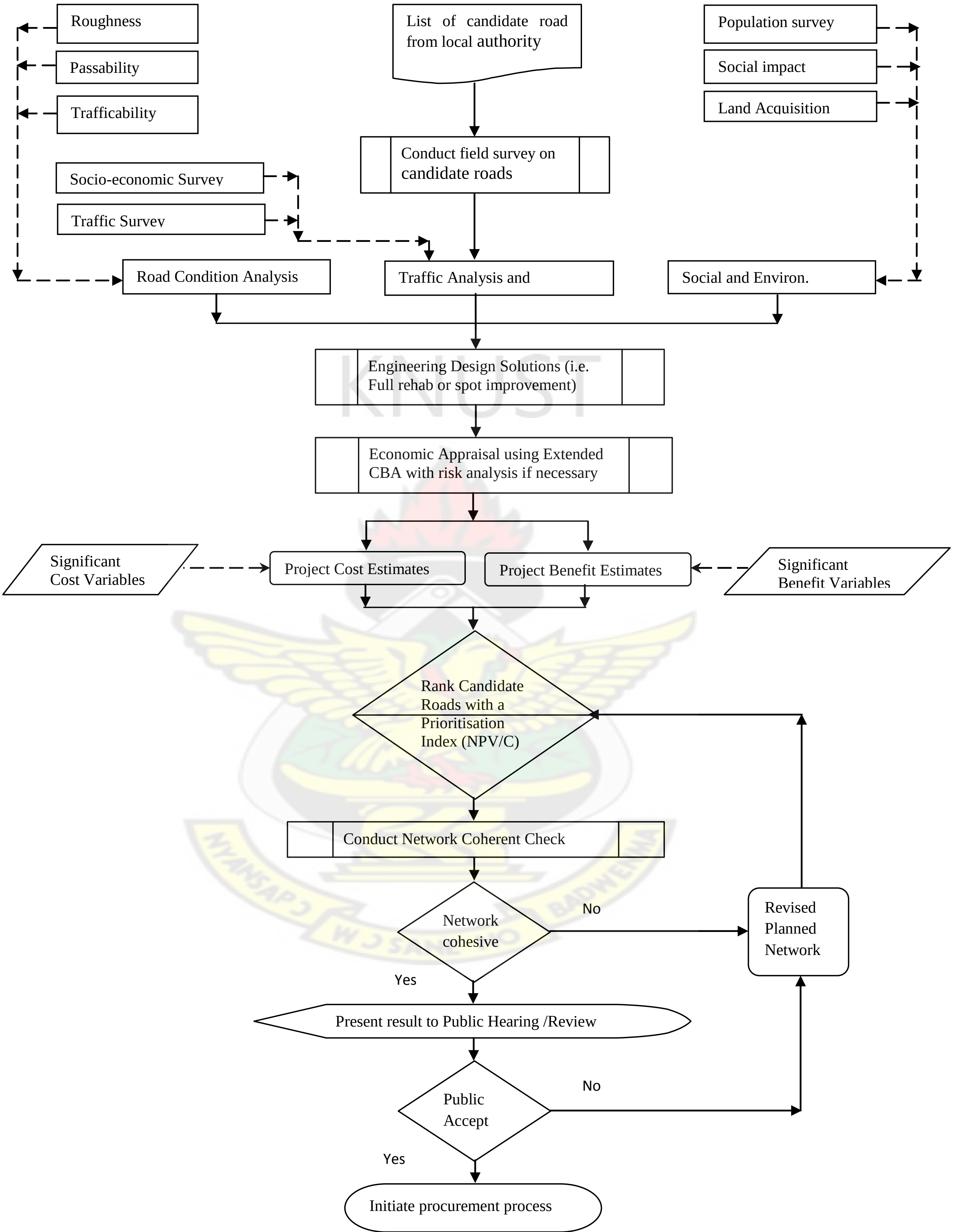


Fig. 5.1 – Flowchart for Appraisal and Prioritisation of Feeder Roads

CHAPTER SIX - CONCLUSIONS AND RECOMMENDATIONS

This chapter summarises the main findings of the research and recommends an outline for conducting economic appraisal of feeder roads in Ghana.

6.1 RESEARCH CONCLUSIONS

The main conclusions of the research were as follows:

1. The significant cost variables in economic appraisal of feeder roads in Ghana were initial construction/rehabilitation cost, major maintenance cost and routine annual maintenance cost. It can therefore be concluded that life cycle costing was important in appraising feeder roads in Ghana.

2. The significant benefit variables in appraising feeder roads in Ghana were travel time savings by passengers and freight (TTS), increased in reliability of transport service and stimulation of economic development in the zone of influence of road.

   It can be inferred from the above conclusion that respondents in Ghana relied more on social benefits in appraising feeder roads.

3. It was found that the inclusion of social/secondary benefits become significant in appraising feeder roads in Ghana where investment can provide a very significant improvement in vehicle access as in situation where there was no existing access at all or the access was at risk of being cut.

4. In selecting a discount rate for economic appraisal of Rural Transport Infrastructure in Ghana, it was observed that the choice of a discount rate for appraising feeder roads projects were dependent on the source of funding.

5. There was no unanimity in the choice of discounting period for appraising feeder road projects in Ghana. However, 44.8% of the valid respondents adopted 5 years to less than 10 years as an ideal period for economic appraisal.

6. There was also no unanimity in the determination of zone of influence for proposed feeder road projects. However, adopting a distance perpendicular to the proposed road scored 32.3% of valid responses. It was therefore inferred that, there was no common procedure for determining the impact zone during appraisal of a feeder roads in Ghana.

7. The suitable economic evaluation criterion for selecting feeder roads for intervention in Ghana was found to be Prioritisation Index.

8. The following were ranked as the significant sensitivity and uncertainty test variables in appraising feeder roads in Ghana: project investment costs, delays in construction period, discounting/evaluation period, baseline traffic flow estimates and other developmental projects in the project's area of influence.

6.2 RECOMMENDATION

It was recommended that the economic appraisal and prioritisation procedure proposed under section 5.4 of Chapter Five be adopted for appraisal and prioritisation of feeder roads in Ghana after validation.

6.3 FURTHER RESEARCH

It is recommended that further studies be conducted to identify social benefits variables relevant to appraisal and prioritisation of feeder road projects in Ghana.

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