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The Social Impact Score: a Framework for Including Social Benefits in Rural Road Prioritization Investments and Decision Making

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THE SOCIAL IMPACT SCORE: A FRAMEWORK FOR INCLUDING SOCIAL BENEFITS IN RURAL ROAD PRIORITIZATION INVESTMENTS AND DECISION MAKING

by

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ABSTRACT

Rural roads and transport infrastructure play a crucial role in the larger development picture. These physical assets have non-economic impacts including reaching goals such as reducing poverty, increasing access to health centers and schools, expansion of agricultural and non-farm economic activities, increasing political participation, access to information, and can play a role in reducing the traditional taboos that engender discrimination of women and minority groups.

However, there remains a disconnect between these potential benefits and their implementation in policy decisions. The inclusion of social benefits in rural road investment prioritization has not become a routine part of the decision making process of policy makers and infrastructure planners. Several reasons contribute to this, including a focus on economic justification and return on investment, as well as the difficult and often impossible task of fully isolating the impact of indirect and induced impact of road infrastructure on the larger development picture.

However, simply ignoring the larger impact of rural road infrastructure because of difficulty in quantifying the impacts fails to fully seize the opportunity to contribute to larger development goals in transport planning. The purpose of this thesis is to create a metric called the *Social Impact Score* (SIS). Building on three main pillars of research, the SIS seeks to fill the gap between well-established case study literature highlighting the importance of rural roads and the inclusion of these considerations at the national infrastructure policy level.

The metric was designed in conjunction with other analysis tools, including a life-cycle analysis on road maintenance and construction under current and future climate scenarios.

The information provided by the SIS will serve national level policy makers as an important step in expanding the criteria and justification used to allocate investments in rural road infrastructure, based upon a sustainable life-cycle perspective and more holistic development impact. The ‘further research’ section discusses the use of the SIS as a tool that can highlight areas where further research may be needed or desired at a sub-national level.

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Introduction

In most developing countries, road infrastructure is one component of the overall development picture and competes with limited resources for construction, maintenance, and rehabilitation of the network. Because there is a limited budget available for the needed investments, road projects must be prioritized. Traditionally, this is done by an economic benefit-cost analysis (BCA), but in many cases, most rural roads fail to meet the economic internal rate of return. Characterized by low motorized traffic volume and having value in non-economic ways, current methods of rural road funding, investment, and prioritization must be augmented to capture a more holistic and complete picture of their true impact and benefit.

Many case studies have looked at both the economic and non-economic benefits of rural roads. While many of the economic findings from these studies have been implemented at the policy level, there is little to no implementation from the findings on the impact of non-economic benefits that rural roads may confer; yet the non-economic impacts are often considered to be the primary benefit, and an important component of overall country development.

Additionally, many case studies cite non-direct (‘social’ or ‘development’) benefits from rural roads, including increases in primary school attendance, healthcare access and utilization, increases in employment opportunities, and more. The ability to incorporate these social benefits into the larger prioritization framework should be an imperative for developing country policy makers, yet it is not a routine part of the decision-making process.

Several reasons contribute to the failure to include social considerations in the decision process, including a focus on economic justification and return on investment, as well as the difficult and often impossible task of fully isolating the impact non-direct impacts of road infrastructure on the larger development picture. When social impacts are considered, it is often only at the local level and not incorporated into the funding process at a level where it is prioritized or incorporated in a meaningful manner.

However, instead of excluding the larger impact rural road infrastructure can have in reaching development goals because of difficulty and/or cost associated with quantifying non-direct benefits, transport planners should better prioritize road investments by including these benefits, even if impacts are estimated. The purpose of this thesis is to introduce a metric called the *Social Impact Score* (SIS). The SIS is a straightforward framework that requires only a small set of readily available data to analyze the potential impact of road investments. The SIS serves to bridge the gap between well-constructed case methods and the highest level of decision-making. Applied in the rural context of developing countries, it is designed to help policy makers prioritize key areas for investment based on the non-direct economic benefits.

This thesis paper and the SIS metric is designed to raise awareness of the importance of systematic infrastructure planning by placing rural road prioritization, rooted in social impact literature, in a framework that is easily included in existing decision processes. Specifically, the SIS framework is developed with a systems approach using three main pillars of research: national infrastructure management and planning (as defined in the development literature on rural road infrastructure in the developing world, as well as the author's experience); the social (non-direct economic) impact of rural infrastructure on the surrounding populations; and research in the field of systems analysis and multi-criteria decision analysis frameworks (MCDA).

Research Question:
How can social benefits and impacts be incorporated into high-level rural road planning and investment decision-making?

By understanding the important role rural roads can play in improving aspects of welfare including access to healthcare, education, gender equity, and reducing poverty, among others, can road planning be improved beyond current practice where the focus is on economic cost-benefit justification?

How can measurements be quantified, standardized and simplified to include these impacts and be useful at a high-level of decision making?

If the SIS is incorporated into rural road planning, it can better inform investments by prioritizing areas that serve to benefit from a road more than other potential road investment options. This is especially important for countries with concurrent development goals, including reduction of poverty, increase of health and educational access and use, and improvement in the overall human welfare. Previous research, mostly in the form of case studies whose results are elaborated upon in chapters 2 and 3, show that rural roads have an impact that is not captured in BCA and current planning methods. Developed in conjunction with other analysis tools, including life-cycle costing assessments, which include maintenance and climate change analysis, the SIS is expected to serve four main functions:

1. At the highest level, it can be easily incorporated into the decision-making process to prioritize investments in areas with higher rates of poverty and lower road density, leading to potential substantial benefits in social impact and development areas;
2. Help policy makers identify areas where greater research may be needed and/or key areas for further in-depth research to include local priorities, enhance local capacity, and identify specific vulnerabilities that may be contributing to an under-developed transport network relative to the country/region;

3. Provide information and preliminary analysis for new technology options including labour-based employment (LBE) techniques, which highlight the potential for local capacity building, employment generation, and reinvesting infrastructure funding directly back into the local economy;

4. By creating a usable metric that is rooted in development literature, highlighting the importance of road infrastructure beyond the traditional economic approach, the SIS will serve as a tool to enhance awareness at the policy level of the importance of holistic transport planning, particularly in terms of rural infrastructure.

As mentioned earlier, the current and historical practice for rural road investment is based upon a limited BCA which fails to capture many of the benefits that roads may have on the surrounding populations. Rural road infrastructure is characterized as having traffic less than 25-50 vehicles per day and considered in areas with low population density, little or no economic market dependent on transportation (self-contained rural economies), high levels of poverty, low levels of vehicle ownership, and other features of spatial isolation.

Case studies from the International Labour Organisation (ILO), the World Bank, the UK's Department for International Development (DfID), the Asian Development Bank (ADB) and others show that rural road investments can have positive impacts, notably on: access, use, and quality of healthcare, both for acute and chronic conditions; access, quality, and more equal gender enrollment in primary and secondary education; decreased costs of transport leading to greater mobility and access to markets, information, knowledge, and credit; decreases in poverty as agricultural and non-agricultural market opportunities increase; and decreases in gender-specific prejudices as cultural taboos are affected (Satish 2007; Dorosh et al, 2010).

While the findings do not present rural roads as a turnkey to development and increases in human welfare, they establish that rural roads are a crucial component in the attainment of larger development goals. Equally important, their deterioration or absence "reduce growth opportunities and negate the benefits from investments in other sectors designed to improve the livelihoods of poor communities" (IRF, 2008).

The motivation for this thesis is to bridge the gap between the current road infrastructure planning approach and the potential benefits of rural road investment, even in areas that do not show strong economic returns.

Research Contributions:
Creating a straightforward metric, the Social Impact Score (SIS), designed for implementation into current rural road planning practices at the national or sub-national level. The SIS is designed to utilize readily-available data and limited inputs.

By using metrics identified in several case studies throughout the developing world by IGOs and NGOs, the SIS highlights the important role low-volume roads can play in the broader development picture and incorporate these impacts in a meaningful way to improve the current decision-making practices. SIS is specifically designed for Sub-Saharan Africa, but is relevant to other developing countries, including South and South East Asia.

The approach for developing the SIS is: a literature review of general transportation reviews, historic and recent case studies of rural road impact, and development literature pertaining to rural road investments; field research conducted over the past year in South Africa and Mozambique; and reviewing the use of systems thinking and multi-criteria decision analysis theory to develop a framework where multiple considerations can be prioritized without necessitating economic quantification.

The layout of this paper is as follows: Chapter 2 provides information on the motivation, background, and need for this work. It focuses on the evidence supporting the social impact of rural roads. These are foundational in both the motivation and approach taken in Chapters 4 and 5. Chapter 3 provides a literature review on the three pillars of research used: Development literature, infrastructure management and planning, and multi-criteria decision analysis. Chapter 4 details the research method used, the development of the SIS framework, including the inputs, calculations, and outputs. Chapter 5 details the potential application of the SIS in the case of the South Africa's Western Cape Province current road investment strategy and an illustrative example prioritizing an archetypal road investment choice in Southern Africa. Chapter 6 provides discussion on areas of further study and a conclusion on the SIS method and findings.

Additionally, three appendices are included. Appendix A includes definitions of many terms used throughout this paper to provide clarity about the meaning of terms. Throughout the paper, terms which are defined in the Appendix are starred (*) in their first use (after chapter 1) to provide guidance to the reader. Appendix B includes a thorough explanation of the labour-based employment (LBE) approach as background in the techniques discussed in this paper, and Appendix C an explanation of the Millennium Development Goals and their relation to transport.

It is acknowledged that there are limitations to the MCDA approach taken in this framework, but where, "efficiency and equity concerns are inseparable, information is incomplete in important ways, and resources are limited," the SIS metric seeks to be a first feasible step in bridging this gap (Van de Walle 2002).

Chapter 2: The Case for Social Impact Assessment

The focus of this thesis and creation of the SIS metric is rooted in the belief that the impacts of rural road infrastructure in developing countries have important components that are not incorporated in current planning and implementation practices. These components can be quantified as the 'social'* impacts: sometimes defined as indirect* and induced* benefits. Broadly, these are arranged into a few categories by the author and each is expanded upon below: the impacts on gender equity, healthcare, education, and impact on poverty and other factors.

This chapter discusses the motivation and support for a road planning metric that focuses solely on social impacts, including a section on the Millennium Development Goals (MDGs)* and rural transportation infrastructure. While not explicitly mentioned in the MDGs, rural transport is tied to each of the eight goals; the MDGs are a common reference point for global human welfare and development, and thus, play a role in clarifying and focusing the vast amount of information that can be attributed to the 'social' realm. Appendix B provides more information on the MDGs and their links to transportation.

Additionally, this chapter provides the brief introduction for the main challenges facing policy makers which have largely inhibited the adoption or incorporation of including social benefits in current transport planning practice. This is expanded upon further in chapter 3, with a discussion of existing transportation planning in developing countries as well as the merits of a MCDA approach. These are combined with findings in development literature case studies to highlight the methods and indicators developed for the SIS metric. Further, a brief introduction to the labour-based employment* concept, technique, and merits is included in this chapter, with further information available in Appendix B.

The Social Impacts of Rural Road Infrastructure

Rural roads are an important component of any development strategy for economic and welfare reasons. While urbanization is an increasing trend in the developing world, in 2000 over 60% of persons in Africa still lived in rural areas; while this number is expected to decline, by 2030 approximately half of the population of Africa will still be living in rural areas (Kumar and Barrett, 2008). This is important because poverty is often worse in rural areas for a myriad of reasons, but relating in large measure to a lack of access to services, representation at the political level, access to credit, access to information, availability and access to healthcare, education, and markets (African Union, 2005; Lombard and Coetzer, 2006; IRF Bulletin, 2008). Additionally, where economic growth is a principal concern for most developing countries, a lack of transport infrastructure, including rural roads, can reduce and hamper growth opportunities, negate benefits from investment in other sectors, and have a negative overall impact on human welfare in economic and social terms (Gachassin, et al. 2010; Lombard and Coetzer, 2006; Bryceson et al, 2006).

Before presenting the findings on the social impact of rural road infrastructure, it is worth acknowledging that there are significant challenges inherent in quantifying non-direct social impacts. As stated in Fouracre, 2001, the overriding challenge is that, "no hard and fast distinctions can always be drawn between the social benefits and the economic… often these two areas go together because an improved economy is likely to benefit a community in social terms while social benefits such as cleaner water or basic access to healthcare leads to economic benefits by lowering mortality and illness, increasing productivity (paraphrase)". Another challenge is that impacts may vary between different geographic regions and within regions based on socio-economic factors, cultural factors, and institutional factors, among others (Van de Walle 2002; Duncan, 2007; Howe, 2003; Fox and Porca, 2001; Satish 2007).

These challenges are discussed in greater detail later in this chapter, but this paper is an attempt to quantify the benefits presented below because, as stated in Van de Walle, 2002, "it is arguably better to directly confront this problem, and set explicit 'best guess' estimates rather than putting important classes of development projects outside the evaluation system, such that we have little or no idea if we are investing too much or too little in these types of projects."

Keeping this perspective in mind, the following sub-sections illuminate the development research in five areas: the general areas of impact, the links between transportation and the MDGs, and the impact of rural roads on gender equity, healthcare, and education. There are also two sub-sections which introduce labour-based employment and the negative impacts that can stem from new road construction in rural areas.

General Impacts

This sub-section is designed to cover the factors not explicitly covered in the sections below, those of healthcare, gender equity, and education impacts and ties to the MDGs. A chart (Table 1) from (Edmonds, 1998; modified by author) details how several dimensions of poverty are impacted by access* and transportation. Each of these ten areas is a component of rural development, and shows the diverse impact that roads and reliable access to these components can have.

Table 1: [Selected] Factors Affecting Poverty Related to Access
(Author's modification, information from Edmonds, 1998)

Category	Selected Contributing Factors
Employment	Physical access to job locations; lack of transport services; lack of job opportunities
Land	Distance and time to fields
Information	No radio; no telephone; poor postal services
Credit	Location (time/distance) of credit facilities
Health Services	Lack of health centres; poor access; lack of transport services; limited personnel; lack of medicines
Water	Lack of irrigation; distance to supply; lack of wells
Energy	Limited electricity; decreasing supply of wood; distance to source
Markets	Poor transport facilities; location
Transport	Poor tracks; poor transport facilities; lack of roads; limited number of vehicles
Education	Poor tracks; lack of transport facilities; lack of teachers; limited materials

Limited access to markets and economic centers is a field of great study, especially in terms of agricultural development and factors such as transportation cost and time to market for sensitive agricultural goods. However, the broader goals of socio-economic development are often rooted in the basic services and must be considered an important part of the overall growth and development equation. Lombard and Coetzer, 2006, cite that socio-economic development is a precursor to economic growth, and is hampered by several factors including a lack of adequate road infrastructure. The “unreliable and difficult access” that characterizes much of the African (and other developing countries’) road infrastructure can “reduce growth opportunities and negate benefits from investments in other sectors [which are] designed to improve the livelihoods of poor communities” (IRF Bulletin, 2008). In this view, it is clear that reliable rural roads are important in areas far beyond the direct economic impact, and perhaps can even be described as the building block upon which many components necessary for economic growth lie. For example:

> “A study in Bangladesh compared two sets of [129] villages showed that villages with road access, compared with villages without access, fared much better in farm-gate price of produce, fertilizer use, land under irrigation, household income, income per acre of field crops, wage income of landless labor, and percentage of employed women…improved rural access provides social benefits in promoting education, particularly girls, health benefits, increased labor mobility, the spread of information and knowledge and improved access to markets. Many studies demonstrate the dynamic changes that improved rural mobility(*) brings to the social and economic life of rural areas” (Lebo and Schelling, 2001)

Additionally, components such as social infrastructure are highly important for accessing and participating in things like credit, political participation, and growth and strengthening of community organizations (Satish, 2007; Edmonds, 1998). The sheer amount of time spent in completing daily household activities is a limiting factor in the creation and implementation of community organizations, school attendance, and other secondary needs. Rural roads are one way to lessen the transportation burden on rural households (Edmonds, 1998).

Transport and the Millennium Development Goals

The MDGs were created under the United Nations in 2000 as a set of eight separate goals designed to encompass many of the top development concerns globally. Each goal has several components, with specific targets and dates set for completion. More information can be found in

Appendix C, including a table prepared by the African Union that specifically outlines much of the information presented below. The MDGs are set for a final target date in 2015. While many have not been reached, nor are they on track to be reached by 2015, they represent a holistic set of agreed-upon priorities for developing nations and embody larger development strategies that have been in place for decades. Because of their global recognition and succinctly organized format, they provide a useful context for discussing a large topic such as transportation and social development.

While transportation and road networks are not explicitly stated in the eight goals, lack of road infrastructure is perceived to be a major constraint to many of the targets including the improvement of gender equity, reduction in infant and maternal mortality, increasing food security, reducing extreme poverty, and achieving universal primary education (African Union, 2005).

Specifically, the MDGs do set a target of 2 km motorable road access (basic access*) levels globally. Some case studies cite that 5 km is an acceptable distance (and more realistic) in Sub-Saharan Africa due to highly dispersed populations over large areas of land (African Union, 2005). However, it is worth noting that this target is still short of ideal welfare: a number of NGO workers surveyed by the author in South Africa in 2012 stated that 2 km is still a considerable distance for someone needing acute medical attention ("Surveys" 2012).

For MDGs 2 and 3, specific target indicators relating to rural road infrastructure are identified. These include measurements to calculate: primary schools with reliable road access; the number of households which report constraints on education due to a lack of time for children (girls) to attend school; the cost and difficulty and safety of accessing healthcare centers and/or schools; and the quality of primary education offered at accessible schools (See Appendix C) (African Union, 2005). Ensuring the basic quality of roads as well as cheaper, safer, and easier access of local transport infrastructure is considered an important element in achieving universal primary education by reducing the amount of time that household members, including children, devote to basic needs such as collecting fuel, water, and food. The time constraint is considered a principal reason for non-enrollment but is subject to other conditions such as quality of education and cultural and institutional realities (African Union, 2005).

For MDGs 4 and 5, specific target indicators relating to rural road infrastructure are identified: the number of health centers and clinics with reliable rural access; the percentage of lower-income households reporting constraints on health due to distance, cost and difficulty of travel; cost of immunization per capita; and emergency transport availability for medical crisis (See Appendix C).

Rural road infrastructure and MDG 6 are connected with indicators including the prevalence of HIV/AIDS among transport sector workers; the prevalence of HIV/AIDS in roadside communities; the inter-country coordination of actions relating to AIDS in transportation sectors; and concerns with passenger and road safety including fatalities through automobile accidents.

Several countries and regional bodies, including the African Union (See Appendix C) and Cambodia, created a set of MDGs and/or targets specific to their development concerns and country or regional context. In Cambodia, rural road provision is considered a “critical factor in reducing poverty in rural areas” and an “investment that can contribute to the achievement of many of the Cambodia MDGs” (Ministry of Rural Development, 2012).

Gender Equity

Gender equity is a key focus of much development work. As mentioned in the MDGs section above, several of the goals are specifically geared towards reducing the discrimination of women in many areas of society. There are sobering statistics about gender inequality, including that in developing countries, a woman dies in childbirth every 1.5 minutes, and fewer than 50% of women have jobs whereas nearly 80% of men are employed in some capacity (Kim, 2013). In relation to transportation, poverty, and rural livelihoods, rural roads can play a positive role in several areas.

In 1982, USAID began to acknowledge the significant impact that rural roads play in the 'impact on women' - both benefits and dis-benefits – although these were not directly incorporated into decision-making because of difficulty in quantification and analysis (Howe, 2003). In several studies (Edmonds, 1998; Hine et al, 2000; Lebo and Schelling, 2001; African Union, 2005; Lombard and Coetzer, 2006), a different view in regards to the importance and role that rural roads play in daily life was observed between men and women: men tended to identify benefits in terms of access to markets and time to employment, whereas women saw benefits in terms of increased household security (due to better and more reliable incomes) and a substantial benefit if the roads reduced the amount of time and effort required (the 'transport burden'*) to collect fuel, water, and meet other basic needs. Lack of an adequate rural roads network was identified as hampering the efficient performance of these tasks and the existence of an improved rural road is shown to reduce this burden (Lombard and Coetzer, 2006; Bryceson et al, 2006).

In Cambodia, one study estimated that 6.7 hours are required daily to meet household needs (Ministry of Rural Development, 2012). An African-focused study cited that 90% of the transportation requirements were for daily household needs and performed 'almost entirely by women', occupying 20-25% of their productive working time (African Union, 2005). While "better access to farms, wood lots, water supply points, and markets is only one of the measures needed to reduce the load and free up time for other purposes…it is an important one" (African Union, 2005).

Another positive area of impact that rural roads may have on gender equity is improving female participation in the labour force and reducing traditional 'taboos'. This may result in "economic spin-off effects" where women benefit through micro-enterprise or may be more directly implemented through intentional hiring of women for LBE projects (See Appendix B). This may also result through increased school attendance and higher literacy rates among women (Satish, 2007; Fouracre, 2001; Kim, 2013; Kocks Ingenieure, 2008).

The healthcare and education components are discussed in separate sections, but it is worth noting in the gender equity section that rural roads often increase disproportionately higher school enrollment rates for girls, increase access to healthcare for women (specifically due to pregnancy). The negative impact may also be higher for women, as increased rural road density are factors in the spread of HIV/AIDS and transactional sex as well as incidences of human trafficking (See 'Negative Impacts' section below) (Kocks Ingenieure, 2008).

Healthcare

Alongside education, the impact on healthcare is a predominant theme of literature looking at rural development and rural infrastructure. Many of the benefits described in this section overlap with those mentioned in the Gender Equity and MDG sections, but the importance and prevalence of healthcare and access to health facilities in development literature and case studies necessitates a section devoted to these findings.

There are two main reasons that road transportation and healthcare are closely linked. Firstly, the links between healthcare and health services to human welfare and overall socio-economic development are clear. Whether the distribution of mosquito nets to fight malaria, the availability of drugs and vaccines to all segments of the population, or the treatment of illness to allow for greater economic participation and productivity, general access and availability of healthcare is crucial to greater development goals and is facilitated by transportation infrastructure. Secondly, the availability to access healthcare in times of acute medical need, such as complicated pregnancies, injuries, or acute medical cases (such as cerebral malaria) is highly dependent on availability and reliability of road transport (Kocks Ingenieure, 2008; Bryceson et al, 2006; African Union, 2005).

In a survey of rural roads and poverty reduction in 2006, Bradbury et al states that rural surveys done in case studies in Africa and South Asia repeatedly find that rural roads have high value in part due to access to medical centers. This was largely attributed to the second reason above: the high opportunity cost of ease of travel associated with pregnant or acutely ill persons.

Additionally, in surveys conducted by the author in South Africa in 2012, responses from staff working in health-related NGOs stated that transportation and rural roads were a considerable factor in project costing, timing, and other considerations. One respondent stated that there were two major constraints on project cost and implementation, as well as the ongoing need for intervention by the private sector: the failures in institutional capacity (including lack of local governmental capacity and mismanagement of allocated funds) and the lack of infrastructure (including water and sanitation infrastructure, health and school facilities, and poor rural roads) ("Surveys" 2012).

Several staff surveyed at two health-related NGOs in Limpopo Province, South Africa reported similar responses: poor roads affect all areas of development, including healthcare, economic growth, education, empowerment (of vulnerable groups), and poverty. In the absence of more clinics and health facilities built, funded, and adequately staffed, they stated that improvement in rural road infrastructure is a crucial component to increasing rural health:

> “[Due to poor roads] people are restricted in their access to essential services, and it further presents a barrier to the service implementers being able to reach them. For instance, clinics serve very wide areas and people are required to travel large distances to reach them. In order to support the communities, however, mobile clinics are supposed to visit each [local] clinic. These large vehicles [mobile clinics] rely on adequate roads” ("Surveys" 2012).

In relation to healthcare, the ability to provide vaccines and other medications is often reliant upon the ability to keep the ‘cold chain’ – the ability to refrigerate and control the temperature at which medications are transported and stored. Roads are a key element of this, because of refrigerated transportation and the prevalence of other infrastructure including electricity at on-site clinics. There are creative examples where this barrier is overcome, such as solar-powered refrigeration that can be transported by camels (Parsons, 2009), but generally roads are considered an important part of extending healthcare services.

Another factor identified by NGO respondents was the high cost that poor road infrastructure contributes to overall project cost. Costs that are incorporated include the wear and tear on vehicles (specifically in South Africa, higher rates of depreciation are given to vehicles used in rural service delivery) and the staff time being spent on travel. The 'productive time' wasted on transportation was identified by all respondents (health and non-health related NGOs) as the greatest potential positive impact if rural roads were greater in number and quality.

The intersection of healthcare and rural transport is a vast literature body including many non-technical research projects designed by the healthcare community. Roads do not present the only barrier to healthcare provision or use (Ensor and Cooper, 2004), but where healthcare goals are of particular consideration among local or national infrastructure planners, the specific needs of rural areas should be identified through research conducted in focused community participation groups as well as NGO input to determine the most meaningful types of interventions.

Education

Paired with findings on health benefits, impacts on education are the most widely touted positive non-direct impacts of improved rural road infrastructure (Lebo and Schelling, 2001; African Union, 2005; Fuglestvedt et al, 2007; Bryceson et al, 2006). Most evidence is from locational case studies, a few of which have results presented below. On a general level, the MDGs highlight the need for rural roads in their indicators including the distance to primary schools and other metrics (African Union, 2005). It is important to note that other factors such as cultural constraints, availability and location of schools, and quality of education are other factors that may contribute to low enrollment factors (Van de Walle 2002).

There are two main components of the impact rural road infrastructure has on improving education in rural areas. The first is the improved ability of students to get to schools, mainly due lower travel times both for travel to and from school and due to lower transportation time for other needs

(Fouracre, 2001; African Union, 2005). The second is the availability of more and higher quality teachers. This is linked to provision of road infrastructure for many indirect reasons, including the higher quality of life offered by areas with better access to services (such as healthcare and businesses) (Howe, 2003; Bryceson et al, 2006; Van de Walle 2002; Kocks Ingenieure, 2008).

Education is identified as the dominant reason for travel for non-economic purposes (Bryceson et al, 2006). A study in Ghana showed that distance and difficulty of travel to primary schools was an important consideration in attendance, but was inhibited largely not by the availability of primary schools, but the distance and difficulty of travel to secondary schools; where secondary schools were deemed inaccessible, primary school enrollment decreased (even when it was accessible) because it was perceived to provide little benefit in the longer term. Findings in Vietnam and Lesotho similarly identify gains in education beyond the primary level where road investments were made.

A study of Morocco concluded that the presence of a paved road in a rural community more than doubled the attendance rate of girls at school (from 21% to 48%), and attendance by boys increased from 58% to 76% (African Union, 2005; Howe, 2003). The contribution of roads was multi-faceted, including paved roads requiring fewer closures (reducing teacher and student absenteeism), easier teacher recruitment, and greater availability of supplies. This was in conjunction with an increased investment in school staffing in the areas being served by the paved road investments.

In Sub-Saharan Africa, one study showed that the probability of a child being enrolled by primary school was increased by approximately 20-50% if a primary and secondary school were located within the community. In Lesotho, the social value (including education) of road upgrading is identified as much higher in remote mountainous areas (African Union, 2005). In Cambodia, evidence shows ‘substantial links’ between the development of rural roads and increases in enrollment rates for both boys and girls, due to improved school accessibility (Ministry of Rural Development, 2012). In Vietnam, the links between poverty, poor infrastructure, and lower rates of attendance mainly impacted the enrollment and completion of secondary education (African Union, 2005).

Regarding gender, there are several case studies which cite that the improvement in attendance was gender neutral (Cote d'Ivoire, Lesotho and others). In many others, specifically where enrollment rates among girls began at a lower rate than boys, there was a substantial increase in female enrollment when improvements in rural infrastructure were seen (Ghana, Morocco, Bangladesh, Bhutan). This may due to several factors, including lower transport time for school and other activities as well as increased safety in school travel for girls (African Union, 2005; Howe, 2003; Ministry of Rural Development, 2012; Bryceson et al, 2006; Van de Walle 2002; Kocks Ingenieure, 2008; Fouracre, 2001).

In summary, the benefits to increased school enrollment rates have been identified through increases in attendance at the primary level and higher rates of completion for students at the secondary and tertiary levels. The main reasons for this include better recruitment of teachers and lower levels of absenteeism by teachers, the availability of supplies (both school-related and other including water) and less time spent on other basic activities necessary for household survival.

Labour-Based Employment Potential

Labour-based construction is a potential option for the construction and maintenance of rural roads in developing countries. Championed by the ILO, it focuses on creating people-intensive construction methods that require unskilled labour and can produce similar quality roads to traditional, machine-intensive methods. The benefits of LBE are both economic and non-economic, but are not considered in current CBA or traditional economic evaluation methods applied to rural roads. The LBE approach has the potential to transfer skills and resources to an unskilled, impoverished local labor force, with positive impacts on poverty, the gender disparity in income distribution, and overall maintenance of the road due to higher levels of ownership and skill level for basic repairs (Lebo and Schelling, 2001; Satish, 2007; Paige-Green, et al. 2004; Mozambique FRP; Bradbury, 2006; Donnges, 1998).

On an economic level, LBE can provide a technically effective solution to road construction and routine maintenance at similar or lower costs to traditional methods. Additionally, LBE sees a majority of costs being reinvested directly into the local economic through local wages. In areas where local rural road maintenance needs may be stretched extremely thin or non-existent, LBE construction can provide valuable training and skills transfer for communities to be able to handle spot repairs and routine maintenance without dependence on local government. Successful case studies have been implemented in Kenya, Mozambique, and Zambia, and research on similar techniques applied to other types of infrastructure have seen positive returns with community engagement in the form of longer-term maintenance of equipment (Fouracre, 2001; Lebo and Schelling, 2001; Bradbury, 2006; Paige-Green, et al. 2004). In other areas, the engagement of government with local persons, who often are disenfranchised and express a level of frustration in a failure to influence decision-making, LBE can be one method of increasing contact and communication between rural persons and local government (Bradbury, 2006).

LBE is not suitable in all cases and requires a level of commitment and institutional capacity to ensure quality training as well as logistics including the timely transfer of wages to local persons and skilled workers to monitor the progress and quality control of construction. More information on the techniques, parameters, and three case studies (Cambodia, Kenya and Mozambique) are provided in Appendix C.

The Negative Impacts of Rural Road Construction

The social benefits of rural road investment are substantial and merit greater consideration. However, it is not a simple matter where all investment is singularly positive. Several negative impacts from road investment may occur, dependent on local conditions, needs, and other factors. A few of the most notable are: the increase in the spread of disease, including HIV/AIDS; an increase in human trafficking and transactional sex; environmental concerns including increases in traffic and pollution; and safety concerns among pedestrians (Kocks Ingenieure, 2008; Ministry of Rural Development, 2012; Fouracre, 2001; Pinard and Greening, 2004; African Union, 2005; IRF Bulletin, 2008).

Specifically in considering the HIV/AIDS, transactional sex, and human trafficking concerns, national policies and local interventions designed to combat these impacts can be effective. For example, with a World Bank project improving a road corridor running through rural and poor areas of Moldova, the Social Impact Analysis (required for World Bank investment projects) identified a high incidence of poverty and a history of sex trafficking for women in the area. Ideally, the corollary follow-up to such a finding is dedicated resources and training to raise awareness of the issues, hire women to increase income potential (reducing vulnerability to trafficking and transactional sex), and providing healthcare awareness and treatment for HIV/AIDS concerns (Kocks Ingenieure, 2008; Ministry of Rural Development, 2012; African Union, 2005).

The International Labour Organisation has additionally addressed many of these components in their LBE programs through workshops and training (IRF Bulletin, 2008; "Labour-Based Technologies"). Policy makers and planners should collaborate with local NGOs and other health organizations in road construction areas to highlight the risk and promote integrated project assessment to minimize these negative impacts (African Union, 2005). Safety considerations are negative impacts that can be mitigated in many ways. Some examples include stricter licensing and policing forces where safe driving practices are taught and enforced; increased construction of sidewalks and dedicated pedestrian areas may also help reduce fatalities and injuries.

Challenges Facing Integration of Social Considerations in Decision-Making

With all of the evidence cited in this chapter, the potential impact of rural roads on areas outside direct economic impact is clear. However, it has not yet been incorporated into decision-making at the initial levels of funding and investment prioritization. This is discussed in greater detail in Chapter 3, but briefly, the exclusion lies in the challenges of quantifying (usually discussed in economic terms) the benefits described above (Howe, 2003; Ensor and Cooper, 2004; Van de Walle 2002).

According to Howe, 2003, among other sources, early CBA methodology for rural roads was dominated by the idea that, "social effects are not quantifiable and the approach must be limited to economic aspects." In 1982, USAID recognized the social benefits of rural road construction, but along with other agencies, failed to decisively incorporate them into a routine part of the decision-making process. More recently, there is recognition of the impact that transport networks play, as evidenced by World Bank social protection loans to countries including Argentina, Georgia, Burundi, Madagascar, and Vietnam for reasons implicitly and explicitly citing social reasons such as improving access to healthcare (Ensor and Cooper, 2004).

However, these benefits may be generally acknowledged, but have yet to be integrated in a meaningful way. Current approaches to road planning are predominantly technical; for example, South Africa uses the World Bank's HDM-4 ("Highway Design and Management") model as their main tool for prioritizing investments. This model incorporates metrics such as income level, vehicles per day (VPD)*, and other economic metrics. However, at the rural road level, many of the roads see motorized vehicle transport at levels lower than 25 VPD and very little economic justification for investment. Conversely, these low-volume traffic rural areas are the most likely to benefit in terms of social impact (Hine et al, 2000; Pinard and Greening, 2004).

As shown in chapter 3, the difficulty of including non-direct benefits in a precise and quantified manner is substantial and has served to exclude it from the decision-making process. However, "If the alleged social benefits are real, conventional methods are unlikely to be a reliable guide to project selection" (Van de Walle 2002). Therefore, chapter 4 will outline the SIS metric as an approach to prioritizing these benefits for their inclusion at the policy level.

Chapter Summary

The purpose of this chapter is to provide the evidence that rural roads play a significant and important role in the overall development picture of rural communities. These impacts extend beyond direct economic impact and the social benefits are likely to be greater in areas where economic impact might initially be less. The ability to access services, information, and improve overall welfare is an important baseline for economic growth.

Overall, this paper is designed to increase awareness of the potential benefits of rural roads and introduce a framework that can incorporate these components into the existing decision process. Chapter 3 and 4 elaborate on this method and a representative application is discussed in Chapter 5.

Chapter 3

Pillars of Research

This chapter reviews the three main pillars of research used to support the writing of this paper and creation of the SIS Framework. These pillars are: the current practice of infrastructure management and planning in developing countries, multi-criteria decision analysis and systems thinking as a veritable approach to infrastructure investment situations, and a review of the case studies and variables used in develompent literature and rural road investment prioritizations projects in developing countries.

First, current practice of rural road infrastructure planning in developing countries is reviewed. As this is a complex topic, the paper focuses on the practices, shortcomings, and needs of infrastructure investment planning as highlighted in the literature pertaining to rural roads and development in developing countries. It also highlights, using the author's field experience in South Africa, why traditional economic CBA analyses are unlikely to capture the needs and areas with the highest potential social impacts. Next, the MCDA concept is briefly introduced. Several case studies used in Chapter 2 use a MCDA or similar approach, and several of the variables used in these case studies are highlighted as examples to lay a foundation for the variables used in the creation of the SIS metric. For continuity of the paper and the intertwined nature of the method and variables used in case studies, the variables and indicators highlighted and used to help develop the framework in Chapter 4 are combined under the "MCDA Use in Current Practice and Field Studies" section below.

Infrastructure Management and Planning: An Overview of Current Practice

Road infrastructure management and planning varies among countries, but tends to follow a general structure. This includes a national treasury or similar body responsible for the funding and allocation of road budgets; a national roads authority responsible for highways and major roads; provincial governments responsible for secondary roads within their geographic region and for allocating funding to the tertiary authority at the local level responsible for carrying out the construction and maintenance on local roads and feeder roads. In many countries, the national authorities are often the most competent at construction and maintenance of roads, while the local authorities lack the funding and/or capacity to maintain local and feeder roads to a sufficient quality and quantity (Van de Walle 2002; Howe, 2003).

Rural road planning and implementation is broadly characterized by a top-down approach which focuses on economic CBA and return on investment calculations, limited local consultation, and only allows for inclusion of short-term (3-5 years) planning practices and budgeting. There is a noted lack of maintenance capability and funding, as well as sustainable ancillary works such as bridges, culverts, and other drainage infrastructure ("Surveys" 2012; Donnges, 1998; Lebo and Schelling, 2001; Van de Walle 2002).

Field Research: South Africa

In field research conducted by the author in South Africa in 2012, it was found that where the local authority has funding, it is often a victim of corrupt practices and much of the funding is not spent as it is earmarked ("Surveys" 2012). Additionally, when rural road infrastructure is being planned at any level, there are often corrupt tender processes for awarding contracts and/or an allocation process focused nearly wholly on economic returns. The use of modeling and prioritization software such as the HDM-4 or RED (Low Volume Roads Economic Decision Model) models produced by the World Bank do not incorporate social impact in a manner which captures the social impacts described in Chapter 2 (Lebo and Schelling, 2001; "Personal Communication, South African Roads Ministry" 2012).

The HDM and RED Models produced by the World Bank are a series of Excel workbooks available online ("HDM-4 Dissemination Tools, 2008"). They are ideal for roads with estimated traffic of 50-200 VPD. The models focus mainly on economic factors, such as road condition, vehicle savings, the internal rate of return on projects, roughness and passability, and others. For example, the HDM is designed to calculate paved and unpaved differences, but has an acknowledged weakness in the context of rural roads because it is not calibrated for unpaved roads and is designed for use on roads with higher levels of traffic. Additionally, further research is being conducted into enhancing the capabilities including roads with no passability and the inclusion of social benefits, but does not yet contain capability to incorporate such considerations, yet the decision tools are utilized in many developing countries (Archondo-Callao, Rodrigo, 2006).

A gap between the models described above and realistic needs was evident during field work in South Africa: discussions with the provincial transportation office showed that rural roads planning was done using the HDM-4 model, yet much of the authors field work was conducted in isolated* and impoverished villages such as Devillersdale. Devillersdale Village is located in the Limpopo Province and isolated from a main road by several kilometers. A rough stone and sand road does exist to the town, but is often unpassable by any but the most rugged vehicles at very low speeds but would be classified as a limited access* or no access* road. The village is extremely impoverished with small subsistence agriculture and cottage industry. LINGO* (Limpopo NGO group) is a group of NGOs working in Limpopo Province who have organized to provide a holistic development solution to Devillersdale through the implementation of several complementary projects, including training and implementation of: a household-level rainwater storage tank, improved pit latrines, a village-sized reservoir and gravity-fed tap stand distribution system, and a borehole well. Until the completion of the projects by LINGO, there will be no electricity in the village and there remains no public or private motorized transportation methods into or out of the village. The only source of water is a stagnant pond (see Image 2). Reportedly, Devillersdale Village was not on the local councils map or registry of cities until the project was implemented and local approval for the project was sought by the NGO (“Surveys” 2012).

This village highlights several issues in current rural road planning and overall development. In terms of development, roads are only one aspect crucial to improving the welfare of the village’s citizens, yet it impacts many of the other aspects: increasing transportation time and costs for the NGOs, limiting the access inhabitants have to markets, political representation, healthcare, education, and most other basic services.

As a case study example on road planning practices, the current unpaved road prioritization process for Western Cape Province, South Africa is provided in Chapter 5. South Africa has an established road investment process, including for unpaved roads. There is recognition of socio-economic impact and these are considered in the planning prioritization process, but not until the roads have passed two levels of screening for prioritization. Additionally, at the third step, social considerations account for 1/3 of 40% weighted decision-making factor, or approximately 13% of the third step in the decision process. Because step 2 and 60% of step 3 focuses on economic aspects, using HDM-4, the social impact is restricted in its overall influence in the decision making. More information on this process, including graphical depictions of the three phases, is presented in Chapter 5.

Generally, however, this process and the HDM-4 model used in South Africa is not well suited to capture the benefits a basic-access* road could bring; they would likely estimate a very low rate of economic return on investment for Devillersdale and disqualify any road investments at step 2; prior to the third step where social impact is considered in the decision process and where the analysis would yield high results in terms of social impact investment return. This is because there is very little attachment of the current Devillersdale economy to the larger local or regional economy and agriculture and other industries are not at any capacity to expand in the immediate future. It is in these cases where the inclusion of an SIS metric could prioritize these types of villages over other potential investment options which may be favored by the current planning practices.

Image 1, 2: Pictures from South Africa: Road Infrastructure Impacts on Development

Picture 1: NGO staff trying to move a NGO vehicle out of several feet of sand and dirt. A regular occurrence, 'transportation' considerations like this occupy an estimated 20-50% of a field work day and put added deterioration stress on the vehicles used

Source: Author

Picture 2: Main water source in Devillersdale Village. A LINGO project was being implemented to bring clean water (source and storage), sanitation and health knowledge through committees, improved pit latrines, and electricity to the village. Electricity is necessary to operate the pump to bring clean water to the reservoir (picture 3); once it is stored, a gravity fed system feeds it to several tap stands throughout the village.

To bring electricity to the village, the LINGO project had petitioned the local government/electric company for over 180 days, two times the posted amount of time necessary to secure approval. At the time of the field research, no time frame had been provided for electricity provision and the NGO was trying to raise additional funds to buy a generator to begin operating the water pump as soon as possible.

Source: Author

Literature: Transportation Research and Description of Need

To bridge this gap, several case studies and methods have been developed by various NGOs, including the International Labour Organisation (ILO), Department for International Development (DfID), Transport Research Limited (TRL, UK), the World Bank, and others. Their findings were discussed in Chapter 2, and the section below highlights some of the variables and indicators included in their research. However, many of these case studies require specific and time-consuming, as well as costly, household level surveys, trainings, extensive local consultation meetings, and detailed economic and social data such that their inclusion as part of the normal planning process is not feasible. For example, the ILO's Integrated Rural Accessibility Planning (IRAP) program focuses on local employment generation, skills transfer and capacity building of local institutions, and a high priority focus on poverty and social welfare, but requires approximately two years and $500,000 USD to carry out. This program serves a need for large-scale rural road investment and capacity building; the SIS is aiming for a streamlined impact by incorporation into existing processes with little to no extra resource requirements (Edmonds, 1998; "Mozambique FRP"; Donnges, 1998).

The overarching challenges facing transportation planners in developing countries are vast. The existing infrastructure is underdeveloped in both rural and urban areas, there is a limited amount of funding that cannot fully cover the need, the institutional history has a limited emphasis on sustainability and life-cycle planning, minority groups and other social benefits are often excluded from the process, and climate change poses increasing stress on the existing assets. Case studies which target some of these challenges are costly and difficult to replicate without specific, dedicated resources and require a large amount of data input and costly analysis, which is not easily justified for relatively low-cost roads.

There is a growing recognition of the importance of roads in non-direct economic impact as well as an emphasis on an increase in human welfare. This is reflected in an increase in developing country governments asking for guidance on how to incorporate benefits, and donor insistence that social impact assessments are included in road planning investment proposals (Lebo and Schelling, 2001). As stated in a 2003 report by DfID, "It is widely recognized that there are circumstances under which socio-economic benefits are not possible, and hence the qualification of social benefits for low volume roads need also be investigated. However, economic appraisal models, such as the Highway Development and Management Model (HDM-4) base their prioritization for investment on economic criteria." (TRL Limited, 2003).

Therefore, a new, more holistic approach, yet one that is simple enough for inclusion in the existing processes, is necessary. As described in the section below, MCDA is an approach which provides an ideal framework to address many of these challenges and focus the priority of roads to a broader development picture. Many of the case studies in this paper assert that a MCDA framework is needed to more accurately capture the induced and indirect benefits of roads and therefore better inform transportation planning and road investment prioritization.

The Multi-Criteria Decision Analysis (MCDA) and Systems Approach

What is 'Systems Thinking'? A Brief Introduction to the Systems Approach

Systems thinking is a broad area of study that is applied in many contexts. For the purpose of this thesis, the background given here focuses on systems thinking as applied to large, interdisciplinary problems and policy making. Systems thinking is essential for taking an holistic approach to understanding problems that have many inputs and potentially many outputs, including unintended consequences and side effects. Sterman, 2001, states that, "with a holistic worldview, it is argued, we would be able to learn faster and more effectively, identify the high leverage points in systems, and avoid policy resistance. A systemic perspective would enable us to make decisions consistent with our long-term best interests and the long-term best interests of the system as a whole" (pg. 10).

Systems thinking is most effective when implemented into policy systems with tools that are easy to understand, use, and which include consideration (or, at the minimum, awareness) of external effects of decisions (Sterman, 2001; Wright, 2008). Systems is concerned with how to consider and solve problems.

Several facets of systems thinking are highlighted in Wright's study of Donella Meadows' works in Thinking in Systems. These include seeking the wrong goal, the tragedy of the commons, the nonlinear nature of many complex issues, and policy resistance. Essentially, each of these applies to the context of rural road decision making: the goal may be stated that increased welfare and development is the purpose of construction, however this may not provide the only or best framework for considering investment purposes (such as the emphasis on BCA). The goal, instead, may need to be more clearly defined and may need to be communicated to policy makers more clearly. The SIS framework is built on this idea of systems thinking: an effective, simple tool to highlight the external and additional impacts of road investments in an effective manner for implementation in the policy realm.

MCDA is a framework which aligns with systemic thinking and is explained in greater detail below.

What is MCDA? A Brief Overview of the Theory and Field of Study

MCDA or MCDM is a technique which is applied in many contexts for decision making, from economics to group theory to policy and strategic decision making. In its most historically recognized form, MCDM is traced to Benjamin Franklin and the organized method he utilized for decision making: simply listing benefits and negatives of potential decision outcomes using a paper method and crossing out alternatives until one side seemingly outweighed the other. This method continued to be utilized and formalized over the two hundred years until the publishing of *Theory of Games and Economic Behavior* in 1944 by John von Neumann and Oskar Mogenstern. This monumental work is ascribed as foundational in the origin of utility functions relating to decision analysis. A more extensive background on several foundational works and key persons involved in the history and development of MCDM can be found in: "MCDM - From Early History to the 21st Century".

In current practice, MCDA is used to help clarify decision-making where there is not a simple answer, even when the objectives are clear (Montibeller and Franco). This applies to business and economic theory, among other areas. MCDA also plays a role in helping break complex problems into smaller components. This can help decision makers highlight certain areas of emphasis or concern, or at the minimum, it helps clarify the components that are being considered in a complex problem and can enhance transparency (Keeney and Raiffa, 1976).

There are several types of MCDA. Some of the most commonly used in engineering and decision-making practice including pair-wise comparison, fuzzy sets, utility theory and multi-attribute preference functions (Figueira et al, 2005). The MCDA used in this paper falls broadly into the multi-attribute preference functions, which is defined in Figueira et al as: "a decision problem which has multiple attributes which can be decomposed into additive and multiplicative forms under certain conditions of certainty and risk." The most common use of MCDA is when decisions are being made by one party on behalf of a greater party, including in government and policy making. These decisions require judgment decisions and strategies that are justifiable based upon a reasonable set of axioms and is designed to replace an ad hoc approach. Both Keeney and Raiffa and Figueira et al provide extensive discussions of MCDA and its roots, mathematical validity, and applications.

In the instance of this paper, focusing on the 'social' benefits of rural roads, the term is oft used in different contexts; the MCDA approach can help clarify which aspects are being considered in the SIS and be utilized with incomplete information by using the available components. MCDA is also a useful tool in quantifying impacts which are hard to quantify: subjective categories can be utilized and produce outcomes that guide in decision making, and MCDA can be particularly useful in CBA or CEA* problems (Keeney and Raiffa, 1976). The approach taken in this paper is similar to that introduced by Montibeller and Franco in utilizing the application of MCDA for strategic decision making. While their work focuses on "infrequent decisions", their consideration of decisions which are "important, in terms of the actions taken [and] the resources committed" are a relevant application to the SIS framework as a component of larger prioritization of rural road investment strategy.

MCDA and Transportation: Literature Review Findings

The literature base on development and rural transportation establishes several common findings for infrastructure impact as well as the current planning and management practices. As described above, the consensus among most of the literature is consistent with field work completed by the author: the current method used in most developing countries to allocate funding and prioritize investments is inadequate for capturing the true needs and potential benefits yielded by rural road infrastructure.

The multi-criteria decision analysis (MCDA), multi-actor, multi-criteria analysis (MAMCA), or multiple-criteria decision making (MCDM) approaches are suggested and/or used by many of the case studies. While MCDA is a fairly broad term applied to many areas of study, in this paper, the three terms are relatively synonymous, and MCDA refers to the inclusion of multiple criteria to estimate a prioritization list of a finite number of alternative choices (Ruiz, 2012). In reference to roads, this is an appropriate approach because rural road investment is characterized by a limited amount of funding, a need for social impact inclusion, and several investment needs. MCDA copes with additional criteria outside economic aspects by allowing for evaluation without explicit economic quantification and can incorporate diverse criteria into one metric (TRL Limited, 2003; Macharis and Ampe, 2007; Engineering the Future, 2011; Fouracre, 2001; Belton and Stewart; Robinson, 1999). According to Macharis and Ampe, “the kind of decision subjects handled by MCDA the most are infrastructure choices” (Macharis and Ampe, 2007) and a 2011 publication states that “systems thinking…and an integrated approach to planning and managing infrastructure development is key” (Engineering the Future, 2011).

MCDA Use in Current Practice and Case Studies

MCDA or similar multi-criteria analyses are used in many of the development literature case studies whose findings are presented in Chapter 2. A few of the frameworks used in the case studies and the variables and indicators they used are provided in the following two subsections.

Urban Considerations

While the majority of this paper focuses on the impact and incorporation of low-volume roads in rural areas, some of the literature focusing on development in urban areas finds similar positive impacts for road investment in urban slum areas. This stems largely from an existing urban road network that is inadequate for the demand, the inefficiency or inexistence of public mass transit options, and the high level of safety factors facing urban pedestrians due to poor road infrastructure. For example, in most developing country cities, road networks account for approximately 7% of land area; in developed countries, 25-30% of land area is for road networks alone (excluding other transportation options such as trains). In developing country cities, over 2/3 of fatalities due to road traffic is to pedestrians, highlighting the unsafe condition of many urban roads. As the poorest segments of urban populations often commute by walking because of a high cost or inconvenient mass transit options, these impacts are skewed towards the poorer populations and should be taken into consideration when prioritizing road investments even in urban areas (Kumar and Barrett, 2008; African Union, 2005).

Secondly, urban metrics are considered in this paper because it is unlikely that all rural road planning will not include any urban segments. In this context, rural road planning which prioritizes sound investments in urban infrastructure where impoverished communities see benefit can similarly help contribute to a positive impact in overall development and human welfare goals.

Two large reports looking at the effect of transportation in Africa highlight the plight of poor road infrastructure in impoverished urban areas (Kumar and Barrett, 2008; African Union, 2005). Both show substantial impacts on the urban poor and limitations on income, welfare, and access to social and political institutions. The indicators and variables used to estimate the impact and problems facing the urban poor include: meters of road per population, km of road relative to urban land area, and others. Suggestions for improvement include more roads, the inclusion of dedicated mass transit lanes to reduce congestion and increase incentive, and dedicated sidewalks to protect pedestrians.

One of the four indicators in the SIS metric focuses on urban accessibility and mobility to reflect the positive (and not included) social benefits from urban road investment. As described in chapter 4, the SIS framework is additive; the urban component does not have to be included for an analysis to be done.

Rural Considerations

Several studies on the inclusion of social benefits in transportation planning are not location specific but focus on rural road investments. Notably, sources including TRL Limited, 2003, Van de Walle 2002, and Lebo and Schelling, 2001, focus on the larger development needs of developing countries and the development of non-economic analysis metrics. Each calls for a variation of the 'cost-effectiveness allocation (CEA)' method: a method for allocating funding when there is a fixed and limited budget, and normal vehicle traffic is below 50 VPD. This includes the basic-access approach where priority is given to reliable, least life-cycle cost, all-season roads to the greatest number of persons with a subjective weighting towards areas of poverty. The CEA is considered a subset of MCDA (Lebo and Schelling, 2001). They highlight a need for flexibility, awareness of subjectivity for metric weighting, and a need for incorporating local input through community consultation.

A review of the impact of rural roads in Africa and Asia (Bryceson et al, 2006) showed several of the impacts discussed in Chapter 2. The review also highlighted the need for differentiating between 'accessibility' and 'mobility' enhancing improvements. While this may seem a linguistic formality, it matters especially in areas where there is little or no pre-existing conditions to help augment the impact of the road. Briefly, when the following preconditions exist, the benefits of the road are greater and considered "mobility enhancing"* improvements, such as evidenced by road investments in Vietnam. When the preconditions do not exist, the road can still be beneficial. While less tangible in the short-term, "accessibility enhancing"* improvements can eventually lead to mobility enhancing improvements over time. The preconditions identified in this study were: a relatively high existing rural road network density; a high level of social and economic infrastructure; a level of ownership and/or access to wheeled/motorized vehicles; and a purchasing power among households to access public/mass transit

(Bryceson et al, 2006). This differentiation may also help clarify why rural roads see economic gain in some poor areas and not others.

A 2010 case study conducted in Cameroon included variables for prioritization and analysis such as the time to reach the closest health and education centers (Gachassin, et al. 2010). In Ghana, several studies have been performed, and considerations for evaluation include a splitting of the fixed budget such that 50% of total funds were distributed evenly among all provinces being considered for road projects and the remaining 50% were allocated based on need. The 'need' was determined by metrics including the prevalence of NMT* and IMT*, passability and all-weather access, community involvement (as determined through project-specific household surveys), gender differences in prioritizing investment needs, and higher weights given to areas with the poorest 1/3 of the population and isolation from market centers (defined as greater than 10 km distance) (Hine et al, 2000).

In Uganda, a similar criteria set was used to determine impact and prioritize investments, but for roads that failed to meet traditional economic justification, only areas where the median income of the population was below 50% of the country's average household income were considered (Howe, 2003). In Vietnam, a cost-efficiency method included a calculation determining the impact per project divided by the total cost of the project. The impact was determined by factors including the poverty level of the surrounding communities and distance to markets, schools, and health centers (Lebo and Schelling, 2001; Howe, 2003).

In China, an "efficiency-oriented poverty alleviation strategy" was employed under the World Bank's 'Road Improvements for Poverty Alleviation' (RIPA) program in the mid 1990's. The program concentrated on linking rural villages which did not have all-weather access to existing road networks, but the social impact of road investment on villages was only considered when they failed to meet other economic standards (Howe, 2003; Duncan, 2007; Hajj and Pendakur, 2000).

Throughout the case studies and broader development literature including the MDGs, different distances are cited as 'reasonable' or indicators of equitable development. The most common distances are 2 km (used by the MDGs in sources including *African Union, 2005* and *Lebo and Schelling, 2001*) and 5 km (cited by *African Union, 2005* and *Robinson, 1999*). For this paper, 5 km is the distance used to determine social impact area.

SIS Metric: Departure from Existing Case Study MCDA Methods

As described in the above section, MCDA frameworks in varying forms have been utilized for rural road prioritization of investments. The departure in the SIS metric explained in Chapter 4 is primarily in two ways: the target audience and the intended use. The target audience for the SIS metric is national or provincial governments and donor agencies that are investing in rural road infrastructure. The framework is designed to address both audiences simultaneously through use by the former and requirement as a basic test by the latter (TRL Limited, 2003).

It is recognized that the case studies presented above do a thorough means of understanding and ranking road investments. However, they are unfeasible to be utilized as a routine part of the annual budgeting processes in all rural areas of a country. Therefore, the SIS metric is an acknowledged simplification of MCDA framework criteria, notably lacking in the form of local community consultation. However, it is designed to be utilized at a higher level for two reasons: a limited representation of social benefits and impact for prioritization is better than no inclusion, and the framework is created with four separate indicators and multipliers designed to highlight specific areas that may merit greater research after the SIS analysis.

Challenges

There are many challenges when using MCDA frameworks and these are often compounded by the difficulty in quantifying social attributes. Only one source reviewed for this paper advised against using MCDA, stating that the disadvantages outweighed the benefits because it is too complicated, requires too much data collection and input, and is less transparent than more straightforward methods (Robinson, 1999). However, it is feasible that while being mindful of these challenges, they do not prohibit the development of a MCDA method appropriate for the national and/or regional planning levels.

The challenges of transparency can be overcome largely by simply establishing a replicable, standardized methodology which is well documented and whose inputs are standardized and understood and whose results are implemented consistently. Subjectivity is more difficult to circumvent, and in some cases it is impossible to be fully objective. Local factors may place more weight upon different priorities, and indeed this often varies between genders. However, the metrics included in SIS are designed to limit the subjectivity by including metrics such as km of road per population, a decisively objective measurement.

Local consultation is an important component of ensuring sustainability, ownership, and best use of investment funds. While the SIS is designed to be implemented with limited data, including no requirement for local consultation, it can be improved through increased local input, especially through NGOs or local officials familiar with development needs in the area.

Additionally, the MCDA framework introduced in the next chapter is designed to be used in conjunction with existing (or developed) economic frameworks and engineering and technical life-cycle evaluations. This is highlighted in the application example of chapter 5; SIS is not designed to be a holistic and comprehensive method for evaluating rural road planning. It is designed to supplement existing practices which focus on CBA and technical concerns.

Chapter Summary

This chapter focuses on the pillars of research which lay a foundation for translating the findings of chapter 2 – the social impacts and positive benefits for welfare and development – with the method proposed in chapter 4 – the creation of the SIS framework.

Infrastructure management planning practices in developing countries are discussed: commonly, they tend to be short-term focused with a failure in life-cycle assessment planning, focus on an economic justification (such as analysis tools as HDM-4), and the challenges facing overwhelming needs and a limited budget. When burdened by rate of return justifications and limited budgets, perhaps the inclusion of social considerations could further enhance the justification for greater investment in rural infrastructure.

Case studies are discussed including the approaches many of them take to capture and measure the social benefits from road investments in various geographic locations. Each focuses on poverty and emphasizes that most economic calculations will bias investments against the most impoverished areas. Rural and urban metrics and their use are discussed from certain case studies. Additionally, MCDA approaches are used in many of the case studies and are recommended for their suitability to capture benefits which are difficult to quantify.

Building on these foundations, the SIS is designed with a different audience and use than those focused upon by the case studies mentioned. It does not focus on community consultation, but captures some of the social impacts in a straightforward analysis that does not require additional resources to use.

Chapter 4

The SIS Framework

Overview

As discussed in chapters 2 and 3, there are many difficulties inherent in isolating and social impacts from road infrastructure. However, based upon the literature review presented and the evidence from case studies, this chapter describes the SIS framework created to provide an attempt at capturing some of these benefits and presenting them in a simple and usable metric for decision makers.

The SIS is a single metric designed for prioritizing rural road investment choices. The metric provides a relative score that can be used to rank potential investment options. There are 4 indicators that comprise the metric, each with 2-4 components. Currently, the scoring for each component is based upon a weighting system. The weighting system is subjective and can be easily adjusted to local conditions where information is available. The default weights are calibrated to generalized Sub-Saharan Africa conditions. Alongside the SIS, two additional pieces of information are provided: the difference in total wages reinvested into the local economy and total person days of employment generated if LBE techniques are employed during construction. These are described in greater detail later in this chapter.

The SIS framework is created in Excel and has been translated for use in Matlab in the IPSS tool. At the end of this chapter, screenshots of the Microsoft Excel workbook are provided. They detail the inputs and weights in chart form to aid in understanding along with the written explanation below.

Indicators

The four indicators that combine to produce the SIS metric are:

1. Rural Mobility (Figure 3)
2. Rural Access (Figure 4)
3. Urban Access and Mobility (Figure 5)
4. Employment Potential (Figure 6)

Rural Mobility:

The rural mobility indicator is a measurement of the rural population with new or improved access to an all-season road. The potential impact of the increased proximity to a new, reliable road is increasing mobility to utilize social infrastructure, markets, information, and other components inhibited by isolation.

There are four components that combine to produce the Rural Mobility indicator:

1. Population impacted by road (new)
2. Population impacted by road (additional road)
3. Population poverty level
4. Motorized vehicle ownership

Population impacted by road (new and additional)

The population impacted by the construction or rehabilitation of a rural road project is defined as the population within 5 km of the road. Roads must provide all-season basic access, including for vulnerable points during the wet season such as bridges or drainage infrastructure that accounts for flooding (Lebo and Schelling, 2001). The 5 km metric is a distance defined by Sub-Saharan Africa-specific information on ‘willingness to walk’ distance. The Millennium Development Goals cite a 2 km distance as the metric for measuring rural access, and this is the metric applied globally (African Union, 2005; “UN MDGs”). However, because of the relatively low spatial density of populations in Sub-Saharan Africa, as well as ‘willingness to walk’ studies, 5 km is considered to be a more realistic target (Robinson, 1999; Lebo and Schelling, 2001).

To determine the impacted population, local data should be used where it is available at the sub-national levels (Admin01 or Admin02 levels). Data on provincial estimates or in GIS formats can be quickly utilized to determine this information. Population within 5 km of either side of the road should be included.

The default metric for calculation is the total rural population and land area being considered to determine the average rural population density per km^2. The length of road being considered (km) is multiplied by 10 to determine the population within 5 km^2 of the road on either side.

A new road is defined as a road which is the only road infrastructure within 5 km of the proposed location. An additional road is defined as either investment in a road within 5 km of an existing all-season basic-access road or the rehabilitation of an existing road (of a quality at least partial access) to restore it to all-season basic access quality. Where GIS or other data is not available to determine whether this is a road with 'new' or 'additional' road, the road is treated as 'new'. This is for two reasons: the first is simply the need for straightforward calculations. The second is the likely reality that if data is not available on any existing road infrastructure in the area, the majority of maintenance needs are probably not being met for the road, and therefore it cannot be relied upon to maintain quality at a basic or full level* of access. Higher populations being served weight the road value higher.

Motorized Vehicle Ownership

Motorized vehicle ownership is included as a component of the rural mobility indicator to capture, where data is available, the relative ability of an impacted population to utilize the road immediately through motorized means. It is an optional component of the rural mobility indicator, and therefore there is no default calculation used, as it may vary widely between country and region, even within Sub-Saharan Africa. Where information is available, the input required is in the form of motorized vehicles per capita. Weighting should be calibrated to local conditions using a quintile estimator where higher per capita vehicle ownership corresponds to higher scoring.

There should be an understanding with this indicator that it may bias road investment towards areas of relatively greater wealth. When included, it should only be used if local information is available for all road options being considered.

The potential benefits captured by the motorized vehicle ownership include the ability of a vehicle owner to lower vehicle operating time and costs associated with poor roads, increase wealth by providing private transport services, and ability to provide private transportation in acute medical situations.

Population Poverty Level

The poverty level of the population impacted by a road can help prioritize investment by highlighting areas where populations may have lower incomes than other areas being considered for investment decisions. This indicator reflects the potential for the road investment to be prioritized based upon populations which may require the greatest amount of development to increase human welfare. The poorest populations often lack access to many kinds of infrastructure and services. Where populations with different median incomes are being considered, the poorest populations may benefit more greatly in terms of non-direct economic benefits. Conversely, it also may allow for correction for the bias that may occur in the direct economic (BCA) analysis.

The default calculation for this indicator is a score in reverse of the economic quintile the population falls into (for example, the highest quintile in income would result in the lowest score. Conversely, the poorest quintile for income would result in the highest score).

Multiplier

The rural mobility indicator additionally includes two potential multipliers. First, if the population being served (median income within 5 km^2 of the road) is below $2/day income equivalent, the total score of the four indicators above is doubled. Secondly, if equal to or greater than 50% of the constructed road is planned to be constructed with an improved gravel or paved (bitumen) road surface, the multiplier is applied to the rural mobility indicator because of the likelihood of benefits from full access including higher speeds, lower cost to vehicle use and deterioration, and more likelihood of affordable mass transit ("Personal Communication, South African Roads Ministry" 2012; Kumar and Barrett, 2008).

Rural Access

The rural access component indirectly estimates the potential social development impact through access to services that may be enhanced by new road access. The services measured in this indicator are primary schools, health centers, and non-governmental organization presence or dedicated work projects within the affected area of 5 km^2 within either side of the road. The rural access indicator gives higher scores to areas where the density of primary schools and/or NGO project work is higher and high scores to areas where there is limited healthcare access and density because roads are likely to improve access and utilization by reducing the transportation burden.

This indicator requires data which may be harder to obtain (although is expected to be available at the Admin01 or Admin02 level). When the inputs (described below) are not available, default inputs are calculated as follows. For each of the three inputs, the default calculation is the same (an example of primary schools is used for explanation). As a note, all metrics described are for the lowest administrative area where data is available. If no data is available below the national level, this indicator should not be used. The number of primary schools which exist in rural areas is divided by the total rural land area (km^2) of the administrative area to provide the density of primary schools.

This biases road investment towards areas where services already exist. As discussed in chapters 2 and 3, the existence of roads can serve to promote investment through greater accessibility, lower transportation costs, and greater development. If road projects are being considered in conjunction with other investments in rural services, this component may be more useful if not included in the SIS calculation. Additionally, where NGO presence exists, a consultation with local staff to determine needs and additional considerations should be an important component of the road planning and investment process.

Health Centers and Primary Schools

Health center and primary school density per capita serve as an indirect tool for measuring the potential immediate benefits to access to services for rural populations. As stated in the MDGs, access to (and use of) health centers and primary schools are key direct components of achieving Goals 2-6.

The input for this component is the density of health centers and primary schools per capita in the land area affected by the road. For this component, a 2 km distance is used for impact area because it is the global component set by the MDGs and while the impact of roads in sub-Saharan Africa may extend beyond this distance, it is a more feasible distance when pertaining directly to service access. For health centre applications, a lower density yields a higher score, while school density yields higher scores.

NGO Presence

The density of NGO projects present in the area impacted by the road also utilizes the2 km metric. The NGO input is defined as the number of NGO projects or offices existing within the road impact area. This component reflects the ability of NGOs to lower the cost of transportation, staff travel time, and vehicle deterioration. This translates directly into lower project costs, leading to increased intervention ability that may take a variety of forms.

Multiplier

The multiplier for the rural access indicator is applied if there are projects planned in coordination with the road investment in a given area. If the project is designed with additional infrastructure components (electric services, piped water and/or sanitation services, etc.) and/or the construction of primary schools, health centers, community centers, or similar service areas, the score from the above components is doubled.

Urban Access and Mobility

While the focus of this thesis is on rural road infrastructure, a road under consideration may include a portion of length that travels through an urban center. When this is the case, an urban access and mobility indicator can be used to differentiate potential benefits and impacts between options. This indicator should only be used where all road options under consideration include an urban portion;

otherwise the SIS will be skewed towards the road options that include urban portions because the SIS metric is built to be an additive framework where each component is scored then added together to determine the SIS. As an alternative option, when multiple options are being considered with both roads that include and do not include urban segments, the urban access and mobility indicator can be used separately from the SIS metric and other indicators to provide guidance on potential benefits between the road options that consider urban segments.

The motivation behind providing this indicator is to bring awareness and basic analysis for non-rural roads. Based upon a few case studies, notably the "Stuck in Traffic" Report produced in 2008 by the AICD group at the World Bank (Kumar and Barrett, 2008), increases in urban road density can decrease travel time, congestion, and potentially increase access to public transport and contribute to pedestrian and non-motorized transport safety. These impacts can lead to a better quality of life, lower opportunity cost of moving people and goods between urban areas and increased public and private mass transit options. When urban roads are being considered, the inclusion of sidewalks is especially important for ensuring benefits to the urban poor; walking, bicycling, and other means of non-motorized transport can be heavily utilized and often pose safety hazards where there is non-existent or non-enforced dedicated pedestrian walkways.

The components included in this indicator include two urban road density calculations, a calculation to incorporate an increase in public transit considerations, and a multiplier which is applied when the road plans include specific creation of a dedicated bus lanes (mass transit lane) and/or sidewalks.

Urban Road Density

The two components for calculating urban road density are the increase in urban paved road density per capita and the increase in urban paved road density per land area. Both are calculated as an increase relative to the existing road density. The inputs are simply the 'before' and 'after' urban paved road density in meters, the urban population in thousands, and the km^2 urban land area. For example, the increase in paved road density per capita is calculated as: [‘after’ construction density (total m paved road / 1,000 population in urban area) minus the ‘before’ construction density (total m paved road / 1,000 population in urban area)] divided by the ‘before’ density. This provides the percent increase in urban road density due to the construction of the proposed road. The same calculation is utilized to determine the increase in urban density in paved roads per area.

Public Transit Considerations

This input is to account for road construction plans in an urban center that include an increase in public transit offerings. Because public transit provides quicker transportation options for those without personal or private motorized transportation options, the benefit to populations in lower incomes in urban centers may be increased if there is a plan to include public transportation in conjunction with new road construction. Therefore, if the construction of a new road includes plans for public provision of bus transportation, the input is a ‘yes’. If part of the road will be serviced by public transportation, a ‘yes’ is entered if the distance served is equal to or greater than 50% of the total road length. If no public transit options are being considered in conjunction with the new road construction, or the distance served is less than 50% of the total length, the input is ‘no’ and there is no benefit in this component to contribute to the urban access and mobility indicator.

Multiplier

There are two parts to the multiplier for the urban access and mobility indicator: the inclusion of a dedicated busway lane (public or private mass transit), and the inclusion of a sidewalk. The creation of a dedicated mass transit lane can benefit by reduced congestion and faster travel times, both which provide incentive to utilize mass transportation options. Ideally, this also leads to fewer individual cars on the road and can be incorporated into a larger urban plan to reduce emissions from transportation growth. The creation of sidewalks alongside the new road is important for pedestrian safety and can be of particular benefit to the poorer segments of the population that utilize walking or bicycling as a primary mode of transport. One or both multipliers can be applied if there are considerations in the road construction plan for equal to or greater than 50% of the total urban kilometers being constructed.

Employment Potential

As discussed in chapters 2 and 3 and elaborated in Appendix B, the potential, under the right conditions, for employment generation by the construction of new rural roads is considerable. When training, institutional support, and other necessary factors exist, labour-based construction techniques can produce results similar to machine-intensive (traditional) road construction with less pollution, greater employment including disadvantaged populations, and cost a similar amount with a higher percentage of the costs of construction being reinvested into the local economy through the wages of local workers.

This indicator serves to capture the potential benefit to local persons in the form of short-term employment, skills transfer, increased knowledge and awareness of social concerns including health and HIV/AIDS, and increased ability to maintain the road when severe events occur and/or the local road authority is unable to immediately address road maintenance issues. Additionally, this indicator measures the potential amount of road construction costs that are directly reinvested into the local economy. This is contrasted with non-labour based construction (machine-intensive) where generally a higher proportion of the costs that is paid to contractors living outside the immediate impact area of the road.

The components used to create this indicator are the number of short-term jobs created by road construction (either labour-based or non-labour based construction choices), total amount reinvested into the local economy (if labour-based considerations are being considered), and the multiplier which is included if the labour-based program is chosen and an awareness training of health and HIV/AIDS is incorporated into the other training. As shown in chapter 2, a negative impact of road construction is often the increase in HIV/AIDS due to a higher number of truckers and traveling persons, and a correlation with transactional sex. When local training will be provided to instruct in labour-based construction techniques, the inclusion of training on the risks and treatment of HIV/AIDS may help reduce the spread of the disease and help reduce stigma associated with those who contract the disease, as well as increase the utilization of treatment options.

The LBE indicator is simplified for ease of high-level comparison. The only inputs required for this indicator are whether labour-based construction techniques will be utilized. If LBE is considered for the construction of the road, the number of kilometers to be constructed by LBE must be entered. Additionally, the average daily wage for a non-skilled LBE worker must be entered. Different levels of optimization may be required to attain an efficient balance of road construction and employment generation; depending on the terrain, local employment conditions, and cost of unskilled worker wage, the number of person hours generated through LBE may vary and, if considered, should merit further study and expert consultation before implementation ("Labour-Based Technologies"; see Appendix B).

For this indicator, LBE must utilize local labour living within the 5 km proximity of the road, and must include a plan to hire a percentage of disadvantaged populations including women. Different studies suggest different numbers, but at least 25-30% of the total LBE labour-force should be women. For the multiplier, the input includes whether or not a health and HIV/AIDS training will be included. This should last for at least one full day and be created and implemented in conjunction with the health authority and/or local NGOs that work in the area and provide health services.

Additionally, the LBE output is slightly different. Alongside the SIS ranking metric, the Employment Potential indicator will yield two measurements for comparison: a labour-based and non-labour based total wages reinvested into local economy total amount and the amount of person days of employment generated due to LBE techniques. This is simply for planning and comparison purposes and the difficulty of comparing metrics across different options.

Figures 3-6: Screenshots of the Excel SIS Explanations Workbook

Rural Mobility Indicators		Calculation of Weight	Weight (1-5)
Explanation			Category Weight: 5
Input	1. Number of people within 5 km of road (new)	As a percentage of total rural population. Increase of:	3 to 5
		0-5%:3	
		5-10%: 4	
		>10%: 5	
	2. Number of people within 5 km of road (additional or rehabilitation)	As a percentage of total rural population. Increase of:	1 to 3
		0-5%:1	
		5-10%: 2	
		>10%: 3	
	3. Vehicles per capita	As a percentage of total rural population:	1 to 5
		0%: 1	
		1-5%: 2	
		>5%: 3	
	4. Median income of impacted population	Relative to National Income Quartiles:	3 to 5
		<25%: 5	
		25%-50%: 4	
		50%-75%: 2	
		>75%: 0	
Additional Information/Multiplier	1. Is median income of population (input #4) is below $2/day equivalent?	Yes = 2	1
		No = 1	
	2. Is road going to be >50% of total length improved gravel surfacing or paved surfacing?	Yes = 2	
		No = 1	

Rural Accessibility Indicators		Calculation of Weight	Weight (1-5)
Explanation			Category Weight: 5
Input	1. Health center / clinic / hospital density	Average number of clinics per sq. km (within 2 km of road)	3 to 5
		0-0.25: 5	
		0.25-0.5: 4	
		>0.5: 3	
	2. Primary school density	Average number of primary schools per sq. km (within 2 km of road)	1 to 3
		0-0.25: 3	
		0.25-0.5: 4	
		>0.5: 5	
	3. NGO project presence density	Average number of projects in road impact area, per sq. km (within 2 km of road)	3 to 5
		0-0.25: 3	
		0.25-0.5: 4	
		>0.5: 5	
Additional Information/Multiplier	1. Are coordinated infrastructure or welfare service investments planned in the road impact area?	Yes = 2	1
		No = 1	

applicable)

Urban Mobility Indicators		Calculation of Weight	Weight (1-5)
Explanation			Category Weight: **5**
Input	1. Increased percentage Urban paved road density (km paved road/thousand people) [Increased urban density as a percentage of previous density]	Density Increase: 0-5%: 1 5-10%: 2 10-15%: 4 >15% 5	2 to 3
	2. Increased percentage Urban paved road density (km paved road/km of urban area) [Increased urban density as a percentage of previous density]	Density Increase: 0-5%: 1 5-10%: 2 10-15%: 4 >15% 5	2 to 3
	3. Is public transportation being offered along >50% of the total urban road length?	Yes = 2 No = 1	5
Additional Information/ Multiplier	1. Does >50% of the total urban road length include a dedicated mass transit lane?	Yes = 2 No = 1	1
	2. Does >50% of the total urban length include constructed pedestrian sidewalks?	Yes = 2 No = 1	1

Employment Potential		Calculation of Weight	Weight (1-5)
Explanation			Category Weight: **3**
Input	1. Is LBE technology utilized in this project?	Yes = 2 No = 1	5
	2. Local wage for unskilled worker (daily)	N/A	N/A
	3. Total km for construction where LBE is utilized	N/A	N/A
Additional Information/Multiplier	If LBE is used for construction, does training include health and HIV/AIDS awareness training conducted in conjunction with local NGOs and/or health ministry?	Yes = 2 No = 1	5

Chapter Summary

This chapter has provided a detailed method for the creation of the SIS. The SIS is a simple method designed to help prioritize rural road investments based on social impact factors and the potential benefits that may accrue to different areas based on variables including poverty level, road density, density of services, and employment opportunities. The weights assigned are subjective, but designed to be transparent and accessible via the format above in Excel. Multipliers are utilized to help specific indicator areas identify key interventions that can increase the potential social impact of a road project. When different road projects are being considered, SIS can be an important component in the decision process. This is outlined more clearly in the case of Western Cape Province, South Africa, in Chapter 5.

Chapter 5

Illustrative Application

This chapter focuses on the feasibility of implementing the SIS into current decision practices in the context of the existing decision processes. Field research yielded information on the current prioritization process for Western Cape Province, South Africa, as well as generalized provincial data about the road network, quality, challenges, and a LBE project. For many reasons, the South African case is unique to development planning. It has a well-developed, 3-step process for unpaved road network prioritization. The country's road network is also more extensive than most other Sub-Saharan African nations (a total network length of 364,131 km and a road density of .30 km road/km^2 land; the average for SADC countries is 58,326 km and a density of .10)[1].

Despite this extensive road network, South Africa faces many challenges in maintenance, rehabilitation, and equity of the network. According to SANRAL (South African National Roads Authority, Ltd.), only 21% of roads are paved (Figure 7) and 54% are managed by local authorities. The municipal level therefore has the greatest need for better capacity building to implement their mandate, which includes: construction, maintenance and management of infrastructure networks associated

Table 10.1 South Africa Road Network (2010)

Road Authority	Paved (km)	Gravel	Total	Network Split
National Roads	16 170	–	16 170	2%
Provincial Roads	48 176	136 640	184 816	25%
Metros & Municipalities	89 373	316 619	405 992	54%
Unproclaimed Rural Roads		140 000	140 000	19%
Total	**153 719**	**593 259**	**746 978**	**100%**

Source: SANRAL (2010)

Figure 7: South Africa Road Network

[1] Southern Africa Development Community (SADC) calculation estimated by author for SADC countries for which data was available, excluding island nations of Mauritius and the Seychelles. Data from (Gonzalez and Sagon-Sierra Perez, 2012)

with roads, storm water, footways, and traffic mobility.

Many of the roads are ‘unproclaimed’ – approximately 140,000 km (all in rural areas) – which means they have no maintenance or rehabilitation program in place. According to field research, there is a large gap in communication and cooperation between national and provincial authorities and those of the municipalities. This leads to a large lag in data, especially in rural areas and “undermines the prospects for development in these areas”.

Additionally, South Africa provides an ideal case study for the implementation of SIS because they have successfully utilized labour-based techniques in KwaZulu-Natal, but have not incorporated the process into wider policy. The SIS metric provides an analysis tool to understand the potential impact of LBE in construction projects in a straightforward manner that may increase its utilization throughout the country. Additionally, approximately 54% of the total road network is currently managed by local government, so the need for better prioritization and investment strategy is clear.

Currently, South Africa’s Western Cape Road Authority currently uses a three-step process for prioritizing investments in roads. A social component is incorporated at the third step as approximately 13% of the decision process. The SIS in this case could be implemented to help expand the current social analysis and the overall road impact. The information available from the Road Authority included the process for gravel road management; thus this decision process is utilized in this chapter as an example and coupled with illustrative population and other input data to show how the SIS can be incorporated into current processes as an additional variable used for consideration.

Current Road Prioritization Process: Western Cape Province, South Africa

Currently, roads in Western Cape Province are prioritized based on a ranking system. The example used in this section is for gravel road prioritization with vehicle use of less than 200 VPD; much of this paper focuses on benefits for RTI; roads with less than 50 VPD estimated traffic. However, the systems overlap substantially and Figure 8 (from Lebo and Schelling, 2001) helps clarify these distinctions. This paper focuses on the impact from roads which are on the left side in blue, whereas the South African process described in this chapter is utilized mainly for roads in the green box categories.

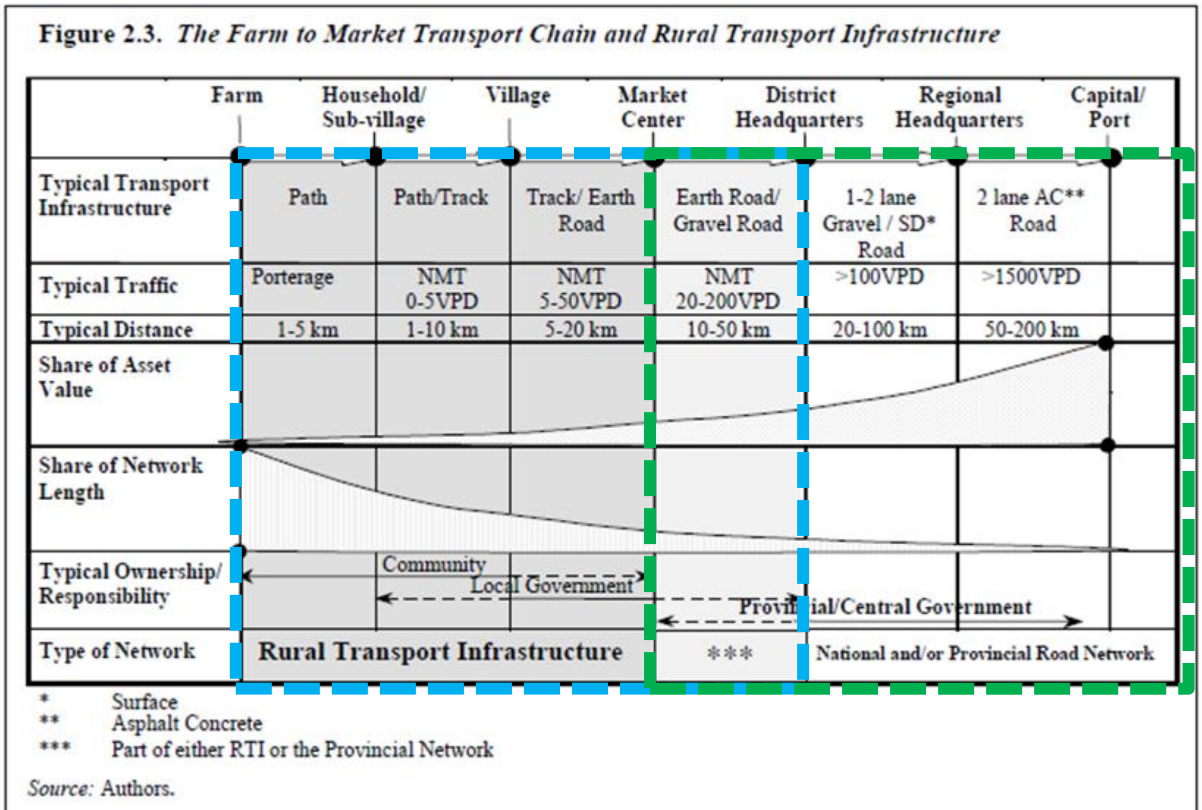

Figure 8: Rural Transport Infrastructure definitions and explanations (Lebo and Schelling, 2001)

The South African approach is based on a three-step process where initially, all unpaved roads (gravel) are analyzed at a network level* using technical input parameters such as riding quality, gravel thickness, visual evaluation of traffic, and budget constraints (See Figure 9). The only factor considered that may fall into the social considerations category is the number of accidents and fatalities. These input parameters are determined based upon a field team's visual inspection of high priority roads identified in previous years to create a priority investment list.

Second, any road which, due to the above technical consideration, is due for re-gravelling is combined with other factors including socio-economic, internal rate of return, and environmental factors to be ranked by a panel out of ten total points. Any road which scores higher than 5 out of 10 is considered an 'urgent need' and the road is eligible for re-grading in the current year. This second step is still considered a network level assessment and is undertaken at the provincial level. The detailed inputs include calculations such as vehicle operating costs and time savings of transport between major markets. The environmental factors include 4 areas: sensitive agricultural, non-sensitive agricultural, tourism, and whether the road is a link to other roads (see Figure 10).

Once these roads are determined, there is still a limited budget to meet the needs. Therefore, a more detailed third step is included in the process: a local prioritization procedure. This local assessment* is done at the sub-provincial level to determine the most necessary investments within each sub-provincial administrative region. For this process, a 'visual assessment' accounts for 60% of the overall weight and includes technical considerations such as traffic, gravel thickness, condition index, and maintainability; each is scored on a 1-5 scale. A 'developmental assessment' accounts for 40% of the overall weight and includes three considerations: agriculture, tourism, and social. The agriculture component is a detailed ranking based on each sector (type of produce) and ranked based on employment and value added. The tourism assessment is given either a score of "0" (no tourism facilities, not a tourist route), "3" (under-developed tourist facilities, route provides some scenic opportunities), or a "5" (well-developed tourist facilities, route of high scenic significance). The social assessment is a sub-national ranking by province of poverty level (number of people per ward below 1500 Rand/month (approximately $150 USD) and location of primary and secondary schools). Two graphics are provided below to illustrate this three-step process. Steps 1 and 2 are seen in Figure 9 and step 3 is illustrated in Figure 10.

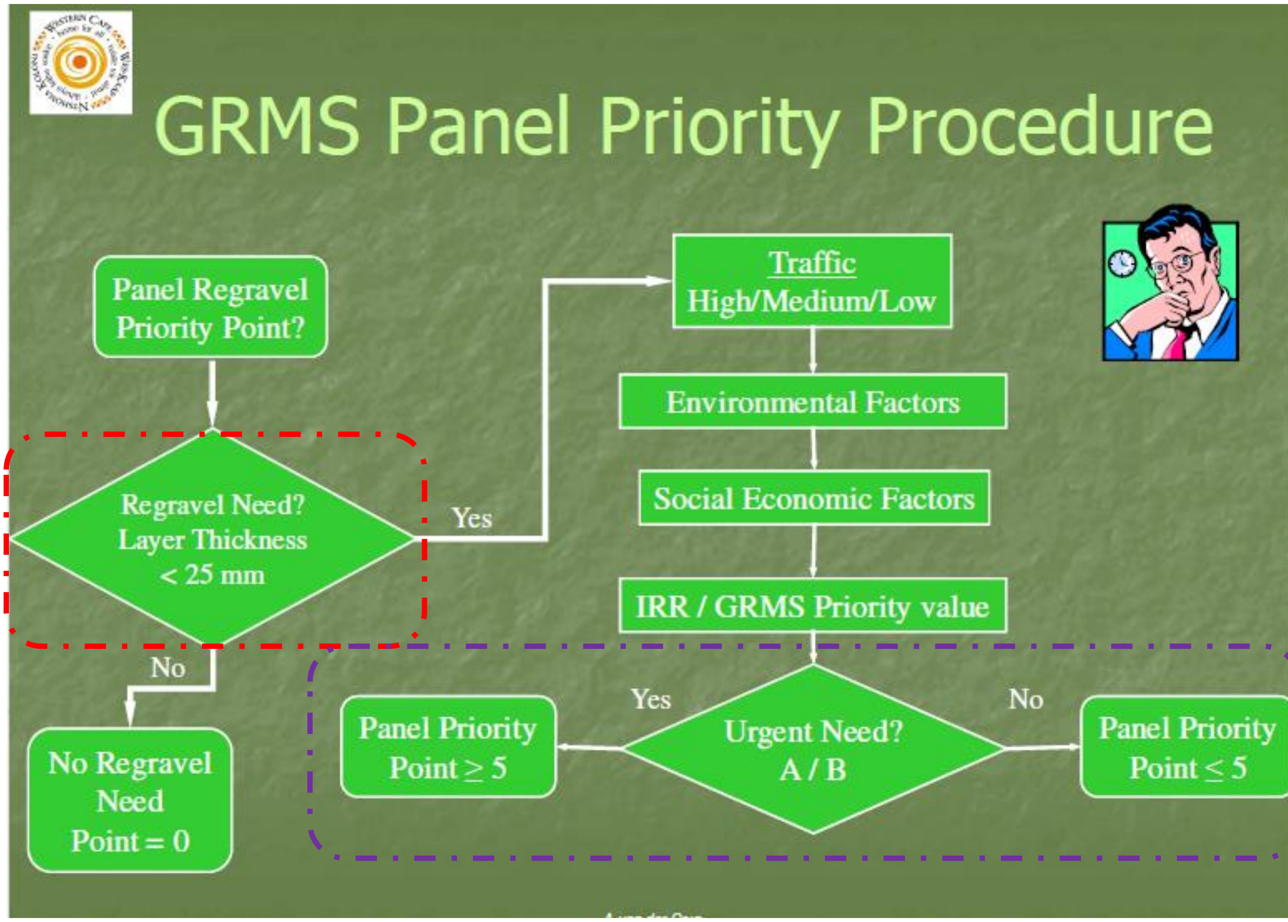

Figure 9: Gravel Road Maintenance Panel Priority Procedure, steps 1 and 2

Step 1: Left (red): Is there a need to regravel? If yes, then move to step 2

Step 2: Right (purple): If there is a need to regravel, a panel ranking exercise determines the priority rating for each road based on traffic levels, environmental factors, social economic factors, and internal rate of return priority value. 10 total points are awarded based on 3 categories. Any road which score greater than 5 is considered a priority and a local prioritization procedure is undertaken for step 3 (Graphic 3). The SIS would be implemented as a 4th category for the ten point panel priority procedure.

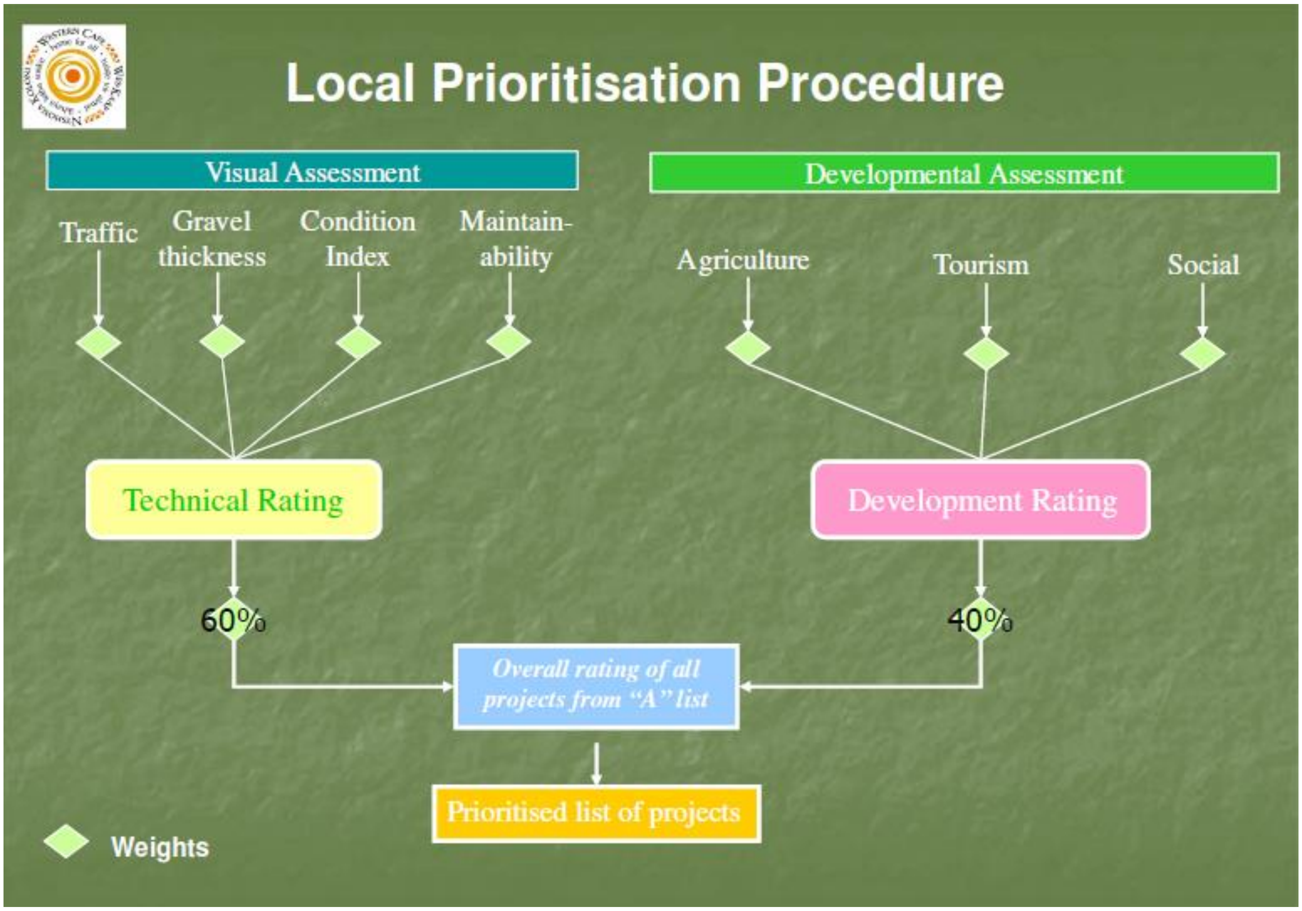

Figure 10: Gravel Road Maintenance Panel Priority Procedure, step 3, "Local Prioritisation Procedure"

Step 3: Only undertaken if road is identified as a priority in steps 1 and 2. A visual assessment is undertaken to assess technical need and capacity and a developmental assessment is undertaken to consider other impacts including agriculture, tourism, and social.

Inclusion of SIS

As described above, the current process for prioritizing gravel roads in Western Cape Province is: 1. Technical Need; 2. Ranking; 3. Local Prioritization of Projects. The first step, technical need, is a logical screening framework. There is no inclusion of social considerations, as defined in this paper, until the third step. This is because, at least in part, it is difficult and tedious to estimate the social benefits. It is also partially due to the need for justification of investments based on economic rate of return.

In the South African context, while the national income is higher than most Sub-Saharan African countries, the wealth disparity and development gap is considerable. The SIS could play a key role in informing investments that potentially lessen this gap by producing positive social benefits alongside the current economic analyses. While there is inclusion of social benefits including poverty rates and primary school locations, these are incorporated with a 1/3 of 40% weighting (approximately 13% of total decision factor) and only after the roads have been scanned at the second step by heavily economically-weighted factors, which are likely to prioritize roads with higher economic value and less social impact.

The SIS could be most beneficial if included at the second step by being combined with the current ranking factors. At this stage, the SIS is still a 'network' level road consideration and a good example of the level it is designed for implementation (Figure 11). It will help balance investments between those roads that merit a high rate of economic return on investment, while also highlighting roads that technically are in need of repair and may yield high social returns. The field research collected did not specify the weighting system used at the second step, so a proposed weighting including SIS is below.

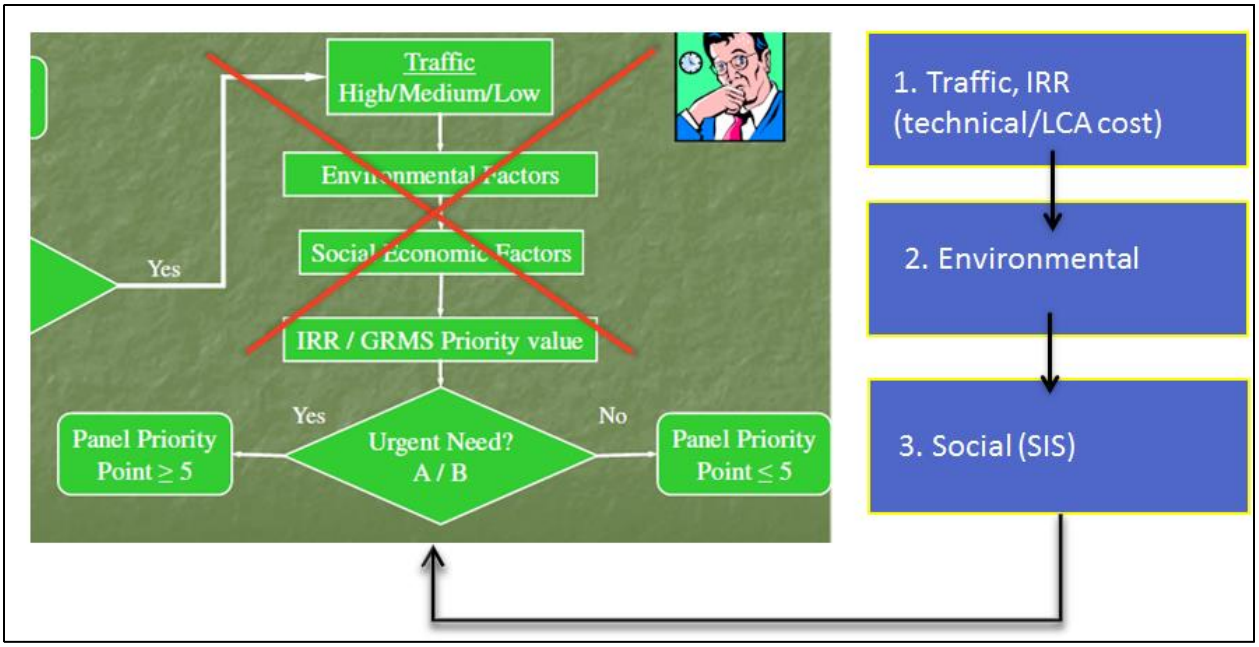

Figure 11: Step 2 revised: consider LCA, Environmental, IRR, and Social Impacts for 10-point road prioritization

Because the road prioritization process in Western Cape is well developed and utilized in the province, the author's best estimate of the inclusion of SIS would be to apply it as an equally weighted factor at the second step (25% of total ranking). In provinces where social development factors are of greater priority, it could be weighted more heavily. For Western Cape, this would mean that SIS, environmental factors, IRR, and socio-economic considerations are equally weighted. At the third step, any roads that are considered could still use the existing system. The current process is still valid at the third level for two reasons: first, the social considerations of school location and poverty are still highly important, and secondly, because the social considerations only determine approximately 13% of the total third step weighting factor.

While the SIS is originally designed for the prioritization among new roads projects, almost every metric is flexible enough to yield value where the project is rehabilitation. In the Western Cape case, the rehabilitation funding of roads is very limited, so only projects of utmost urgency are addressed each year.

Among the first two steps, a pool “A” (>5 total points scored by panel - highest urgency) and pool “B” (<5 total points scored by panel - less urgent) are identified. Even among group A, not all roads that are identified are rehabilitated each year, meaning that the roads addressed likely see a substantial overall improvement in road quality, connectivity, and other factors that yield socially beneficial results.

Illustrative Example: SIS Rankings from Two Road Choices with Different Characteristics

Two example roads are compared to illustrate how incorporating the SIS into the second step of the decision process used by Western Cape Province would prioritize roads in impoverished rural areas. The data used is from field research, Gonzalez and Sagon-Sierra Perez, 2012, and the World Bank’s AICD website. Neither road actually exists; they are simply illustrations using regional data.

Both roads are of similar length, technical need, and cost. They are located in similar climate zones and would be maintained and under the jurisdiction of the local roads authority once funding is allocated at Step 2 by the Provincial Authority. At Step 1, technical need, both roads qualify for needing further analysis and investment.

Two roads with the following characteristics are likely within one province. Road 1, for example, may be a road which connects a municipal government office to the main trunk road. The road is characterized by higher traffic because of persons traveling to work each day. Additionally, there are two game reserves which border this road, making it important for economic reasons (tourism and transport of food and supplies), but the median income of the area is around the average for South Africa in general. There is only one NGO project focusing on working with women to start micro-enterprises. Road 2, for example, may be a road which connects two small, remote villages to a trunk road. The villages consist mainly of subsistence agriculture and transportation only for employment purposes. Many villagers work outside the home and travel home only on weekends or once per month. Mass transit in the form of private mini-bus accesses the village once per week, on Friday mornings and evenings. If construction and maintenance works were to be undertaken, LBE methods would be utilized on Road 2 because of high unemployment and lower traffic. Road 1 would not utilize LBE.

Table 2: Illustrative Example Road Characteristics		
Metric	**Road 1**	**Road 2**
Road Length (km)	20	20
Road Density (land)	5.8%	1.6%
Paved road density (total road)	0.0%	25.0%
Population impact	4500	1500
VPD	150	40
Median income (GNI/capita, USD)	6900	1400
Vehicle ownership (% pop)	30%	20%
Mass transport currently?	Yes	No
# Primary schools	10	5
# Health centers	5	1
#NGO projects	1	5

There are other considerations which go into Step 2. These include environmental impacts and internal rate of return as estimated by the HDM-4 model. SIS, if incorporated, would augment the decision process by weighting 25% of the prioritization at Step 2 towards the SIS. If SIS is not incorporated, the prioritization would go heavily towards Road 1: with higher incomes, traffic, schools and the existence of mass transit, the rate of return on investment is much higher economically. In each of the three areas, Road 1 is ranked higher: more vehicle ownership (social-economic returns due to lower vehicle operating costs), importance for tourism and political reasons, and a higher income and greater overall population served.

However, if SIS is incorporated, the weighting would be more even, with a lower SIS for Road 1 and a higher SIS for Road 2 balancing out some of the economic bias. With just two roads, the SIS is not entirely useful; however if the prioritization process is taking place with 10% of the existing unpaved roads, this is equivalent to over 50,000 km of unpaved roads nationally. Where only 50% of this need is met each year, prioritization which incorporates social return may move many roads from the bottom 50% to the higher bracket and help qualify the roads to reach Step 3. Social considerations are part of the decision process; however most roads that are of value mainly for social reasons will not pass the threshold at Step 2 for prioritization at the local level.

Chapter 6

Discussion, Further Research & Conclusion

The purpose of this thesis was to create a metric that enhanced the decision-making capabilities of policy makers in developing countries in terms of rural road investment prioritization. The focus of the enhanced capabilities is the inclusion of social impact factors in the decision process. Currently, most rural road prioritization focuses on economic return and BCA, yet evidence cites that the main benefits of many rural roads are not captured in this analysis and instead stem from increased access and mobility allowing for greater utilization of healthcare services, education, access to markets, and greater NGO project access, among many other factors. Chapter 2 elaborated on these impacts while Chapter 3 focused on the pillars of research that help organize and lay a foundation for the creation of the SIS method explained in Chapter 4.

The SIS method is used in an illustrative case study in Chapter 5, where the current planning process for Western Cape Province, South Africa, is enhanced with the SIS framework to illustrate how social impact factors affect prioritization. SIS is designed for implementation at the national or provincial level of decision making where the number of roads being analyzed each year is in the thousands. This is difficult to illustrate without an extensive example, but case study evidence provides clear justification for the implementation of SIS to incorporate social factors at an earlier stage of the decision process. Additionally, where LBE is appropriate in some cases and not others, SIS provides a framework for understanding the economic value that construction may have to the local economy through job provision, wage transfer, skills transfer, and employment.

The SIS was designed to be one component in the overall decision process. Rural road prioritization, investment, maintenance, and sustainability requires sound technical appraisal and construction, quality ancillary works projects (bridges, culverts, curbs, etc.), and consideration of elements such as traffic, climate, and growth. However, these traditional decision components do not capture the broader role that roads may play in a community's development, especially communities where there is a high incidence of poverty and other human welfare concerns. The focus on economic BCA can be expanded to incorporate social considerations and rural roads will, in many cases, yield higher overall returns in analysis.

This is important because when dealing with non-economic concerns, "a large share of the benefits cannot be explicitly recognized in monetary terms and therefore are not included… If the alleged social benefits are real, conventional methods are unlikely to be a reliable guide to project selection" (Van de Walle, 2002). There is a challenge to isolate the variables regarding social impact which are attributed to the road, but the SIS seeks to identify key indicators which are cited in many case studies to capture induced and indirect benefits and may aid in road planning where social considerations are important.

Lombard and Coetzer highlight the importance of rural roads in the larger picture: "rural social infrastructure such as education and health facilities is an essential source of economic growth and it is of imperative importance that accessibility and mobility be provided to such infrastructure, through the provision of continuous rural roads investment, to provide sustainable rural roads infrastructure over the long term."

Limitations

There are several limitations to the SIS approach highlighted throughout this paper. Briefly, the main limitations stem from the aim of the SIS metric: to be utilized by decision makers in developing countries. Because this places constraints on the data that is available and the resources available for analysis, the SIS does not account for local consultation, unique concerns at the village level, and uses a simplified approach to estimate social impact.

There are inherent assumptions made by many of the metrics; for example, the density of health facilities is used as a ranking factor in the rural accessibility indicator. There is ample evidence that building or improving a road in a rural area where transportation burden is a barrier to use will improve healthcare access and utilization. However, where cultural constraints, failures in policy, or other barriers exist, the road cannot be considered a turnkey solution to fixing health issues within an area.

Many of the case studies analyzed for this paper use detailed household level surveys and data as well as placing emphasis on community involvement and consultation. While this is an extremely valuable component of rural development, the SIS does not prescribe community consultation for any of the data sources. The SIS is designed to provide guidance on general guidelines regarding the social impact of infrastructure provision, but may fail to capture significant local factors only available through local knowledge and communication.

Finally, a criticism of many MCDA approaches and analysis methods used at policy levels is that they often lack transparency. The SIS is designed to be transparent and simple to understand; yet this causes it to lose some of the robust analysis that is available through more intensive research and analysis. Many examples of more detailed processes can be found in Donnges, 1998, Lombard and Coetzer, 2006, Van de Walle, 2002, Hine and Riverson, 2001, Howe, 2003, and Bryceson, et al, 2006, among others. These serve as foundational works in understanding social impact of road infrastructure and build a strong platform for analysis and continued improvement in analysis methods.

Further Research

There are many areas where further research can be utilized. Understanding how to better estimate social impact using either the metrics provided in the SIS or similarly straightforward and simplified metrics should be ongoing. Socio-economic development is a priority for most development organizations and governments, yet has not been meaningfully implemented into routine decision processes. Being able to better understand the organizational culture, improve capacity and introduce new techniques that are feasible, understood, and perhaps required at the donor or national government levels may produce greater adoption of techniques.

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Appendix A: Definition of Terms Used

Access – When a service/activity comes to an agent (Bryceson et al, 2006); the opportunity that rural people have to improve their social and economic well-being (Edmonds, 1998). (See: "Accessibility Enhancements", "Mobility")

Accessibility Enhancements – Allows for rural areas to be more able to attract better infrastructure, staff, and could eventually lead to increased mobility. Defined in reference to ("Mobility Enhancements") (Bryceson et al, 2006)

Basic Access -reliable all-season access for the prevailing means of transport, with limited periods of inaccessibility; minimum level of RTI network services required to sustain socio-economic activity; Least-cost LIFE-CYCLE intervention for all-season passability (Lebo and Schelling, 2001)

Cost-Effectiveness Approach – A method for allocating funding – works where there is a fixed budget and the main objective is to figure out how to best spend available funds. Used in areas where <50 VPD is normal and is referred to as a multi-criteria analysis (Lebo and Schelling, 2001)

Direct Benefits - usually quantifiable and can be expressed in monetary terms. Easiest to establish accurate measurements (Lombard and Coetzer)

Full Access -Uninterrupted all-year high quality (high speed, low roughness) access (Lebo and Schelling, 2001)

Human Capital – Human capital facilities that are essential to escape from poverty, including access to health and educational facilities (Pinard and Greening); the number of persons 15 years and younger who have completed primary school (Van de Walle 2002)

Intermediate Modes of Transportation (IMT) – Means of non-motorized transport including bicycles, handcarts, and animal-powered transport

Indirect Benefits – Benefits which do not directly impact the road user [in economic/monetary terms] and have a wider impact, such as employment opportunities related to road investment, construction, maintenance, service to workers, policemen, licensing. (Lombard and Coetzer)

Induced Benefits – Benefits which can be attributed to local economic development as a result of road investment. Can include enhanced self-sufficiency, increased production and efficiency as a result of improved access to markets, social services and increase in household income. [Includes benefits from improved access and mobility to healthcare centers, schools, access to information, and gender improvements]. (Lombard and Coetzer)

Isolation (economic) – Defined as travel time during the dry season from the commune center to nearest urban center – implies lower agricultural productivity, increased transport and transaction costs, and increased insecurity. *(Raballand et al 2009, from Stifel and Minten (2008))*

Isolation (Health) - Mean road distance to a hospital is more than 10 km (*Howe 2003)*

Labour-Based Employment (LBE) – "The term labour-based technology is used to describe a technology that applies a labour/equipment mix that gives priority to labour, supplementing it with appropriate equipment where necessary for reasons of quality or cost. While producing or maintaining infrastructure to a specified standard in a cost-effective manner, people are employed under fair working conditions. It is in this respect important to distinguish between an optimum and efficient use of labour, as opposed to a maximum, and possibly inefficient use." (Donnges, 1998; "Labour-Based Technologies")

LINGO – "Limpopo Non-Governmental Organization" – a group of NGOs working in Limpopo Province, South Africa. LINGO is a consortium of six NGOs based in the Limpopo Province. Tsogang (a local WASH NGO) will take on the administrative role while the other organisations will be creating and managing their own projects. It was started with a grant from the Flanders government)

Local Assessment – Specific to Western Cape, South Africa, the local level assessment is the third step in prioritizing gravel road investments. It is undertaken if the "Network Level Analysis" shows that it merits investment. It consists of both technical and development assessments. (See Chapter 5).

Mobility – When an agent comes to a service/activity (Bryceson et al, 2006) (See "Access", "Mobility Enhancements")

Mobility Enhancements – When travel can be further and cheaper than before, leading to increases in household income and overall welfare. Most likely if preconditions exist, including: a relatively high existing rural road network density; a high level of social and economic infrastructure; a level of ownership and access to wheeled/motorized vehicles exists; purchasing power of households is such that access and utilization of public or private mass transit is possible. Where these do not exist, road investments are still beneficial in terms of "Accessibility Enhancements" (Bryceson et al, 2006).

Network Level Analysis – Specific to Western Cape, South Africa, the network level analysis is a high-level prioritization process where gravel roads are ranked in two steps to determine if they merit investment in the calendar year. The first step is an assessment of technical need; if there is a need for rehabilitation, a second step is taken. If both steps determine that the road is eligible for investment, a third step, the "Local Assessment" is undertaken. (See "Local Assessment", Chapter 5)

No Access - No motorized access within one to two kilometers of a household or village (Lebo and Schelling, 2001)

NMT – "Non-motorized transport". Includes transportation methods such as bicycling, walking, livestock transportation (cart and non-cart), and headloading.

Partial access - Motorized access with interruptions during substantial periods of the year (the rainy season) (Lebo and Schelling, 2001)

RTI – "Rural Transport Infrastructure" – includes gravel and dirt roads, footpaths, bicycles, animal carts, and other transportation infrastructure

Social Impact – Impacts which are not direct economic benefits. Focused on impacts on access and mobility. Impacts include lower transport burden to allow for greater use and utilization of services including healthcare, education, and information. Strengthening of social and community organizations, access to credit, and increases in gender equity. See Chapter 2

Social Capital - Consists of the networks, norms, relationships, values, and informal sanctions that shape the quantity and co-operative quality of a society's social interactions *(Howe 2003)*

Sustainable development - Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs *(Gagnon et al 2009, quoting the UN World Commission on Environment and Development, 1987)*

Transport Burden – The amount of time and effort needed to complete basic household tasks and meet basic needs (African Union, 2005; Bryceson et al, 2006)

VPD – "Vehicles per day". A common metric used in transportation planning to ascertain value and technical considerations of road construction

Appendix B: Labour-Based Employment Techniques

Description: What is LBE?

The ILO has done a number of research and implementation projects, as well as support, for many countries and rural road projects. Also referred to as labour-based technology, LBE applies to a mix of equipment and labour-based construction, where priority is given to labour-intensive methods. The construction is supplemented with equipment and machinery where necessary for reasons of quality and/or cost. Local consultation and management is important to determine the maximum, and most efficient, mix of machinery and labour based construction. A focus in the LBE programs is fair working conditions and wages for non-skilled labourers. ("Labour-Based Technologies")

Quality, Cost, and Potential Benefits

Project experience has shown that for similar cost investment in infrastructure, LBE can reduce foreign exchange requirements 50%-60%, create two to four times more employment in unskilled labour, and potentially decrease overall project cost by 10%-30%. Additionally, environmental impacts can be reduced.

LBE programs also focus on using local resources in the area where construction is taking place, when available. These include materials, equipment, tools, skills, knowledge, and finance. This can stimulate the local economy, reduce dependence on imports, and increase the percentage of financial investment that remains in the region where the project is taking place. ("Labour-Based Technologies")

The ILO Programme

("Labour-Based Technologies"): "The ILO promotes the use of labour-based methods as a regular component of recurrent public investment programmes for the infrastructure and construction sectors, and supports special training and awareness programmes for this purpose, as well as the development and use of technical and contractual materials for the realisation of such programmes. Due to the high dependence on labour, the ILO actively promotes the application of appropriate labour standards and at least minimum working conditions including minimum wages, non-discrimination, the elimination of forced and child labour, the right to organize, protection of wages, safety and health and insurance against work accidents. Likewise, the inclusion of women as workers and leaders is also advocated."

LBE Case Studies & Results

Kenya

A World Bank review (Lebo and Schelling, 2001) produced the following box to highlight a LBE program in Kenya, including an overview of the project, the works and implementation and the project cost and results.

Box 3.1. ***The Roads 2000 Program in Kenya: A Spot Improvement and Labor-Based Approach to Network Rehabilitation and Maintenance***

The Roads 2000 Program is a maintenance implementation strategy that supports a number of policy objectives of the Kenya Road Maintenance Initiative. It was developed as a solution to the deteriorating unpaved road network of 53,000 km. Road condition surveys identified a limited number of trouble spots, rather than general conditions, as the main cause of non-trafficable roads. Furthermore, the surveys found that the traditional equipment-based maintenance approach could not provide the required services with the current funding levels.

Building on the successful experience of the labor-based Rural Access and Minor Roads Programs, Roads 2000 adopted a new approach to rapidly bring the network up to a maintainable standard and place it under effective maintenance with the optimum use of local resources.

The three principal components of the Roads 2000 approach were:

- Rehabilitation Phase: Bring roads back to minimum maintainable standard
- Routine Maintenance: Establish labor-based maintenance system
- Spot Improvement: Plan and carry out a follow-up program of selected spot improvements

During initial preparation work, the road was brought to a passable and maintainable standard by labor units. The role of these work-units was to clear the vegetation and drainage system and re-establish the road camber.

This preparation phase was followed by the establishment of small-scale contractors (group or single person contracts) to carry out routine maintenance on a permanent basis. On the more heavily-trafficked roads (> 50vpd), they were supported by tractor-towed graders.

During the rehabilitation phase, required spot improvements were identified and implemented as funds and resources allowed. Typical works included:

- Installation of new culverts (on average one new line per km);
- Replacement or rehabilitation of existing culverts;
- Spot regravelling (to a maximum of 4 percent of the road network length);
- Provision of alternative surfacing over limited distance (for example, steep sections, approaches to structures);
- Full road reconstruction over a limited distance; and
- Bridge and drift rehabilitation;

The following costs have been established for unpaved roads (adjusted to year 2000 prices):

- Partial rehabilitation and spot improvement — $ 2,000 / KM
- Labor-only routine maintenance — $240 / KM / Year
- Routine towed grading — $280 / KM

Source: Authors.

Cambodia

In 1992-1997, the ILO supported a project in Cambodia which created 2.7 million workdays of employment. Approximately 43% of the employment was held by women. The project was used as a model for future infrastructure investments in Cambodia because of its results as promoting local employment and capacity building while producing high quality and cost-effective interventions. ("Labour-Based Technologies")

Mozambique

All information from ("Mozambique FRP"):

The Mozambique Feeder Roads Programme (FRP) was first established in 1981 with support from the ILO. Several agencies were involved in the funding and support and the program was designed to achieve many objectives following the civil war. These included:

- Lack of access to services and goods - addressed through rehabilitation and maintenance of tertiary roads
- Inadequate management capacity – addressed through institutional strengthening of the government management structures at central level
- Centralized management system -addressed through decentralization of the management of tertiary and other regional roads
- Unfavorable policy environment – addressed through reforming policy and institutional environments
- Unemployment - addressed through introduction of LBE pilot project in 1981 and mainstreaming the approach

Between 1992-2002, over 7,900 km of feeder roads were opened which helped contribute to resettlement of previously abandoned lands. The project created eight million worker days that employed over 40,000 rural persons. The total project cost exceeded 26 million USD with daily wages ranging from USD 2.50 to USD 1.20. Women's involvement in the program expanded from approximately 2% in 1991 to 19% by 2002. Productivity for full rehabilitation of a road averaged about 2,600 person days per km.

Additional benefits of the program include acquisition of skill such as masonry that are beneficial for workers beyond the program, education in HIV/AIDS awareness, and growth in micro enterprises from local entrepreneurs as more revenue was injected into the local economies. Additionally, increased attendance at schools was noted.

Appendix C: Millennium Development Goals

What the goals are (United Nations MDGs)

1. **Goal 1: Eradicate Extreme Poverty and Hunger**
    a. Target 1A: Halve, between 1990-2015, the proportion of people whose income is less than $1.25/day
    b. Target 1B: Achieve full and productive employment and decent work for all, including women and young people
    c. Target 1C: Halve, between 1990-2014, the proportion of people who suffer from hunger

2. **Goal 2: Achieve Universal Primary Education**
    a. Target 2A: Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling

3. **Goal 3: Promote Gender Equality and Empower Women**
    a. Target 3A: Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015

4. **Goal 4: Reduce Child Mortality**
    a. Target 4A: Reduce by two thirds, between 1990 -2015, the under-five mortality rate

5. **Goal 5: Improve Maternal Health**
    a. Target 5A: Reduce by three quarters the maternal mortality ratio
    b. Target 5B: Achieve universal access to reproductive health

6. **Goal 6: Combat HIV/AIDS, Malaria and Other Diseases**
    a. Target 6A: Have halted by 2015 and begun to reverse the spread of HIV/AIDS
    b. Target 6b: Achieve by 2010 universal access to treatment for HIV/AIDS for all those who need it
    c. Target 6C: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases

7. **Goal 7: Ensure Environmental Sustainability**
    a. Target 7A: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources
    b. Target 7B: Reduce biodiversity loss, achieving, by 2010, a significant reduction in the rate of loss
    c. Target 7C: Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation
    d. Target 7D: Achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers

8. **Goal 8: Develop A Global Partnership for Development**
    a. Target 8A: Develop further an open, rule-based, predictable, non-discriminatory trading and financial system
    b. Target 8B: Address the special needs of least developed countries
    c. Target 8C: Address the special needs of landlocked developing countries and small island developing states
    d. Target 8D: Deal comprehensively with the debt problems of developing countries

e. Target 8E: In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries
f. Target 8F: In cooperation with the private sector, make available benefits of new technologies, especially information and communications

Transportation Targets and the MDGs (African Union, 2005)

MDG	Targets	Indicators
MDG 7 Environmental sustainability	Share of urban residents for whom mobility problems severely constrain access to employment and essential services halved	% of households (in the various urban living environments) which report transport costs and time as major obstacles to employment
		% of households which report access as a major obstacle for essential services
	Environmental sustainability promoted in all transport operations and development programs	Environmental impact identified by audits of programs undertaken
	Production of leaded petrol ceased by 2010	Number of countries banning sale of leaded petrol
MDG 8 Global partnership for development	Transport cost for landlocked countries reduced by half and their access to global markets improved, all TAH missing links completed and existing portions of regional transport corridors maintained by 2015	Percentage reduction of missing links of the Trans-African Highways (TAH) network and transit corridors. % reduction in transport cost for landlocked countries
	All non-physical transport barriers that increase journey time, customs clearance, border delay and impede the flow of goods and services dismantled by 2015	Proportion of countries that have reduced checkpoints along their main transit corridors to a maximum of 3 (between port and border of landlocked country). Proportion of countries that have reduced their border crossing time to OECD average. Proportion of countries that have reduced their port clearing time to OECD average.
	Axle load limits, vehicle and road technical standards harmonized between RECs by 2015	Proportion of RECs with harmonized axle load limits Proportion of RECs with harmonized standards for vehicles Proportion of RECs that have harmonized road design standards
	Air transport services improved fares reduced, and movement of goods and services facilitated in all African countries by 2015	Number of new connections between African countries established. Number of products and volume of traffic of products transported by air. Percentage reduction in air transport fares.

TRANSPORT TARGETS AND INDICATORS RELATED TO THE MILLENNIUM DEVELOPMENT GOALS (MDGS)

MDG	Targets	Indicators
MDG 1 Eradication of extreme poverty and hunger	Access to inputs and markets; and generation of employment opportunities, improved by halving the proportion of rural population living beyond 2 km of an all-season road	Proportion of rural population within 2 km of an all season road % Reduction of travel and vehicle turnaround time % Increased productivity in agriculture and economic activities % Increase in employment opportunities and income generation from transport related activities
	The difference in average transport cost between Africa and Asia narrowed down by 50%	% Reduction in passenger fares (passenger kilometer) % Reduction in unit goods transport cost (ton kilometer) Level of affordability of transport cost by the urban and rural poor % Increase in the use of intermediate means of transport (IMT) Existence of sustainable financing mechanisms like Road Funds… % Increase in the proportion of roads in good and fair condition
MDG 2 + 3 Universal primary education and gender equality	Rural access and urban mobility improved to eliminate constraints on the time which all children have to participate in education and to enable effective education to be delivered and reached safely	% of schools which have reliable access % of households which report constraints on education due to: Lack of girls time for school Difficulty (cost) of access Poor quality of education service Lack of safe access to school
MDG 4 + 5 Child Health and Maternal Mortality	Rural access and urban mobility improved for reliable supply of inputs to health facilities, to provide affordable access for all households and to enable cost effective outreach health activities	% Health centers, clinics etc with reliable rural access. % of households reporting constraints on access to health services because of: Distance Cost / difficulty of travel Poor quality health service Unit cost immunization / capita Unit cost / coverage of outreach services / capita
	Emergency transport response for medical crisis in rural communities improved through community communications facilities linked to improved transport services	% Emergency patients unable to reach health care in time: Expectant or postnatal mothers Children under 5 years
MDG 6 HIV/AIDS, malaria and other diseases	Ensure transport sector ceases to be an agent for spreading HIV/AIDS	HIV/AIDS Prevalence among transport sector workers (public and private) HIV/AIDS prevalence rate in transport affected communities Inter-country coordination of actions relating to AIDS in transport
	Rate of road accident fatalities reduced by half by 2015	Rate of fatality (per million vehicles-km) Number of countries adopting road safety strategies