FRAMEWORK FOR INTEGRATING INDIGENOUS AND SCIENTIFIC KNOWLEDGE FOR TRANSPORTATION PLANNING IN DEVELOPING COUNTRIES

by

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A DISSERTATION

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ABSTRACT

Conventional transportation planning is developed based on theories that originate from industrialized countries and is based on the rational/comprehensive model, which is an exercise in data manipulation. The basic requirements of the process are the availability of large amounts of good data and analytic capabilities. These are readily available in industrialized countries, but often lacking in developing countries, hence the need to explore other non-traditional methods for project evaluation.

This research documents a framework suggested for screening urban transportation projects in developing countries to reflect local issues relevant to sustainability. The framework is based on the integration of indigenous and scientific knowledge to reflect the sustainability of candidate projects. This is achieved through a transactive or dialogical instrumentalism and social learning, to integrate inputs from system users and providers to produce a term defined as the Localized Sustainability Score (LSS). This is a method that readily identifies with the consensus building tradition of local communities in developing countries.

The LSS of the projects are then used to produce a relative ranking of potential projects, for use as a decision support for project screening and selection. The proposed method was developed through a case study in Accra, Ghana and the results indicate that the framework adequately represented local sustainable transportation needs, priorities and perceptions. The LSS determined for some selected projects maintained the original relative rankings that were already derived using conventional methods. The LSS also has the added advantage of evaluating projects of different scales.
DEDICATION

This dissertation is dedicated to my ailing mother who out of poverty had the courage to set me on this path.
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AHP</td>
<td>Analytical Hierarchy Process</td>
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<tr>
<td>ANP</td>
<td>Analytic Network Process</td>
</tr>
<tr>
<td>BRT</td>
<td>Bus Rapid Transit</td>
</tr>
<tr>
<td>CBA</td>
<td>Cost-Benefit Analysis</td>
</tr>
<tr>
<td>CBD</td>
<td>Central Business District</td>
</tr>
<tr>
<td>CI</td>
<td>Consistency Index</td>
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<tr>
<td>CR</td>
<td>Consistency Ratio</td>
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<tr>
<td>CSS</td>
<td>Context Sensitive Solutions</td>
</tr>
<tr>
<td>GAMA</td>
<td>Greater Accra Metropolitan Area</td>
</tr>
<tr>
<td>GHA</td>
<td>Ghana Highway Authority</td>
</tr>
<tr>
<td>GM</td>
<td>Geometric Mean</td>
</tr>
<tr>
<td>GPRTU</td>
<td>Ghana Private Road Transport Union</td>
</tr>
<tr>
<td>HDM-4</td>
<td>Highway Development and Management Model</td>
</tr>
<tr>
<td>IMT</td>
<td>Intermediate Means of Transportation</td>
</tr>
<tr>
<td>LOS</td>
<td>Levels of Service</td>
</tr>
<tr>
<td>LSS</td>
<td>Localized Sustainability Score</td>
</tr>
<tr>
<td>MAUT</td>
<td>Multi-Attribute Utility Theory</td>
</tr>
<tr>
<td>MCDM</td>
<td>Multi-Criteria Decision Making</td>
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<tr>
<td>MOP</td>
<td>Multi-Objective Programming</td>
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MTTU  Motor Transport and Traffic Unit
NAIADE  Novel Approach to Imprecise Assessment and Decision Environments
NGOs  Non-governmental Organizations
NMT  Non-Motorized Transportation
PROTOA  Progressive Road Transport Owners Association
REI  Request for Expression of Interest
RI  Random Index
SCSPS  Sub-Criteria Specific Project Score
VKT  Vehicle-Kilometers of Travel
ACKNOWLEDGMENTS

I wish to express my profound gratitude to Dr. Steven Jones for the priceless effort he has put into bringing me this far, often going beyond the role of an academic advisor. He is the epitome of a Mentor, affecting my academic, social and family life and always striving to bring out the best in me.

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My ultimate thanks go to God Almighty for granting me good health and the peace that is needed to complete a daunting task of this nature.
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CHAPTER 1 INTRODUCTION

The term “developing country” is often used by the World Bank and other international organizations to describe countries with low levels of material well-being. The World Bank classifies such countries into two groups: low income and middle income countries, based on their Gross Domestic Income per capita (World Bank, 2006). The levels of development vary from country to country, and some developing countries may exhibit relatively high standards of living among some portion of the population. Also, developing countries are countries that qualify to borrow money from the World Bank and other international donor or aid agencies. Some similarities that characterize these countries include system of governance, economic conditions and demographics. Africa appears to have the highest concentration of developing countries.

Developing countries often experience high levels of rural to urban migration resulting in a growing number of urban poor. Much of these urban poor cannot afford standard housing, and some end up living in the inner city, where temporary structures are erected on any available space resulting in urban slums. Others also develop unplanned substandard townships on less expensive lands at city outskirts. The result is uncontrolled expansion of cities, which leads to increased trip distances and accessibility impediments for all urban dwellers. In addition, lack of enforcement of development planning results in buildings being placed haphazardly, encroaching on public lands and undeveloped road reservations (Gwilliam, 2003; DHV and MDC, 2005a). It has long been known among development planners and social scientists that transportation play
an important role in development (Cooley, 1894). In the modern era, developing countries have spent much of their transportation sector expenditure on roads (Freeman, 2009).

Questions still exist on how much is known about transportation and development in developing countries, pointing to the need for new approaches to research on the subject. Questions also exist about how limited resources can be used by developing countries to meet the transportation needs of larger communities. Having recognized limitations of traditional evaluation methods like cost-benefit analysis (CBA), new methods are needed for addressing these complex issues of efficient transportation delivery (Leinbach, 1994).

1.1. Problem Statement

It is often difficult for developing countries to plan and provide basic transportation infrastructure, let alone to identify, plan and provide sustainable transportation projects. And if the needs of the present generation cannot be met, then the concept of equitable provision for future generations in line with sustainable development seems truly not achievable.

Urban transportation planning is a complex process, which is characterized by uncertainties. There are uncertainties in the decision-making process, as it is often difficult to foresee all the solutions to the problem at hand. Every decision also leads to other possible consequences due to a myriad of externalities as transportation concerns transcend social, economic, environmental, cultural, and ethical boundaries that require subjective interpretations (Khisty & Arslan, 2005). In addition, rapid urban growth makes it very difficult to predict the consequences of possible actions (Jeon et al, 2010). Community needs and priorities change over time, rendering original goals obsolete. Most often, there are a number of alternatives to choose from, each of which may yield different consequences, not all of which can be predicted.
Whenever one decision leads to multiple possible consequences, it gives rise to uncertainty (Khisty & Arslan, 2005), and also when the input data itself is uncertain or cannot be obtained accurately. These attributes of transportation infrastructure renders the decision-making based solely on quantitative analyses, very difficult.

Traditional transportation policy development and project prioritization methods such as cost-benefit analysis rely significantly on quantitative data, which may not be readily available (Franklin & Niemeier, 1998). Even when available, such data may not adequately address the multiple externalities and uncertainties inherent in transportation planning. Data needs are a challenge in transportation planning, because good and reliable data must be accurate, transparent, comprehensive, frequently collected and updated, consistent, and available to users (Litman, 2010). Any data that meet these attributes would be difficult and expensive to collect, and such data is hardly available in a developing country due to the restrictive costs, and in some cases, institutional limitations. In addition, sustainable development demands that planning goes beyond the quantitative and adopts an integrated analysis of the cumulative social, economic, environmental, ethical, and cultural impacts of transportation (Khisty, 2001).

The transportation planning process adopted in most developing countries follows conventional methods that are designed for and used by industrialized nations (Dimitriou, 1992; Feng et al, 2010). These models are often designed to suit the American system, which is automobile dependent and is aimed at efficient movement of automobile traffic at high levels of service (LOS). The needs of public transportation, pedestrians, cyclists and other non-motorized forms of transportation are often secondary (at best) in this type of planning (Feng et al, 2010; Zheng et al, 2011; Samberg et al, 2011). Meanwhile these are the modes that are essential to mobility/accessibility in developing countries.
The dominant conventional decision-making model, which is used in both developed and developing countries for transportation planning, is known as synoptic planning or the rational comprehensive approach, which emphasizes ‘scientific efficiency’ through a systematic step-by-step approach to the planning process (Hudson, 1979; Rosenhead, 1989; Szyliowicz, 2003). This planning theory has been used for decades without due cognizance for indigenous values, and has been criticized for many years for its deficiency in accommodating qualitative information, such as social, ethical and environmental impacts, which are critical elements for sustainable development (Khisty and Arslan, 2005). There are other planning theories such as transactive planning and social learning, which emphasize interpersonal dialogue and are in tandem with the decision-making tradition of indigenous institutions in developing countries (Appiah-Opoku, 1994). Hence a new approach may be possible to develop a methodology that is more relevant and applicable in the context of developing countries.

In recent years, the World Bank, a major development partner to developing countries, has made efforts to embrace a multi-criteria based participatory framework to accommodate a wide scope of concerns beyond the traditional quantitative performance measures of travel time, level of service (LOS), and cost considerations (World Bank, 2008). Participatory approaches introduce further uncertainty into the transportation planning process, but the adoption of participatory planning methods that incorporate elements indigenous to developing countries tends to improve the planning process (Rotmans & Asselt, 2000). This calls for a systematic organization of the information and judgments that go into the decision making (Richards, 1999).

Multi-Criteria Decision Making methods (MCDM) are particularly applicable in this regard as they are able to structure complex problems for systematic consideration (Franklin & Niemeier, 1998; Rotmans & Asselt, 2000; Saaty & Vargas, 2001; Macharis et al., 2007; Campos
MCDM directs the use of numerous stakeholders to evaluate options based on several criteria (Macharis et al., 2007). The method has been used in many countries in project prioritization for sustainable development (Munier, 2004). It has also been used for the prioritization of transportation alternatives (Jeon et al., 2010). MCDM is not a substitute to cost benefit analysis (CBA) when it is possible to quantify values in monetary terms (Communities & Local Government, 2009). In some instances, however, MCDM is preferred to traditional tools (e.g., CBA) because of its ability to include stakeholders into the analysis and to deal with uncertainty, and the fact that it does not rely solely on quantitative data (Macharis et al., 2007).

1.2. Research Objectives

It has been established that there are limitations to traditional transportation planning methods with regard to developing countries (Won, 1990; Piantanakulchai, 2005; Jennings & Covary, 2008). It has also been shown that there is a growing awareness of the potential benefits of incorporating indigenous knowledge in addressing developmental needs (Agenda 21, 1992; Sharp & Briggs, 2004; Rist & Dahdouh-Guebas, 2006; Evers et al., 2009; Nakashima & Roue, 2009). These concerns give rise to the following questions:

- Is there a benefit to indigenous knowledge in transportation planning?
- If yes, how can relevant indigenous knowledge be captured and integrated into the transportation planning process?
- Can the integrated knowledge be used in lieu of quantitative data to make high-level, strategic urban transportation decisions such as project screening, prioritization, etc.?
- In what other ways can indigenous knowledge be used to enhance urban transportation delivery in developing countries?
The primary objective of this research is to seek answers to the questions posed above. In doing so, the research developed a generalized framework for capturing indigenous knowledge (Participatory Approach) and analyzing it to create scientific knowledge (MCDM) on which to base sustainable urban transportation strategies and policies in the context of a developing country. The viability/applicability of the resulting methodology was developed and tested through a case study of Accra, Ghana.

1.3. Research Contribution(s)

This research work has developed a methodology for integrating indigenous knowledge and additional scientific knowledge derived from it to serve as guidance for sustainable urban transportation planning strategies and policies. The work builds on previous efforts to integrate stakeholders into the transportation planning process in developing countries (World Bank, 2004; Bhattarai & Starkl, 2005; Caliskan, 2005; Fouracre et al, 2006; Lee & Chan, 2007; Macharis & Ampe, 2007; Sangle & Babu 2007; Campos et al, 2009; Celik et al, 2009). It is also in keeping with a direction set out by the World Bank to “move to a multi-criteria, multi-alternative, participatory framework capable of accommodating a wide scope of concerns, going well beyond travel time and cost considerations” (World Bank, 2008).

In addition to enhancing the transportation planning process in developing countries, the proposed framework also provides a mechanism to score and document the sustainability of transportation projects within the local context. The ability to document sustainability is of particular importance to international and multi-lateral donor and aid agencies that support transportation development in developing countries. This point is underscored by the Request for Expression of Interest (REI) (See Appendix A for the original REI) issued by the World Bank.
in 2009 to perform a “Sustainability Audit of Transport Projects” to assess the extent to which past projects have met sustainable objectives. The framework proposed herein allows for the assessment of sustainability prior to implementation of transportation projects.

As of the writing of this dissertation, the following scholarly products have been developed:

- “Development of a localized Sustainability Score for Screening Urban Transportation Projects in Developing Countries: A Case Study of Accra, Ghana”. Paper accepted for presentation at the “The role of urban mobility in (re)shaping cities” Conference sponsored by the Cooperation for Urban Mobility in the Developing World (CODATU), Addis Ababa, Ethiopia, October 22-26, 2012.
CHAPTER 2 LITERATURE REVIEW

2.1. Urban Transportation in Developing Countries

The problem of uncontrolled development leaves less space for urban infrastructure development and negatively impacts accessibility for all urban dwellers (Gwilliam, 2003). In large developing cities, travel times are already quite high and continue to increase. There is rapid motorization, with travel demand far exceeding the supply of roadways and related facilities (e.g., signalized intersections and interchanges). Public transit trips account for about 75% of urban vehicular trips, and the general mobility concerns demand a viable public transportation system (Gakenheimer, 1999). Transportation infrastructure projects in developing urban areas are often relatively expensive and politically unattractive due to the social cost of demolition and displacement of encroaching roadside development. On the supply side, urban transportation in many developing countries is often dysfunctional because the authorities responsible for planning, maintenance and expansion are underfunded.

Privatization has, in many cases in developing countries, had a negative impact on the quality of transportation and resulting accessibility/mobility in urban areas. Where public buses exist, their operations are often not sustainable because the vehicles deteriorate quickly due to lack of maintenance exacerbated by poor road conditions. Furthermore, low fares and irregular subsidies make providing consistent services, much less high quality services, extremely difficult. The failure of governments (whether on their own or as a result of privatization) to supply organized public transportation has given way to the proliferation of privately operated
minibuses, and in some cases, motorcycles, scooters and auto-rickshaws (Kumar & Barrett, 2008). In some countries, especially in Africa, the minibuses often have colloquial names such as *tro-tro* in Ghana, *matatu* in Kenya, *danfo* in Nigeria, *gbaka* in Ivory Coast, and *sotrama* in Mali. Such minibuses are common throughout the developing world. For example, they are common in former Soviet Union countries in Europe and Asia where they are referred to as *mashrukas*. These are often operated unprofessionally by private individuals with vehicles usually in substandard and even unsafe condition.

Such conditions render public transportation unattractive to emerging middle classes in developing countries. This leads to increased demand for private cars and a resulting increase in private car ownership and vehicle-kilometers traveled (VKT) on an underdeveloped road system. The net effect of these on developing countries is premature traffic congestion at lower levels of car ownership, deteriorating urban environment, reduced accessibility for the poor, and safety and security concerns due to high frequency of transportation related injuries. Of particular significance is the issue of traffic safety, as about 85% of traffic related injuries worldwide occur in developing countries with 75% of these occurring in urban areas (Gwilliam, 2003). In Ghana for instance a recent safety concern is the emergence of motor-cycle taxis locally called *okada*. The operation has been received with mixed reactions. Transportation professionals see this operation as a major safety concern for urban transportation operation, but many of the system users see it as a relief for often-stranded commuters.

In many developing countries, road projects are developed to favor the minority car users while ignoring the majority pedestrians and those riding on bicycles (Ahmed et al, 2007; Freeman, 2009). In addition to the provision of roads and public transportation (e.g., buses), it is particularly important to encourage an equitable development that promotes the safe utilization
of non-motorized transportation (NMT), sometimes also referred to as intermediate means of transportation (IMT) to increase the livability of developing urban areas. Urban transportation provision should recognize the social exclusion of the poor and promote infrastructure development and operations that facilitate accessibility for all (Riverson & Carapetis, 1991; Porter, 2007).

2.2. Sustainable Transportation

The concept of sustainability or sustainable development has culminated from the concern for environmental quality, social equity, economic viability and the threat of a changing climate (Deakin, 2001; Jeon & Amekudzi, 2005; Oswald & McNeil, 2009). These issues interact among each other as depicted in Figure 1.1 to frame a vision of a desired, sustainable future (Beatly, 1995).

![Figure 2.1. Concept of Sustainability](image)
Awareness of sustainability and the need for its practice has been increasing worldwide over the past decade, and there are a growing number of initiatives to address sustainable transportation in both developed and developing countries (Litman & Burwell, 2006; Amekudzi & Vanegas, 2006). Sustainable development has become an important issue in planning initiatives (Hatzopoulou, 2009). The concept may be embraced in high-, middle-, and low-income countries and yet the approach and challenges in meeting sustainability goals will necessarily differ in the respective environments. Hence it is necessary to develop specific priorities, policies and standards to address sustainable transportation based on an understanding of the socio-economic, political and institutional systems of particular countries or jurisdictions (Amekudzi & Vanegas, 2006).

Meanwhile the development of the transportation sector often violates the tenets of sustainability (Szyliowicz, 2003). A broad definition of sustainable transportation tends to favor more integrated approaches that include improved travel choices, economic incentives, institutional reforms, land use management and technological innovation (Litman & Burwell, 2006). These individual interventions may yield marginal impact, but if implemented as a package, they can produce substantial benefits (Litman, 2003). Transportation sustainability can be broadly defined as “the ability to meet the needs of the present generation to provide for the movement of people and goods from one location to another without compromising the ability of future generations to meet their own needs” (Voigt & McCombs, 2010).

Formally addressing sustainability and including it into a planning process requires redefining the measures by which the performance of transportation systems is measured and on which planning and programming decisions are based. Sustainability also requires assessment of both direct and indirect impacts of transportation (Litman, 2003). There is a general consensus
that present trends in transportation are not sustainable. In dealing with the issue, Greene et al (1997) proposed three areas of research from the Western (i.e., European and American) point of view: technology for sustainable transportation, pricing and financing, and thirdly integrated planning for sustainable transportation. Obviously, not all three interventions above may be applicable in developing countries. For instance many developing countries are lacking in technology due to financial limitations. Pricing may not yield the desired result as transportation in many developing countries is considered more of a social commodity, where affordability is of prime significance and high proportions of urban dwellers depend on public transportation. Integrated transportation planning is already being embraced by developing countries with support from development partners like the World Bank (Porter, 2007; World Bank, 2008). Hence integrated planning is one area of intervention that could be readily applicable to developing countries in order to pursue the sustainability agenda.

2.3. Indigenous Knowledge

Indigenous knowledge has been defined in myriad terms to refer to knowledge that is unique to a given culture or society. Everyone living in an area develops some relationship with his surroundings over time, resulting in what is often called local knowledge. The local knowledge, which is held by the people indigenous to an area, is thus referred to as indigenous knowledge (Dekens, 2007). It embodies a wealth of wisdom, gained from direct observations and accumulation of experiences, and most often it is transmitted through dialogue over generations (Mazzocchi, 2006, Appiah-Opoku, 2007; Mercer et al. 2009). There is no universal definition for the term indigenous knowledge, and it has been defined differently to meet different needs. A few key definitions and their context are summarized in Table 2.1.
Table 2.1. Some Definitions of Indigenous Knowledge

<table>
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<th>Definition</th>
<th>Context</th>
<th>References</th>
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<tr>
<td>“Indigenous knowledge is local knowledge - knowledge that is unique to a given culture or society. It is the basis for local-level decision-making in agriculture, health care, food preparation, education, natural resource management, and a host of other activities in rural communities. Such knowledge is passed down from generation to generation, in many societies by word of mouth”.</td>
<td>Agriculture</td>
<td>Warren (1991)</td>
</tr>
<tr>
<td>“Indigenous knowledge is local knowledge held by indigenous people, or local knowledge unique to a given culture or society”.</td>
<td>Resource management</td>
<td>Berkes (1999)</td>
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<tr>
<td>“It is a body of knowledge built up by a group of people through generations of living in close contact with nature. It entails a system of classifications of natural resources, a set of empirical observations about the local environment, and a system of self-management that governs resource use”.</td>
<td>Environmental protection</td>
<td>Appiah-Opoku (2005)</td>
</tr>
<tr>
<td>“It is considered to be a body of knowledge existing within or acquired by local people over a period of time through accumulation of experiences, society-nature relationships, community practices and institutions and passed down through generations”.</td>
<td>Disaster management</td>
<td>Mercer et al (2009)</td>
</tr>
<tr>
<td>“Indigenous knowledge systems are the complex arrays of knowledge, know-how, practices and representations that guide human societies in their innumerable interactions with the natural milieu: agriculture and animal husbandry; hunting, fishing and gathering; struggles against disease and injury”.</td>
<td>Environmental change</td>
<td>Nakashima &amp; Roue (2009)</td>
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</table>

Indigenous knowledge is essentially tacit knowledge that is embedded in community practices and institutions. It aspires towards sound use and control of the environment and represents an important component of global knowledge on development issues. It also provides the basis for problem-solving strategies for local communities (World Bank, 1998; Briggs, 2005). Nevertheless, not all examples of indigenous knowledge relay positive benefits to the local society. For example, bush burning as a farming practice and female circumcision are
clearly not beneficial, but they must nonetheless be considered when pursuing development in relevant cultural/geographical contexts.

Agrawal (1995) refers to indigenous knowledge as common sense, which is generated in the immediate context of the livelihoods of people. In other words local people, especially the marginalized, also have a sense of what they want and should be listened to when planning for the systems that they utilize. Agrawal continued to argue that indigenous knowledge is dynamic and changes as the needs of the community changes.

There are difficulties associated with the recognition of knowledge from indigenous cultures and these are reflected in the way it is described or named. Many terms are used to describe what indigenous people know and each of these names connotes different implications. Some of the names are: indigenous knowledge, local knowledge, farmer’s knowledge, folk knowledge, rural people’s knowledge, traditional knowledge, local oppressed knowledge, and many more (Appiah-Opoku, 2005; Mazzocchi, 2006; Dekens, 2007). For instance the word “indigenous” may be suggestive that such knowledge is found where it originates from, but this may alienate knowledge from populations which are not officially recognized as indigenous, but have dwelled in that environment for considerable lengths of time and have also become custodians of such knowledge. The word traditional may also place emphasis on the mode of transmission of the knowledge type, which is along cultural lines, and lose sight of the ability of traditional societies to adapt to change (Mazzocchi, 2006).

All of the various definitions associated with indigenous knowledge are often intended to contrast this knowledge form unfavorably from the more specialized international scientific knowledge, which is also referred to as western science (Sillitoe et al, 2005). The two are often portrayed as competing knowledge systems (Briggs, 2005). Scientific knowledge, which is
usually the dominant one, often overshadows and dismisses the significance of indigenous knowledge and renders indigenous knowledge to be almost unnoticed. It is seen to be open, systematic and objective. Scientific knowledge is viewed as rational and intelligent. It is considered as part of the notion of modernity, whereas indigenous knowledge is seen to be closed parochial, un-intellectual, primitive and emotional. It is often viewed as part of a residual, traditional and backward way of life (Briggs, 2005; Mercer, 2009).

Other researchers argued that even though scientific knowledge and indigenous knowledge are two different forms of knowledge, they can learn from each other. These researchers continued to highlight some differences between the two forms of knowledge. Scientific knowledge is based on academic and literate transmission, while indigenous knowledge is generally transmitted orally. Also, scientific knowledge is objective and quantitative, while indigenous knowledge is subjective and qualitative. Indigenous knowledge systems adopt a more holistic approach, not separating observations into different disciplines like scientific knowledge. In general, indigenous knowledge systems do not interpret reality on the basis of a linear conception of cause and effect, but rather as a world made up of constantly forming multidimensional cycles in which all elements are parts of an entangled and complex web of interactions (Iaccarino, 2003; Mazzocchi, 2006). Sillitoe et al (2002) argued that the stark polar discrimination between the two knowledge systems is not only inadequate, but can also be misleading and pernicious even to the relationship and distinction between them. In development contexts, it is important to see indigenous knowledge as something possessed by those who are subject to the development, and distinguish it from science as something that will inform the development intervention (Sillitoe et al 2002). In line with this thought, the current research is
set out to use known scientific methods to harness indigenous knowledge for sustainable urban transportation planning.

2.4. Procedural Planning Theories

The conventional process of urban transportation planning can be readily categorized as scientific knowledge. The planning process is generally realized through the four-step classical urban transportation planning method that comprises trip generation, trip distribution, modal split and trip assignment. The process is based on the foundations of Synoptic planning or the rational comprehensive approach, which emphasizes scientific efficiency through rational decision making. It depends on travel data availability, which promotes the development of demand models. By cultivating and exploiting this scientific knowledge, the travel behavior of individuals can be predicted (Meyer & Miller, 2001; Sinha & Larbi, 2007). The synoptic planning, however, has been criticized for decades because it is believed that the basic assumptions of the theory do not hold in practice (Szyliowicz, 2003; Khisty & Arslan, 2005). Other criticisms have to do with the rationality, uncertainty and the complexity of the model as explained below (Khisty & Arslan, 2005)

- Bounded rationality: Bounded rationality is based on the premise that human problem-solvers are rationally limited in identifying all possible solutions to a problem at hand (Khisty & Arslan, 2005). It is relatively easy to solve purely technical problems, which are quantitative. The kinds of problems encountered in transportation planning however, are more complex because they cut across social, economic, environmental, cultural and ethical concerns. Some of these problems
require subjective interpretations without compromising with rational and objective solutions (Khisty, 2001).

- **Uncertainty:** There are uncertainties inherent in the decision-making process, because the consequences of decisions are unpredictable. Uncertainties also arise whenever one decision gives rise to many consequences and also when the input data itself is uncertain or cannot be obtained accurately. In addition, tastes and desires of communities may change with time, so goals may also change. All these concerns give rise to uncertainties. Meanwhile, it is highly subjective trying to conceptualize uncertainty in planning, as individual differences may arise in different minds about identical solutions (Khisty & Arslan, 2005).

- **Complexity:** transportation planning is unique and complex because the system consists of large numbers of elements. These elements interact at different levels, while their attributes cannot always be pre-determined. The interactions are non-linear and probabilistic in nature, and the individual sub-systems evolve with time. The sub-systems are also semi-autonomous, having their own goals. The system is also subject to behavioral influences, while open to the environment (Khisty & Arslan, 2005).

There are several other planning theories, most of which are either adjustments of the synoptic theory or reactions against it. The most important of these other theories include: Incremental, Transactive, Advocacy and Radical planning. These planning theories together with Synoptic planning are referred to as the SITAR package, based on their first letters. Each of these styles has a corresponding rationality and a core paradigm associated with it. Table 2.2 below
summarizes the main distinctions among the various planning theories and their corresponding rationality types (Khisty & Arslan, 2005).

<table>
<thead>
<tr>
<th>Planning Theories</th>
<th>Corresponding Rationality Type</th>
<th>Paradigmatic Core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synoptic planning, public sector strategic planning</td>
<td>Instrumental rationality</td>
<td>Search for the best possible combination of means for given ends</td>
</tr>
<tr>
<td>Incremental theory (disjointed), strategic choice approach</td>
<td>Bounded instrumental rationality</td>
<td>Search for satisfactory alternative, given an unclear and partly collapsed means-end scheme</td>
</tr>
<tr>
<td>Transactive planning, dialogical incrementalism</td>
<td>Communicative rationality</td>
<td>Organize dialogue to promote democracy and personal growth and search for a solution agreed upon in undistorted communication</td>
</tr>
<tr>
<td>Advocacy planning, Planning as questioning and shaping attention</td>
<td>Bounded communicative rationality</td>
<td>Counteract structural communicative distortion to promote equal opportunities and build support for a reasonably effective and fair alternative</td>
</tr>
<tr>
<td>Recalcitrant planning, i.e., planning emphasizing other rationality types than those above. e.g., radical planning, social learning</td>
<td>Other types of rationality, e.g., system-maintaining types, like political and ecological rationality</td>
<td>E.g. Political rationality preserves and improves decision structures to prevent indecisiveness and internal conflict</td>
</tr>
</tbody>
</table>

Source: Khisty & Arslan, 2005

Each of the SITAR procedural planning theories are discussed below to establish a basis for incorporating indigenous knowledge.

2.4.1. **Synoptic/Rational Comprehensive Theory**

Synoptic planning/rational comprehensive approach is the dominant planning tradition. It uses procedures such as cost-benefit analysis and forecasting, which are often used in conventional transportation planning methods. This approach uses conceptual or mathematical models, depending heavily on quantitative data analyses. Such planning methods are technically
rigid and typically weak in public participation. Despite years of criticism, it still remains the dominantly used planning method (Hudson, 1979; Wilson, 2001; Timms, 2008).

2.4.2. Incremental Theory

In Incremental Theory, policy decisions are made and understood by established institutions, which are accustomed to the decentralized bargaining process of free and democratic political economies. Incremental planning is a result of series of criticisms leveled against synoptic rationality such as being unrealistic, insensitive to the capabilities of existing institutions, and exhibiting a failure to appreciate and recognize cognitive limits of decision makers. Public participation under incremental planning is largely restricted to consultation, but the decentralized nature of incrementalism provides a platform for incorporation of other actors, and represent an important shift for public participation in the planning process (Hudson, 1979; Lane, 2005). Incremental planning may only flourish in countries with efficient institutions, data integration systems, and coordination mechanisms.

2.4.3. Transactive Planning/Dialogue Incrementalism

This approach uses communicative rationality and guides communicative action (Khisty & Arslan, 2005). It is people-centered instead of planning for an anonymous target community. The core of this approach is that planning should focus more on inter-personal dialogue and mutual learning. By contrast, incremental planning adheres to the economic logic of individuals pursuing their own self-interest. On the other hand, transactive planning places more emphasis on personal and organizational development, where plans are evaluated in terms of their effect on people (Hudson, 1979; Wilson, 2001; Timms, 2008). Transactive planning places emphasis
on the effect that development has on people, and this effect is in line with sustainable
development. It also focuses on inter-personal dialogue and resonates with calls for the use of
qualitative research (Pottier, 1993; Fouracre et al, 2006).

2.4.4. Advocacy Theory

This method is rooted in adversarial procedures modeled on the legal profession. It is
usually applied to defend the interests of the vulnerable against established powers of business
and government. It helps block insensitive plans by working through the courts. It helps
introduce greater sensitivity to unintended side effects of decisions. A direct result of advocacy is
the increasing requirements for environmental, social and financial impact reports on large scale
project proposals. In practice however, it has been criticized for posing stumbling blocks and not
having the ability to mobilize equally effective support for constructive alternatives (Hudson,
1979). According to Appiah-Opoku (1994) advocacy theory may not work well in most
developing countries, especially those with relatively authoritarian regimes/systems for lack of
truly independent judiciary and legal process.

2.4.5. Social Learning/Recalcitrant Planning

In this model, appropriate knowledge is not seen as the monopoly of the planner. The
planner helps the community to find practical solutions to develop successful strategies through
social learning. This is achieved through broad, grass root participation of community members.
It can be considered a community-based, bottom-up approach to planning, which seeks to
manage development in an equitable manner. The method employs a combined strategy of
community involvement, collective self-empowerment and self-reliance. It can encourage
neighborhood committees to take over planning functions usually vested in central bureaucrats (Hudson, 1979; Beard, 2003). As a result of the high level of illiteracy in developing countries, social learning may only be successful if implemented with some modifications and in conjunction with some of the other traditions.
<table>
<thead>
<tr>
<th>Theory</th>
<th>Central Theme Of Theory</th>
<th>Basic Requirements For Operation</th>
<th>Developing Country Application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Synoptic/ Rational</strong></td>
<td>• Objective analysis e.g. cost-benefit analysis</td>
<td>• Availability of good data</td>
<td>• Lack of data</td>
</tr>
<tr>
<td></td>
<td>• Use of mathematical models</td>
<td>• Analytical capabilities</td>
<td>• Limited analytical capabilities</td>
</tr>
<tr>
<td></td>
<td>• Heavy dependency on numbers and quantitative analysis</td>
<td></td>
<td>• Poor &amp; limited use of data processing instruments</td>
</tr>
<tr>
<td><strong>Incremental</strong></td>
<td>• Decentralized institutional bargaining</td>
<td>• Efficient institutions</td>
<td>• Less efficient administrative institutions</td>
</tr>
<tr>
<td></td>
<td>• Focus on critical points of intervention</td>
<td>• Data integration systems</td>
<td>• Absence of data integration systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Efficient coordination</td>
<td>• Poor coordination</td>
</tr>
<tr>
<td><strong>Transactive/Dialogical</strong></td>
<td>• Interpersonal dialogue</td>
<td>• Consensus building through dialogue</td>
<td>• Have the tradition of consensus building through dialogue</td>
</tr>
<tr>
<td><strong>Incremental</strong></td>
<td>• Public participation</td>
<td>• Efficient communication systems</td>
<td>• Communication systems reasonably acceptable</td>
</tr>
<tr>
<td></td>
<td>• Less field surveys and data analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Advocacy</strong></td>
<td>• Rooted in adversary procedures to defend the interests of the vulnerable</td>
<td>• Independent and effective judicial system must prevail</td>
<td>• Cumbersome and slow judicial system.</td>
</tr>
<tr>
<td></td>
<td>• Modeled upon the legal system</td>
<td>• Legal aid system</td>
<td>• Inadequate lawyers render legal aid inaccessible to the needy</td>
</tr>
<tr>
<td><strong>Radical Planning/ Social Learning</strong></td>
<td>• Household and community involvement</td>
<td>• Consensus building through dialogue</td>
<td>• Have the tradition of consensus building through dialogue</td>
</tr>
<tr>
<td></td>
<td>• Collective self-empowerment and self-reliance</td>
<td>• Efficient communication systems</td>
<td>• Communication systems reasonably acceptable</td>
</tr>
</tbody>
</table>

*Based on (Appiah-Opoku, 1994; Appiah-Opoku, 2005)*
Table 2.3 gives a summary of the SITAR package and its application in the context of developing countries. Synoptic/rational comprehensive theory may be unsuitable for developing country applications as it requires large amounts of reliable quantitative data. Good data is often not available in developing countries, because such data is expensive to collect and maintain. Incremental theory also may be unsuitable for developing country application, because it requires data integration systems and efficient coordination among institutions, and these items are also lacking in most developing countries. Since people are often slow to change, it is important to adopt planning theories that are not completely new and have some bearings with the traditional methods of decision-making. Despite dictatorship in some developing countries, the transactive theory is the type of decision-making process that is practiced by most informal indigenous institutions in most developing countries. In Africa for instance, decisions are made by traditional authorities through consensus building as once stated by the Head of State of Ghana. “Traditionally, decision-making in Africa is done by consensus. The chief and elders create a forum at which each member of the community can make his or her voice heard. As the discussion goes on and new ideas are generated, majority position emerges” (Appiah-Opoku, 1994).

In light of this existing indigenous decision-making process, it seems apparent that communicative rationality, which is based on transactive planning and dialogical incrementalism, with some social learning will be the most suitable combination of theories applicable in developing countries, particularly in Africa. Hence, the current research adopts this approach and develops a framework that seeks to scientifically promote dialogue among indigenous system users and providers to reach a consensus towards sustainable transportation planning.
CHAPTER 3 PROPOSED APPROACH

During its early development, transportation planning has been described as “an exercise in data handling” due to the large amounts of data and information that must be “stored and manipulated” (Schofer and Levin, 1967). The current understanding of transportation planning has evolved into one of an objective scientific process that emphasizes efficient decision-making through a systematic, step-by-step method (Black, 1990; Szyliowicz, 2003; Khisty and Arslan, 2005; Timms, 2008). Such an understanding, while implying considerable precision, may ultimately limit the applicability to certain transportation planning processes (Roorda et al., 2006; Goetz and Szyliowicz, 1997; Handy, 2008; Hatzopoulou and Miller, 2009). Wilson (2001) states that transportation planning “assumes that urban transportation systems operate in mechanistic, predictable ways – that immutable laws about travel behavior can be discovered and used for prediction.” Indeed, the 4-step planning model, which is based on the synoptic/rational comprehensive theory, is used to develop travel demand forecasts from land use or activity patterns (measured or estimated) on which to base decisions regarding transportation infrastructure investments and improvements or projects (Black, 1990; Beimborn, 1995; Meyer and Miller, 2001, Khisty and Arslan, 2005).

In practice, transportation planning is typically used to identify and prioritize transportation projects (Schofer and Levin, 1967; Beimborn, 1995; Meyer and Miller, 2001; Banister, 2002; Sun et al, 2007). Prioritizing projects can be accomplished at multiple levels. Detailed analyses can be conducted to determine which project from a list of candidate projects are to be implemented and to advise their programming (i.e., funding and scheduling). Projects
can also be prioritized at a high level, or screened, to determine which projects best meet a predetermined set of criteria – and thus identified for further, more detailed consideration.

The current research approach has developed and documents a framework for screening urban transportation projects in developing countries to reflect locally derived sustainability criteria. The framework is developed in recognition of the growing need to adopt planning theories that promise to be more applicable in the developing country context and is based on transactive or dialogical incrementalism in conjunction with social learning. The framework is developed around the following theme: to promote dialogue among scientists, transportation professionals, and indigenous people in conjunction with the consensus building culture typically used to address community needs in developing countries. Thus, the framework seeks to integrate indigenous (i.e., local) and scientific knowledge of how specific urban transportation improvement projects might support sustainable transportation development. It is a participatory process that integrates input from system users and providers to produce a term defined as the Localized Sustainability Score (LSS). The LSS of each candidate project can then be used to produce a relative ranking of potential projects.

This new framework is needed because resources for conducting detailed project analyses are relatively scarce in developing countries. Meanwhile, transportation projects in developing countries are often funded by international agencies/partners that require, or at least desire, objectivity and accountability in local decision-making processes. Hence, the framework and its results can be used to implement and document a screening process by which candidate projects can be chosen and/or prioritized for further consideration. It also provides a mechanism to engage system users and document their input for the purpose of auditing and accountability of
transportation project sustainability. The framework is presented through a preliminary case study carried out in Accra, Ghana.

3.1. Integration of Indigenous and Scientific Knowledge

This research proposes that indigenous knowledge can be integrated with elements of scientific knowledge to achieve more sustainable transportation planning in rapidly urbanizing areas in developing countries. Unfortunately the issue of indigenous knowledge is fraught with methodological, theoretical, political, and practical difficulties (Sillitoe et al., 2002). Indigenous knowledge poses a threat to “experts” who built their expertise around conventional western based planning strategies (Briggs, 2005). Hence it is somehow difficult for these same experts to promote it. Also, there still exists some doubt about the ability of indigenous knowledge to offer realistic and meaningful contribution to developmental planning (Briggs, 2005). One of the arguments against indigenous knowledge is that it is too place-specific and cultural-specific to be universal, transferable, and of broader use (Krugly-Smolska, 1994; World Bank, 1998; Watson-Verran and Turnbull, 2005). Meanwhile the use of western science for development in Africa and elsewhere for the past 50 years has also not been successful in transforming the lives of the poor (Krugly-Smolska, 1994). Klooster (2002), following research in Mexico, argued that both knowledge forms lack the ability to handle social practices of environmental management. While local knowledge lacks the ability to monitor the bigger picture, western science also lacks the flexibility to deal with socio-economic consequences. Nevertheless, Mazzocchi (2006) argued that both knowledge systems can learn from each other and according to Briggs (2005), indigenous knowledge can either become a radical alternative to western science and knowledge, or serve to complement mainstream development practices.
Figure 3.1 shows a system of indigenous knowledge relevant to urban transportation, which is composed of knowledge types embedded in community practices. Such knowledge is dynamic and often influenced by structures both within and outside the community, and also by processes such as policies and culture. These happen in the context of community perspectives and common problem solving techniques and cultural practices. The results in urban transportation are local travel patterns and local transportation operations, which are based on the experience of local actors and adaptations that are communicated through stories, on-the-job training, etc. Eventually the incorporation of indigenous knowledge into urban transportation affects the local economy, environment and the society at large.
Figure 3.1. Indigenous Knowledge Systems Relevant In Urban Transportation

Based on: Dekens, 2007
Indigenous knowledge exists mainly as tacit knowledge, but also as explicit knowledge. Polyani (1969) introduced the concepts of tacit and explicit knowledge, with the argument that tacit knowledge is informal and difficult to communicate formally. Nonake and Konno (1998) state that tacit knowledge, “is deeply rooted in an individual’s action and experience as well as in ideas, values, or emotions he or she embraces.” Tacit knowledge, therefore, is personal and experiential. With regard to transportation, it resides in both system users and providers. It forms the basis for problem-solving strategies for local communities and represents an important component of global knowledge on development issues (World Bank, 1998; Briggs, 2005). The potential contribution of tacit knowledge and its role in formal decision-making processes has been asserted by numerous researchers (Gibbons et al, 1994; Innes, 1998; Khakee et al, 2000; Scharmer and Kaufer, 2000; Brömmestroet and Bertolini, 2010). Explicit knowledge, on the other hand, connotes formal knowledge gained through data-driven experimentation, empirical analysis, development of theoretical understanding, etc. Explicit indigenous knowledge is largely maintained by system providers (planners, engineers, administrators, policy makers, etc.).

Scientific knowledge in transportation also exists in both tacit and explicit forms. Tacit knowledge includes engineering judgment as exercised by transportation professionals and is acquired by virtue of their association with the system over a considerable length of time. On the other hand, explicit scientific knowledge in transportation planning includes well documented methods such as the conventional method and multi-criteria decision making (MCDM) methods. Some of the commonly used conventional monetary-based evaluation methods include financial analysis, cost-effectiveness analysis and cost-benefit analysis (Macharis et al, 2008; Communities and Local Government, 2009; Awasthi and Omrani, 2009). These conventional methods have not been effective for the assessment of transportation systems, because such
systems are complex and strongly interrelated with socio-economic and environmental systems, which cannot be easily monetized (Schade and Rothengatter, 1999; Schade and Rothengatter, 2001; Leleur, 2007; Olson, ND; Handy, 2008). This ineffectiveness is particularly important in developing countries, where urban transportation is often not viable and many subjective social considerations must be taken into consideration. The multi-criteria, multi-actor nature of the transportation problem is quickly making MCDM the most suitable method for urban transportation evaluations (Richards, D, 1999; Zietsman et al, 2006; Tudela et al, 2006; World Bank, 2008; Macharis et al, 008; Communities and Local Government, 2009).

incorporating indigenous knowledge into project design and also for the design and implementation of indigenous knowledge research.

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**Figure 3.2. Identifiable Knowledge Sources for Integration**

Drawing on the experiences of previous researchers, the author proposes a model for integrating indigenous and scientific knowledge as it relates to urban transportation in Figure 3.2. Ultimately, the knowledge integration model proposed herein is intended to inform the
development and application of the Localized Sustainability Score (LSS) framework for screening/prioritizing transportation projects in developing countries.

3.2. Participatory Approach

According to Rotmans (1998) “Participatory methods” is an umbrella term that describes assessment methods, which allow non-experts, such as policy makers, stakeholders or lay people to make active contributions to decision-making. These can be achieved through dialogue or mutual learning methods, which are characteristics of transactive planning/dialogical incrementalism and social learning. Dialogue methods are used to extract essential information from intended users. In the mutual learning approach, the participants are considered as co-producers of knowledge. They are individuals who may not be system users, but whose perspectives, skills, and competence may complement the expertise and knowledge of the scientists. For example, informal transport operators can provide valuable input to transportation designers. Mutual learning can also be carried out in one of two forms. It can take the form of focus groups, where experts play the role of facilitators and observers. The groups typically consist of citizens, policy makers or other stakeholders who are provided with scientific input. The second form is the interactive approach where the expert is actively involved as a participant. Here problem definitions and proposed solutions are integrated into a joint assessment.

Formal urban planning techniques are complex and depend heavily on data that are difficult to obtain. This situation is the basis for the growing demand for more simple planning tools that are less data-dependent and capable of processing qualitative data (Rotmans and Van Asselt, 2000). The complexity of sustainable development also leads to multiple solutions
(Rijsberman and van de Ven, 2000; Khisty and Arslan, 2005). The transportation problem and its solutions affect a large number of stakeholders, who will evaluate a given situation according to their diverse goals and interests. As a result, there is no common solution. Meanwhile, the goals and interests of any particular group of stakeholders are by themselves dynamic and changing with time (Khisty and Arslan, 2005). Rijsberman further argued that objective scientific knowledge alone cannot be used in solving a complex problem such as sustainable development, because of uncertainties. This situation calls for an interactive planning process that involves all stakeholders, as each stakeholder would approach the solution from a different perspective (Rijsberman and van de Ven, 2000).

Context Sensitive Solutions (CSS), which is a relatively new approach to transportation planning and project development, occurs when citizens and agencies take an integrated approach to the process. CSS promotes community input and reflects the impact of transportation on both the human and natural environment. This participatory approach is an increasingly important concept, which is being embraced all over the world, and has been used recently in countries like the US, South Africa, Ghana, Zimbabwe and Sri-Lanka (Fouracre et al. 2006; Jennings and Covary, 2008).

Fouracre et al. (2006) carried out a research work that included three case studies from Harare, Zimbabwe; Accra, Ghana; and Colombo, Sri-Lanka. The research covered a wide group of stakeholders, particularly the poor, disabled, women and other disadvantaged groups. Other stakeholder groups were transportation operators and transportation regulators or administrators. The general approach for this study was the use of focus groups to reduce data that was extracted from questionnaire surveys. The questionnaire surveys were concerned with urban travels made by public transportation, covering behavioral and attitudinal aspects of trips.
Expert knowledge can also be obtained through the use of questionnaires developed specifically for various stakeholder groups, giving each the freedom for addition and removal of criteria/sub-criteria and alternatives (Sangle and Babu, 2007). In another research carried out by Porter and Lyon (2006) to study the contribution of group activity in local development in Ghana, data collection was done through participant observation in the form of interviews that were carried out over a span of 8 years. The interviews involved a total of 150 people, which included ordinary citizens, community based organizations, local and international Non-governmental organizations (NGOs), district administrations and other government officials.

Bryceson et al. (2003) used the participatory approach to carry out a study on mobility and accessibility needs in the two sub-Saharan cities of Uganda and Zimbabwe. The study was carried out in three phases:

- Phase 1 consisted of identification of study corridors, survey sites and focus group discussions among local residents
- Phase 2 included household and transportation surveys, and
- Phase 3 involved the selection of 12 households, representing high, medium and low-income households. Members from the selected households reported their individual transportation activities in a logbook for a week.

3.3. Qualitative Decision-Making

Participatory processes support qualitative decision-making. And the qualitative approach to scientific research has become a powerful tool in helping scientists to understand complex transportation problems (Clifton and Handy, 2001), which cannot be easily expressed with mathematical models. “To be realistic our models must include and measure all important
tangible and intangible, quantitatively measureable and qualitative factors (Saaty, 1980).

Qualitative research allows for stakeholder inclusion and the capture of indigenous (tacit and experiential) knowledge (Sillitoe et al, 2005), which has been identified as a basis for problem-solving strategies for local communities and has thus become an object of debate for sustainable development (World Bank, 1998; Briggs, 2005). Qualitative research allows for holistic narrative and verbal description of phenomenon (Scholz and Tietje, 2002), which is necessary for deep understanding of some aspects of human development and can be represented by fuzzy sets like good, moderate, very bad etc. (Menegolo and Pereira, 1996) to facilitate the analysis process.

There is an ongoing shift in the development world that is embracing ‘grassroots’ participatory approach instead of the traditional ‘top-down’ methods. This is because ill-conceived centrally-imposed projects often have failed to meet the needs of developing countries (Sillitoe et al, 2002; Falcocchio, 2004). Fouracre et al (2006) argued that inadequacies in traditional quantitative transportation planning methods, which are based on disaggregate household surveys, have necessitated the need to explore a more participatory approach to the process.

Conventional methods are less effective when it comes to subjectivity in planning, such as putting a value on the number of deaths or injuries saved by an intervention or when evaluating environmental issues. Monetary valuations also do not take into account the joint effect of different impacts. For example when environmental impact and social impact assessments are carried out separately as is currently done in conventional planning, the dangers may be less obvious, but if the two assessments are done jointly in one exercise, potential dangers may become clearer. Unlike the other scientific methods discussed above, Multi-Criteria Decision Making methods are more flexible with valuations that involve both quantitative and
qualitative consequences of proposed investments (Zietsman et al, 2006; Macharis et al, 2008; Communities and Local Government, 2009; Tudela et al, 2009). MCDM is able to put all evaluations such as social, environmental and economic together in one exercise. Hence in recent years many development partners such as the World Bank have been making efforts to move to a multi-criteria, multi-alternative, participatory framework that is able to accommodate a wide range of concerns (World Bank, 2008).

3.3.1. Multi-Criteria Decision Making (MCDM)

Multi-Criteria Decision Making (MCDM) methods are tools that provide alternative means for populating transportation related scientific knowledge. Specifically, MCDM are used for developing guidance for decision makers in dealing with numerous and often conflicting evaluations, by comparatively evaluating multiple dimensions of a problem instead of attempting to develop and utilize a common single attribute like cost-benefit analysis (De Montis et al, 2000). Knowledge generated by MCDM is derived subjectively based on comparative analyses of various elements, and MCDM has been explicitly applied to the problem of providing sustainable transportation planning (Rotmans and Van Asselt, 2000; Munier, 2004; Sun et al, 2007; Campos et al, 2009; Hickman et al., 2011).

There are many MCDM methods in application (Won, 1990; Franklin and Niemeier, 1998; Rotmans, 1998; Saaty and Vargas, 2001; Lee and Chan, 2007; Leleur, 2007; Macharis et al., 2008; Paez and Curry, 2007; Communities and Local Government, 2009; Jeon et al, 2010). Some of these methods include the Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), Novel Approach to Imprecise Assessment and Decision Environments (NAIADE), Multi-Attribute Utility Theory (MAUT), and Multi-Objective Programming (MOP) (De Montis
et al, 2000). Some of the methods are complex and untested in practice; hence, not all are suitable for application. The AHP is selected for use in this research, because it is simple and is a widely utilized and accepted MCDM method.

AHP is considered the most useful MCDM tool in dealing with interdependent criteria that involve both quantitative and qualitative data (Lee and Chan, 2007; Litman and Burwell, 2006). It has been used in the evaluation of sustainable production systems (Presley and Meade, 2004); for integrated approach to rural water supply in developing countries (Bhattarai, S., Starkl, M., 2005); in the evaluation of transportation investment alternatives (Ferrari, 2003; Nubanu, 2006); to improve transportation planning-decision making (Paez and Currie, 2007); in the evaluation of stakeholder satisfaction (Sangle and Babu, 2007); in the assessment of urban quality of life (Lotfi and Solaimani, 2009); and in traffic planning (Pogarcic et al, 2010).

3.3.2 The Analytical Hierarchy Process (AHP)

AHP is a basic approach to decision making in an organized way so as to generate priorities by breaking the decision into steps (Saaty, 1980; Saaty, 2008). In the simplest form, AHP structures the decision problem into a hierarchy at three levels as shown in Figure 3.3. The hierarchy starts with the goal at the top, followed by a set of criteria (and another level of sub-criteria when necessary). The lowest level is usually the set of projects that have been identified for ranking. The decision-maker uses the criteria (and sub-criteria) to compare the alternatives for prioritization using a comparative matrix. The selection is made by first ranking the set of criteria through pairwise comparisons with the goal, shown in a matrix format. Each criterion receives a numeric rank of 1 to 9 based on its significance to the goal. The pairwise comparison is repeated by comparing pairs of alternatives with respect to each criterion. The outcome is a
ranking, with the highest ranking alternative considered the most suitable for meeting the set goal. The linear structure of AHP is based on the assumption that higher levels are independent of lower levels, and elements at the same level are also independent from each other.

![Diagram of Analytic Hierarchy Process (AHP)](image)

**Figure 3.3. The Analytic Hierarchy Process (AHP)
Based on Saaty and Vargas (2001)**

<table>
<thead>
<tr>
<th>Intensity of Importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equal importance</td>
<td>Two activities contribute equally to the objective</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance</td>
<td>Experience and judgment slightly favor one activity slightly over another</td>
</tr>
<tr>
<td>5</td>
<td>Strong importance</td>
<td>Experience and judgment strongly favor one activity over another</td>
</tr>
<tr>
<td>7</td>
<td>Very strong or demonstrated importance</td>
<td>An activity is favored very strongly over another, its dominance demonstrated in practice</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
<td>The evidence favoring one activity over another is of the highest possible order of affirmation</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>For compromise between the above</td>
<td>Sometimes one needs to interpolate a compromise judgment numerically because there is no good word to describe it</td>
</tr>
<tr>
<td>Reciprocals of the above</td>
<td></td>
<td>If activity i has one of the above numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i</td>
</tr>
</tbody>
</table>

**Table 3.1. The Fundamental Scale for Pairwise Comparisons**

The purpose of breaking the problem into a hierarchy is to establish priorities of the elements in the decision problem. The priorities are achieved through pairwise comparisons
using the descriptive judgment scale shown in Table 3.1. For each level of the hierarchy, the elements are compared in pairs against each of the criterion in the hierarchy immediately above. The results of the pairwise comparisons (the judgment) are recorded in a matrix. The pairwise comparison process starts from the top of the hierarchy by comparing the criterion in pairs with respect to the goal. In the case of Figure 3.3, that will generate a 5x5 matrix for the criteria comparisons since there are 5 criteria to be compared. Consider an example, where the three alternatives in Figure 3.3 are compared with respect to a specific criterion. The resulting matrix is a 3x3 matrix as shown below:

Table 3.2. Comparison Matrix

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Alt 1</th>
<th>Alt 2</th>
<th>Alt 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt 1</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Alt 2</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Alt 3</td>
<td>1/5</td>
<td>1/3</td>
<td>1</td>
</tr>
</tbody>
</table>

The resulting matrix is a reciprocal matrix where each of the main diagonal entries are 1 and for every entry $a_{ij}$ the corresponding $a_{ji}$ is given as below:

$$a_{ji} = \frac{1}{a_{ij}} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

The entries, which are the results of the pairwise comparisons, are explained below using the fundamental scale in Table 3.1:

- An element is equally important when compared to itself, so insert 1 where Alt 1 meets Alt 1
- When Alt 1 is of moderate importance compared with Alt 2, insert 3
- When Alt 1 is of strong importance compared with Alt 3, insert 5
The results from the pairwise comparisons are used to populate the 3x3 matrix and used to compute the priority vector. According to Saaty (1980), the priority vector is computed by raising the comparison matrix to powers that are successively squared each time. The row sums are calculated and normalized, and the computation stops when difference between all the normalized row sums in two consecutive calculations is very small (e.g. less than 0.0001). That last normalized row sum is the priority vector, which indicates the relative preference attached to the items under consideration (Alt 1, Alt 2 and Alt 3) by the respondent. As shown in Table 3.3, Alt 1 is most preferred, scoring 0.64, while Alt 3 is the least preferred option, scoring 0.10.

Table 3.3. Comparison Matrix with the Corresponding Priority Vector

<table>
<thead>
<tr>
<th>Projects</th>
<th>Alt 1</th>
<th>Alt 2</th>
<th>Alt 3</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt 1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>0.64</td>
</tr>
<tr>
<td>Alt 2</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
<td>0.26</td>
</tr>
<tr>
<td>Alt 3</td>
<td>1/5</td>
<td>1/3</td>
<td>1</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Another important property of the matrix to compute is the principal eigenvalue ($\lambda_{\text{max}}$), which is used to determine the consistency of the pairwise responses. The consistency is a measure that reflects the reliability of the decision, hence analysis of pairwise comparisons in AHP requires a check on the consistency of responses. For example, responses indicating $A > B$ and $B > C$ should not be followed with responses of $C > A$. Such a series of responses would indicate an inconsistency among the three responses. Saaty (1980) showed that the consistency of a pairwise comparison could be established by calculating a consistency ratio (CR) from the pairwise comparison matrix. Every judgment for which the CR value is higher than 10% is considered an inconsistent judgment, and that judgment is rejected. Only judgments whose
corresponding matrices yield CR values of 10% or below are included in the overall judgment matrix. CR is computed by first computing another property called the consistency index (CI), which is the deviation from consistency.

\[
CI = (\lambda_{max}-n)/(n-1) \ ..................................................(2)
\]

Where:

\( n \) = the number of elements in the matrix, 3 for a 3x3 matrix

\( \lambda_{max} \) = the principal eigenvalue

The principal eigenvalue is a standard matrix property, but can also be computed by using the following steps (Teknomo, 2006):

1. Compute each column sum from the comparison matrix, Table 3.4,

2. Multiply each column sum with the corresponding element in the priority vector and sum the products to get the principal eigenvalue.

\[
\begin{array}{ccc}
1 & 3 & 5 \\
1/3 & 1 & 3 \\
1/5 & 1/3 & 1 \\
1.53 & 4.33 & 9.00 \\
\end{array}
\]

\[
\lambda_{max} = (1.53 \times 0.64) + (4.33 \times 0.26) + (9 \times 0.10) = 3.005 \ ..............................................(3)
\]

\[
CI = (3.005-3)/(3-1)
\]

\[
CI = 0.0025
\]
The computed consistency index is compared with the consistency of a randomly generated reciprocal matrix that is a standard value and referred to as random index (RI). Table 3.6 shows standard RI values for matrices of different sizes ranging from 1x1 to 9x9 (Saaty, 2008).

<table>
<thead>
<tr>
<th>Size of matrix</th>
<th>1x1</th>
<th>2x2</th>
<th>3x3</th>
<th>4x4</th>
<th>5x5</th>
<th>6x6</th>
<th>7x7</th>
<th>8x8</th>
<th>9x9</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.00</td>
<td>0.00</td>
<td>0.58*</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
</tr>
</tbody>
</table>

*Source: Saaty, 2008*

The CR is computed by finding the ratio of CI to the corresponding RI for the same matrix size.

\[
CR = \frac{CI}{RI} = \frac{0.0025}{0.58*} = 0.004
\]

The calculated CR is 0.004 < 0.10. Thus, the responses in Table 3.2 are judged to be consistent.

3.4 The Proposed Process for Integrating Indigenous and Scientific Knowledge

Figure 3.4 shows the process developed as part of this research effort and is aimed at facilitating the integration of indigenous knowledge and scientific knowledge for sustainable transportation. The framework was developed bearing in mind the drawbacks that are associated with indigenous knowledge research. Some of these drawbacks include the apparent lack of compatibility between indigenous knowledge and scientific knowledge, and the lack of methodological coherence for participatory processes. The framework covers the steps taken to
engage transportation experts and system users in meaningful dialogue for data collection. This leads to the development of a prioritized list of projects according to their respective Localized Sustainability Scores (LSS). The prioritized list of projects so developed is a reflection of how favorably the projects contribute to a sustainable urban transportation system.
Step 1: Definition
- Identify local sustainability criteria
  - Identify key stakeholders
  - Identify tacit and explicit knowledge sources, needs and perceptions of system users.

Step 2: Capture
- Make record of Indigenous Knowledge from the different sources identified
  - Get information from existing literature
  - Use dialogue to get relevant information from system providers and users such as needs, perceptions, etc.

Step 3: Integration
- Map scientific transportation solutions to address identified needs and concerns
  - Identify sustainable transport solutions that seek to harmonize the conflicting needs of diverse stakeholders
  - Prioritize the proposed solutions

Figure 3.4. Process for Developing/Applying LSS
3.4.1. Definition

The LSS process commences by developing a system of indigenous knowledge relevant to urban transportation as seen in Figure 3.1. This is followed by an identification of the various sources from which this knowledge can be obtained, and may include various stakeholders such as scientists, transportation professionals, ordinary system users, politicians and key decision-makers that affect the system and others who are affected by the system. It is also important to identify the different forms in which relevant indigenous knowledge exists in the locality such as experiential, explicit and tacit, undocumented knowledge. It is also important to identify points of intervention that identify with relevant SITAR components.

3.4.2. Capture

Qualitative methods are often used to capture indigenous knowledge. These methods can be in the form of interviews, focus groups, participant observations etc., and are methods that seek to foster dialogue through meaningful discussions. The whole process is modeled based on the transactive theory or dialogical incrementalism and promote dialogue among participants by developing a social learning platform. On this platform, the scientist or the transportation expert is not seen to have monopoly of transportation knowledge. Instead, every participant is a potential contributor to the knowledge bank for the mutual benefit of the community.

3.4.3. Integration

Multi-criteria decision making in the form of Analytic Hierarchy Process (AHP) is used to harmonize the different steps of the decision process. Using AHP is necessary because of the qualitative and multi-criteria nature of the information. The decision problem is defined qualitatively to establish a hierarchy of solution, with the goal at the top and the alternatives at
the lowest level of the hierarchy. Between these two levels are the levels of the criteria and sub-criteria that link the alternatives to the goal. Comparative relationships are then established qualitatively across the elements of the different levels through dialogue among participants. The comparisons are made through pairwise comparisons, where the elements at each level are compared in pairs against a given criterion at the level immediately above. The scores assigned in the comparison are used to develop comparison matrices from which priorities are derived to reflect the preferences of the respondent.
CHAPTER 4 METHODOLOGY

The LSS was developed through a case study in Accra, which is the capital of the West-African nation Ghana. More than half of the population of Ghana is considered urban. Accra and its environs, referred to as the Greater Accra Metropolitan Area (GAMA) had a 2010 population of 2.3 million that has been projected to exceed 4 million by 2013 (DHV and MDC, 2005b; CIA, 2011). With regard to transportation, there were some 181,000 cars estimated to be operating in Accra in 2004 while the remainder of urban transportation needs are served by a mixture of private buses (tro-tros), public buses (Metro Mass Transit), taxis, and non-motorized transport (DHV and MDC, 2005a; DHV and MDC, 2005b).

Accra was chosen as a case study as the researchers had access to two recent large-scale transportation studies conducted using conventional planning approaches to rank candidate transportation improvement projects. One report addressed road infrastructure projects (DHV and MDC, 2005a) and the other evaluated four candidate Bus Rapid Transit (BRT) projects (DHV and MDC, 2005b). The results of these studies were compared with the results of the proposed screening process. Specifically, a Localized Sustainability Score (LSS) was developed for five actual projects from Accra using the proposed framework. These include two proposed major roadway projects, two proposed BRT projects and an area-wide non-motorized (NMT) project that was completed in 2000.

The two roadway projects were analyzed and ranked in 2005 among other major roadway projects. The 2005 study used a detailed traffic forecasting model, Questor, and HDM-4 to
project cost-benefit ratios for each alternative. Those projects receiving the highest cost-benefit ratios were ranked higher than those receiving lower scores. One proposed project, the Motorway Extension, received the highest ranking among all roadway projects evaluated, and another project, the Lashibi Road upgrade, was ranked among the lowest (DHV and MDC, 2005a). Similarly, relative rankings were assigned to the BRT projects using a cost-benefit based approach. In the 2005 study, the Winneba Road BRT project was ranked highest among five candidate BRT projects, while the Accra-Tema Beach Road BRT project was ranked lowest. While the NMT project was not included in either of the previous studies, it was included herein to allow for a comparison among multiple modes (roadway, public transportation and NMT) in developing the relative LSS. Each of the projects used in the case study is described in detail (Table 4.1).

The previous studies developed separate comparisons and rankings among roadway projects and BRT projects, and the NMT project had not been previously evaluated or ranked. However, the LSS framework allowed for a comparison among the different transportation modes and project scales represented by the five case study projects.
Table 4.1. Description of Accra Projects Used In Case Study

<table>
<thead>
<tr>
<th>Projects</th>
<th>Project Name</th>
<th>Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>Motorway Extension</td>
<td>The road is a 13.5km major bypass, located close to the periphery, yet passing through a built up area. The road currently has a single carriageway, which is to be upgraded to a 4-lane motorway with full access control. The road is an important link between two major corridors, and experiences heavy congestion, but the upgrading met lots of resistance due to the massive property impact of the project. The conventional method ranked this project in 1st position for immediate implementation.</td>
</tr>
<tr>
<td>P2</td>
<td>Lashibi Road</td>
<td>It is a 7.6km East-West corridor with single carriageway, to be upgraded to a dual carriageway. It is an important link between two suburbs, passing through mostly undeveloped land and expected to have less property impact. It was selected because it was ranked 4th for deferred implementation in the conventional method.</td>
</tr>
<tr>
<td>P3</td>
<td>Winneba Road BRT</td>
<td>The existing 16km road is a dual carriageway with three lanes per direction. Some short 2-lane sections are to be widened to three lanes to provide a dedicated bus lane per direction. The road way is a major commuter route into the Central Business District (CBD), linking the Motorway extension at the other end. Selected because it was ranked in 1st position in the conventional evaluation.</td>
</tr>
<tr>
<td>P4</td>
<td>Accra-Tema Beach Road BRT</td>
<td>The roadway is significantly an 18km single carriageway to be upgraded to provide an extra lane per direction for use as exclusive bus lane. It is an important corridor that links the CBD to the important harbor city of Tema. Project will have considerable property impact and is selected because it was ranked 4th in the conventional method for deferred implementation.</td>
</tr>
<tr>
<td>P5</td>
<td>Nima - CBD NMT</td>
<td>This is a 14km long non-motorized transport (NMT) arterial that links a notable cycling community to the CBD. It is the first known NMT arterial to be constructed in the city, so is often used as a reference for NMT infrastructure. It was selected in this study to add variety and completeness to the evaluated projects.</td>
</tr>
</tbody>
</table>

Source: Compiled from DHV and MDC, 2005a; DHV and MDC, 2005b

4.1. Definition

The first step in developing questions for the dialogue was the review of existing literature on sustainable development and transportation planning in both developed and developing countries. Relevant concepts and terms were identified in the literature and used to develop an initial list of criteria and sub-criteria. The list was used in discussions with local system providers, selected from 15 public/private transportation agencies in Accra during June.
2010, to identify criteria and sub-criteria to be used in the study. Table 4.2 shows the different system providers that were involved in the study. Important local documents and project documentation reports mentioned above were also collected during the meetings and used to further refine the criteria and sub-criteria list. Other key contributors in the selection of the sub-criteria were local transport unions and system users. Discussions were held with members of two main transport unions – Ghana Private Road Transport Union (GPRTU) and Progressive Road Transport Owners Association (PROTOA). Discussions were also held with some selected system users to identify their concerns, needs and perceptions about the transportation system. The final list of sub-criteria were refined to reflect these needs, which tend to be attributes of the transportation system and other local urban transportation sustainability needs as shown in Table 4.3.

Table 4.2. Urban Transportation System Providers for the Accra Studies

<table>
<thead>
<tr>
<th>System Provider</th>
<th>Organization/ Stakeholder Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>National</td>
<td>Ghana Highway Authority (GHA)</td>
</tr>
<tr>
<td></td>
<td>National Road Safety Commission</td>
</tr>
<tr>
<td></td>
<td>Ministry of Transport</td>
</tr>
<tr>
<td></td>
<td>Environmental Protection Agency</td>
</tr>
<tr>
<td></td>
<td>Motor Transport and Traffic Unit (MTTU) of the Police Service</td>
</tr>
<tr>
<td></td>
<td>Vehicle Examination and Licensing Division</td>
</tr>
<tr>
<td>Local Authority</td>
<td>Department of Urban Roads</td>
</tr>
<tr>
<td></td>
<td>Center for Urban Transport</td>
</tr>
<tr>
<td></td>
<td>Department of Feeder Roads</td>
</tr>
<tr>
<td></td>
<td>Town and County Planning Department</td>
</tr>
<tr>
<td></td>
<td>Accra Metropolitan Roads Department</td>
</tr>
<tr>
<td>Public Transport Providers</td>
<td>Ghana Private Road Transport Union (GPRTU)</td>
</tr>
<tr>
<td></td>
<td>Progressive Road Transport Owners Association (PROTOA)</td>
</tr>
<tr>
<td></td>
<td>Metro Mass Transit Company</td>
</tr>
<tr>
<td>Other</td>
<td>Local and international consultants</td>
</tr>
</tbody>
</table>
The list from Table 4.3 was used to develop a set of questions to facilitate dialogue between the research team and respondents. The questions were tested on local volunteers in a pilot study carried out in Accra in August 2011. The clarity and overall flow of the questions and answers were reviewed, and the questions were edited based on feedback from the pilot study.

4.2. Capture

To apply the proposed framework, urban transportation knowledge (indigenous and scientific) was captured using 3 levels of dialogical instruments administered to 32 transportation system providers selected from the list in Table 4.2. The questionnaire was also administered to 305 system users that were randomly selected across the city as shown in Figure 4.1.
Figure 4.1. Accra Map Showing Survey Locations with Number of Respondents
The Level I questions were pairwise comparisons of the economic, social and environmental criteria, which were administered to both system users and providers. Initial tests of the questions indicated system users (i.e., general population) found pairwise comparisons difficult when more than three total choices were available. The Level II questions employed a Likert Scale that allowed the system users to convey how important they attached to each of the sixteen sustainable transportation sub-criteria. The Level III questions consist of pairwise

Table 4.4. Sample Questions

<table>
<thead>
<tr>
<th>Level</th>
<th>Type</th>
<th>Sample Question(s)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Pairwise Comparison</td>
<td>Considering how transport affects economic activities and social issues, which is more important to your daily life? • Economic activities are much more important • Economic activities are more important • They are equally important • Social issues are more important • Social issues are extremely much more important</td>
<td>This is a typical question asked to elicit relative comparison among the three primary areas of sustainability: economic, social and environmental. The questions were answered by both system users and providers.</td>
</tr>
<tr>
<td>II</td>
<td>Likert Scale</td>
<td>How important to your daily life do you consider traveling to your place of work with ease? 1. Unimportant: I do not travel to and from work. 2. Somewhat unimportant: I have many other places to go in addition to work. 3. Important: Traveling to and from work is only one of many trips I make each day. 4. Somewhat important: It is also quite important for me to travel for other reasons. 5. Very important: To go to work is the primary reason I travel.</td>
<td>The questions in this section reflect the needs, priorities and perceptions of system users.</td>
</tr>
<tr>
<td>III</td>
<td>Pairwise Comparison</td>
<td>Which local transport project would you consider better for improving overall transport system quality? • Motorway Extension project is much better • Motorway Extension project is better. • Same project impacts. • Winneba Road BRT project is better. • Winneba Road BRT project is much better.</td>
<td>These questions allowed system providers to compare potential impacts of the case study projects using their knowledge of local transport conditions and their professional/technical understanding of each project.</td>
</tr>
</tbody>
</table>
comparison of the five case study projects (Table 4.4) across the sustainability sub-criteria. Pairwise comparison of 5 projects with respect to 16 sub-criteria resulted in 100 questions. These questions required a relatively sophisticated knowledge of the potential projects and the overall transportation impacts the projects would likely have on the traveling public in Accra. As such, the Level III questions were only administered to system providers. All questions, Level I – III, were administered through direct interview allowing for clarification, explanation, and discussion throughout the process. Samples of the questions for each level are presented in Table 4.4, while the full list of all the questions is provided in Appendices A, B and C.

4.3. Integration

The LSS framework in Figure 4.2 shows the knowledge integration steps, based on a modified Analytical Hierarchy Process. This framework is used to scientifically integrate the indigenous knowledge gathered through dialogue and social learning, and the results were used to determine the LSS for candidate projects. As in the AHP structure, the goal of the study is located at the top of the hierarchy and is determined by comparing the extent to which each of the candidate projects address the locally-identified sustainability criteria and sub-criteria.

MCDM methods, including AHP, allow for the integration of different scales through the process of normalization (Sinha and Labi, 2007). Hence, in this study, the LSS framework employed a modified AHP application by introducing a Likert Scale measure for the sub-criteria comparisons, while using pairwise comparisons at the criteria and project levels. A typical 5-point Likert Scale was used to develop the sub-criteria (i.e., Level II) weightings from the system user responses.
Figure 4.2. Localized Sustainability Score (LSS) Framework

Level I – Pairwise comparisons by system users and providers of sustainability criteria.

Level II – Likert Scale comparisons by system users of 16 local sustainable transport sub-criteria.

Level III – Pairwise comparisons by system providers of potential, project impact on local sustainable transportation sub-criteria.
The pairwise comparisons in the Level I and Level III questions were reduced to a 5-point scale from its typical 9-point scale (Saaty, 2006), to simplify the respondent burden. Miller (1956) indicated that the psychological limit on the human capacity for processing information is 7±2 items. Reducing the pairwise comparison scale to a 5-point scale represents the lower bound. It is assumed that any decrease in relative sensitivity is offset by improved responses. The normalized Likert Scale and pairwise results are then integrated to determine the LSS.
CHAPTER 5 RESULTS

There were three different types of questions that were used in the dialogues with respondents. Level I questions involved pairwise comparisons of the three sustainability criteria and were administered to all respondents, which included 305 system users and 32 system providers. Level II questions involved likert-scale comparison of the sub-criteria, and were administered to the system users only, while Level III questions involved pairwise comparison of the 5 projects with respect to each of the sub-criteria, and were administered to the system providers only. The results of the analysis are presented in this section, with Figures 5.1 – 5.4 representing a breakdown of the demographics of the different system user groups involved in the study.

Figure 5.1. Income Group
Figure 5.2. Gender

Figure 5.3. Employment

Figure 5.4. Age (years)
The consistency ratio (CR) was computed for each of the responses, to establish the reliability of the information generated from the dialogue, and responses with CR values greater than 0.10 were eliminated from further consideration. Hence, only responses from a total of 100 system users and 12 system providers were used to develop the LSS for the case study projects, and Table 5.1 shows the descriptive statistics for the CR for the 100 respondents for the pairwise comparisons in both the Level I and Level III questions.

<table>
<thead>
<tr>
<th>Framework Level</th>
<th>Respondent Category</th>
<th>Average Consistency Ratio</th>
<th>Consistency Ratio Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>System Users</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>System Providers</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>III</td>
<td>System Providers</td>
<td>0.06</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Table 5.2. Level I Comparison Matrix from an Individual Response

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>1</td>
<td>3</td>
<td>1/3</td>
<td>0.26</td>
</tr>
<tr>
<td>Social</td>
<td>1/3</td>
<td>1</td>
<td>1/5</td>
<td>0.11</td>
</tr>
<tr>
<td>Environmental</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>0.64</td>
</tr>
</tbody>
</table>

The objective of the analysis for each level of the hierarchy in Figure 5.2 is to develop a prioritized list of all the elements of that Level using a comparison matrix, computed as set out by Saaty (1980). The list is built up for each level and used to develop a prioritized list for the projects listed at that level. Table 5.2 shows the comparison matrix built from an individual response to Level I questions and used to compute the priorities listed in the last column of the matrix. The results in Table 5.2 indicate that with respect to the goals of the study, this respondent considers the environmental criteria to be more important in achieving sustainable transportation. The respondent also believes that social issues are least important for achieving
sustainability. Each of the 112 respondents is represented by one such matrix. Table 5.3 shows all the responses to Level I questions combined into a single matrix, to represent the group judgment matrix. Each field of Table 5.3 corresponds to the geometric mean (GM) of corresponding fields from the individual matrices, since GM is considered the most appropriate method for synthesizing group judgment (Saaty, 2008; Awasthi and Omrani, 2009). The results in Table 5.3 shows that the group considers economic considerations to be more important for achieving sustainable transportation, while social considerations are least important. This group judgment is completely different from the individual view sampled in Table 5.2, and shows the effect of the group on the decision-making.

Table 5.3. Computation of Priorities from All Level I Responses

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Economic</th>
<th>Social</th>
<th>Environmental</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>1</td>
<td>14/7</td>
<td>12/7</td>
<td>0.42*</td>
</tr>
<tr>
<td>Social</td>
<td>5/8</td>
<td>1</td>
<td>4/5</td>
<td>0.26</td>
</tr>
<tr>
<td>Environmental</td>
<td>7/9</td>
<td>11/4</td>
<td>1</td>
<td>0.32</td>
</tr>
</tbody>
</table>

Table 5.4. Level I (General Sustainability) Priorities Among Respondent Types

<table>
<thead>
<tr>
<th>Sustainability Criteria</th>
<th>System Users</th>
<th>System Providers</th>
<th>All Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economics</td>
<td>0.40</td>
<td>0.42</td>
<td>0.42</td>
</tr>
<tr>
<td>Social</td>
<td>0.29</td>
<td>0.24</td>
<td>0.26</td>
</tr>
<tr>
<td>Environmental</td>
<td>0.31</td>
<td>0.34</td>
<td>0.32</td>
</tr>
</tbody>
</table>

As a matter of interest, the Level I priorities were calculated separately for system users and providers. The results (shown in Table 5.4) indicate that the users showed more concern towards social issues than did the system providers, whereas the providers indicated more concern for economic impacts than system users. This result shows that the sustainability
priorities of the system providers are not out of line with those of the system users in this study, but that the LSS framework is capable of capturing and documenting such differences among stakeholders.

Table 5.5. Summary of System User Ratings of Sub-Criteria (Level II Responses)

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Likert Scale</th>
<th>Geometric Mean (GM)</th>
<th>Priorities (Normalized GM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Number of Responses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Job access</td>
<td>38</td>
<td>27</td>
<td>17</td>
</tr>
<tr>
<td>2. Market access</td>
<td>22</td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>3. Education access</td>
<td>48</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>4. Reliability</td>
<td>48</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>5. Affordability</td>
<td>62</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>6. Roadside commerce</td>
<td>19</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>7. Safety</td>
<td>72</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>8. Non-Motorized Transport</td>
<td>39</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>9. Public transportation</td>
<td>57</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Social</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Healthcare access</td>
<td>61</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>11. Activity access</td>
<td>58</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>12. Personal security</td>
<td>65</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>13. Stress free travel</td>
<td>69</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>14. Neighborhood preservation</td>
<td>43</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Air pollution</td>
<td>74</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>16. Noise pollution</td>
<td>50</td>
<td>11</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 5.5 shows a summary of the Level II (Likert Scale) responses from system users. For example, 38 out of the 100 respondents scored Job access as “5”, indicating that it was extremely important to them, and 33 respondents indicated that neighborhood preservation was not a major concern to them with regard to transportation system development and provision.
The GM of the responses for each sub-criterion were computed and then normalized to represent the Level II priorities. The results in Table 5.5 are considered under the 3 sub-criteria. While public transportation and safety were considered the most important economic sub-criteria with a priority of 0.13 respectively, roadside commerce (peddling of goods by petty traders along stopped vehicles) was considered the least economic sub-criterion with a priority of 0.06. For social considerations, personal security was considered the most important sub-criterion with a priority rating of 0.22, while neighborhood preservation (impact of road projects on roadside properties) was considered the least important social sub-criterion. For environmental, air pollution is considered more important than noise pollution.

<table>
<thead>
<tr>
<th>Projects</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0.30</td>
</tr>
<tr>
<td>P2</td>
<td>1/5</td>
<td>1</td>
<td>1/3</td>
<td>3</td>
<td>1/3</td>
<td>0.11</td>
</tr>
<tr>
<td>P3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0.26</td>
</tr>
<tr>
<td>P4</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
<td>1</td>
<td>1/3</td>
<td>0.07</td>
</tr>
<tr>
<td>P5</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Table 5.7. Group Ranking of Projects with Respect to Reliability

<table>
<thead>
<tr>
<th>Projects</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>1.00</td>
<td>2.33</td>
<td>0.97</td>
<td>1.36</td>
<td>1.50</td>
<td>0.26*</td>
</tr>
<tr>
<td>P2</td>
<td>1/2.33</td>
<td>1.00</td>
<td>0.52</td>
<td>0.75</td>
<td>1.28</td>
<td>0.14</td>
</tr>
<tr>
<td>P3</td>
<td>1/0.97</td>
<td>1/0.52</td>
<td>1.00</td>
<td>1.11</td>
<td>2.29</td>
<td>0.26</td>
</tr>
<tr>
<td>P4</td>
<td>1/1.36</td>
<td>1/0.75</td>
<td>1/1.11</td>
<td>1.00</td>
<td>1.64</td>
<td>0.21</td>
</tr>
<tr>
<td>P5</td>
<td>1/1.50</td>
<td>1/1.28</td>
<td>1/2.29</td>
<td>1/1.64</td>
<td>1.00</td>
<td>0.13</td>
</tr>
</tbody>
</table>

The Level III pairwise comparisons conducted for the system providers were analyzed to ascertain the relative impact each case study project would have on each of the sixteen sub-
criteria. The analysis was conducted in the same manner as the calculations of the Level I priorities. Tables 5.6 and 5.7 show sample computations of the Level III priorities with respect to the Reliability sub-criterion, for an individual respondent and for all Level III respondents, respectively.

Table 5.8. Local Sustainability Score (LSS) for Case Study Projects

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-criteria</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic (0.42)</td>
<td>Job access (0.12)</td>
<td>0.013</td>
<td>0.007</td>
<td>0.013</td>
<td>0.014</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Market Access (0.08)</td>
<td>0.009</td>
<td>0.004</td>
<td>0.009</td>
<td>0.010</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Education access (0.12)</td>
<td>0.012</td>
<td>0.006</td>
<td>0.012</td>
<td>0.014</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Reliability (0.12)</td>
<td>0.013*</td>
<td>0.008</td>
<td>0.014</td>
<td>0.011</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Affordability (0.13)</td>
<td>0.006</td>
<td>0.006</td>
<td>0.018</td>
<td>0.008</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>Roadside commerce (0.06)</td>
<td>0.004</td>
<td>0.005</td>
<td>0.006</td>
<td>0.006</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Safety (0.13)</td>
<td>0.009</td>
<td>0.008</td>
<td>0.011</td>
<td>0.011</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>NMT (0.09)</td>
<td>0.005</td>
<td>0.006</td>
<td>0.007</td>
<td>0.007</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>Transit (0.13)</td>
<td>0.011</td>
<td>0.009</td>
<td>0.017</td>
<td>0.015</td>
<td>0.004</td>
</tr>
<tr>
<td>Social (0.26)</td>
<td>Healthcare access (0.21)</td>
<td>0.014</td>
<td>0.007</td>
<td>0.013</td>
<td>0.015</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Activity access (0.21)</td>
<td>0.014</td>
<td>0.007</td>
<td>0.013</td>
<td>0.015</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>Neighborhood preservation (0.22)</td>
<td>0.006</td>
<td>0.007</td>
<td>0.008</td>
<td>0.009</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Personal security (0.22)</td>
<td>0.013</td>
<td>0.008</td>
<td>0.015</td>
<td>0.014</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>Stress free travel (0.15)</td>
<td>0.013</td>
<td>0.008</td>
<td>0.015</td>
<td>0.014</td>
<td>0.007</td>
</tr>
<tr>
<td>Environmental (0.32)</td>
<td>Air pollution (0.55)</td>
<td>0.028</td>
<td>0.019</td>
<td>0.039</td>
<td>0.035</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>Noise pollution</td>
<td>0.023</td>
<td>0.015</td>
<td>0.033</td>
<td>0.029</td>
<td>0.047</td>
</tr>
<tr>
<td></td>
<td>Calculated project priority</td>
<td>0.193</td>
<td>0.130</td>
<td>0.244</td>
<td>0.227</td>
<td>0.209</td>
</tr>
<tr>
<td></td>
<td>Idealized project priority</td>
<td>0.794</td>
<td>0.535</td>
<td>1.000</td>
<td>0.934</td>
<td>0.860</td>
</tr>
<tr>
<td></td>
<td>Localized Sustainability Score (LSS)</td>
<td>79</td>
<td>54</td>
<td>100</td>
<td>93</td>
<td>86</td>
</tr>
</tbody>
</table>

The results from Level I, II and III analyses were combined into a term defined as the Sub-Criteria Specific Project Score (SCSPS) as represented in the fields of Table 5.8. The
SCSPS is calculated with regard to the impact project $k$ is predicted to have on sub-criteria $j$ (under criteria $i$) as follows:

$$\text{SCSPS}_{ijk} = (\text{Level I Priority})_i \cdot (\text{Level II Priority})_j \cdot (\text{Level III Priority})_k \quad \ldots \ldots (5)$$

As an example, the SCSPS of project $P1$ ($k=1$) with respect to the Reliability ($j=4$) sub-criteria under the Economic criteria ($i=1$) is calculated as $(0.42)(0.12)(0.26) = 0.13$. Table 5.8 shows all SCSPS calculated. The localized project priority is calculated as the sum of all the SCSPS for that project. Saaty (2008) suggests that priorities can be expressed as ideal priorities by taking the highest ranked project and scoring the others relative to it. The Localized Sustainability Score (LSS) then is determined as the idealized priority times 100. The calculated priority, the idealized priority, and the LSS for each case study project are shown in Table 5.8.

The results from Table 5.8 can be interpreted as follows: the Winneba Road BRT Project (P3) was the highest ranked of the case study projects with an LSS of 100. The second ranked project, the Accra-Tema Beach Road BRT (P4), was considered to be 93% as sustainable as P3 according to the locally-identified criteria. The Lashibi Road Project, P2, was scored as being the least sustainable (LSS = 54) of the five case study projects.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Category</th>
<th>Original Relative Ranking</th>
<th>LSS</th>
<th>Relative Ranking by LSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorway Extension Project (P1)</td>
<td>Roadway Projects</td>
<td>Highest</td>
<td>79</td>
<td>4</td>
</tr>
<tr>
<td>Lashibi Road Project (P2)</td>
<td></td>
<td>Lowest</td>
<td>54</td>
<td>5</td>
</tr>
<tr>
<td>Winneba Road BRT (P3)</td>
<td>BRT Projects</td>
<td>Highest</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>Accra-Tema Beach Road BRT (P4)</td>
<td></td>
<td>Lowest</td>
<td>93</td>
<td>2</td>
</tr>
<tr>
<td>Nima - CBD NMT (P5)</td>
<td>N/A</td>
<td>N/A</td>
<td>86</td>
<td>3</td>
</tr>
</tbody>
</table>

The LSS framework rankings of the five case study projects were compared to the relative rankings assigned to them in the original studies. Table 5.9 indicates that the LSS
framework preserved the original relative rankings of the projects. More importantly, the LSS framework allowed for an overall relative comparison among all five projects of different types and scopes, which was not possible with the conventional method. Under the conventional evaluation, the projects were divided into Roadway projects and Bust Rapid Transit (BRT) projects, perhaps, because the benefits of the roadway projects were easier to quantify, than the benefits that accrue to the BRT projects – which were more of social programs. So evaluating both project types with the same metrics could skew the results in favor of one particular project types. On the other hand, the LSS evaluation was able to evaluate all projects based on the same criteria and sub-criteria, with cost implications inherent in the judgment, since the project evaluators (the transportation professionals) had fair knowledge of the projects.
CHAPTER 6 DISCUSSION

In addition to evaluating projects of different types and scopes together, the LSS method also facilitates other considerations that may be difficult with conventional evaluations, such as the documentation of inputs from different target groups, and the effect of demographics on the evaluation results. Decision-makers can also run queries to have deeper understanding of the impact of projects on specific system user groups, such as safety for females, the effect of transport affordability on low income users, etc.

6.1 Capturing/Documenting Input from Target Groups

The weightings in Figure 6.1 indicate the sub-criteria specific project scores (SCSPS) assigned to the different projects by particular system user groups. One unique group of respondents that was interviewed was “work/study adults” as shown in Figure 6.1. These are educated middle aged employees, who work in a regular employment, but are also pursuing educational programs on a part-time basis. They often have an arrangement with their employers, where they close earlier than normal on some days to attend classes in the evenings, in addition to weekend classes. As shown in Figure 6.1, this group of workers is very concerned about public transportation availability as they often have short commute times between work and school. However, the self-employed, who engage in their own business enterprises, showed the most concern for public transportation availability while full-time students were the least
concerned. Perhaps the self-employed have more need for public transportation to access their businesses while the students are mostly resident on campuses. The Winneba Road BRT (P3) is considered by all the system user groups to contribute more sustainably to public transportation availability than all the other projects.

Figure 6.1. Importance of Public Transportation Availability

Figure 6.2. Public Transportation Availability With Respect to Car Ownership
onsidering Figure 6.2, both males and females who do not have personal cars show more concern for public transportation availability than those having their own cars. This means a very high demand for public transportation, since 56% of respondents do not have own cars as shown in Figure 6.9.

![Safety Concern Among Female Commuters In Accra](image)

Figure 6.3. Safety Concern Among Female Commuters In Accra

Female work/study adults show the least concern for safety compared to other female working classes (Figure 6.3). Perhaps self-employed females show more concern for safety because they travel to less safe areas of the city for business transactions and also have the need to travel very early or late into the night, while work/study adults may have more structured travel patterns and to more safe locations such as to formal work and school.
Figure 6.4 shows that medium income respondents are more concerned about transportation reliability, while lower income respondents are the least concerned. All income groups considered the Winneba Road BRT (P3) as the project that will contribute the most towards transportation reliability. This is a very busy corridor and by far has the highest traffic volume among all the roads considered. So this observation that P3 contributes more to reliability is a true reflection of the transportation system. What is interesting is that the respondents were not selected only from the areas served by this particular P3 corridor, and yet almost all respondents agreed on the importance of P3 in improving system reliability. This could some reflection of the fairness in the judgments.
It is interesting to note from Figure 6.5 that among female respondents, the self-employed are more concerned about public transport affordability. Most of these self-employed respondents are petty traders who make several work related trips and so high transportation cost could have more adverse effect on their incomes.

Figure 6.5. Public Transport Affordability

Figure 6.6. Stress Free Travel
Figure 6.6 indicates that employees and work/study adults are more concerned about stress free travel than the self-employed, perhaps because the self-employed have more flexibility in their movements, while the employees and work/study adults have more stringent time constraints. Also, the unemployed show the least concern for stress free travel, perhaps because they have more flexibility in their job search trips.

As shown in Figure 6.7, both work/study adults and the self-employed are more concerned with system reliability. It would have been expected that employees would be more concerned about reliability than the self-employed, since employees have to report at work at specific times. Perhaps the self-employed show more concern because of their personal commitments to their businesses.

From Figure 6.8, the self-employed show more concern for market access, which is more important for business transactions. Employees also show more concern for market access than
work/study adults, as employees—especially women, pass the market to engage in after work activities such as shopping or to meet other household needs.
6.2. Importance of Public Transportation

In addition to developing the relative ranking of the five Accra case study projects, the author summarized an analysis of the public transportation-related characteristics of the participatory process. While no specific mode split data were collected within the LSS framework, the dialogue ascertained the importance of public transportation. Figure 6.9 shows that only 20% of the respondents owned personal cars, and 56% do not have access to any form of personal car. About 24% reported having a car available at home, but not available for use on a regular basis. Thus, public transportation is an important mode in Accra even as car ownership increases.

The significance of public transportation in a developing country cannot be overemphasized. As shown in Figure 6.10, over 55% of all respondents considered public transportation among system users very important.

![Figure 6.10. Car Availability and Public Transportation Among System Users](image-url)
transport to be very important, irrespective of car ownership. However, it is surprising to note that a small group, less than 10%, considered public transportation to be unimportant, even among the respondents that do not have any car available to them.

Figure 6.11 shows the importance attached to public transportation by all income groups, as over 50% of all income groups considered public transportation to be very important. Hence, concern for public transportation in Accra is not limited to the poor only. Figure 6.12 shows the importance attached to public transportation by the different groups of workers. The employment group that attached the most significance to public transportation is the work/study adults, who are ordinary workers, but also attend school as part-time students.
This is a group of people to whom time is of great importance because they have to shuttle between job and evening classes within short time intervals. Most of these workers do not have a personal automobile and are dependent on public transportation. Hence, public transport is of great economic value to this group of workers. The unemployed seemed to have the least value for an efficient public transportation, as only 30% of this group considered public transport as very important, compared to over 60% for all the other employment categories. Interestingly, 40% of the unemployed respondents considered public transportation to be unimportant. Such a result either reflects a lack of mobility (or demand) on the part of the unemployed or that their travel behavior is less time constrained than those adhering to work-related schedules.

Figure 6.12 shows the relative importance of public transportation with respect to the age and gender of the respondents. About 70% of male respondents considered public transportation to be very important as compared to 55% of women respondents. Typically, more of the males
are employed in the formal sector with strict time constraints, and more women are employed in the informal sector with more flexibility in their travel needs. Less than 10% of each category considered public transportation to be unimportant. These figures imply that public transportation has some importance to more than 90% of both males and females and any difference may only be a function of external factors (job schedules, etc.).

![Figure 6.13. Gender And Public Transport Importance](image)

From Figure 6.14, all (100%) respondents over 60 years of age considered public transport to be very important, whereas only an average of 60% of respondents below the age of 60 considered public transportation to be very important. This finding could be another reflection of the transportation system in Accra, where supply is much lower than demand, so commuters struggle to board the few available vehicles. The result is that commuting becomes more stressful for the elderly, especially those above 60 years of age. So, they place more value on having an efficient public transportation system than any other age group.
6.3 Impact of Demographics on LSS

Tables 6.1 and 6.2 present the LSS results after using Level II inputs from high and low income groups (middle income responses were excluded). It is interesting to note that there were significant differences in the scores from the two groups, to the extent of changing the ranking of the NMT and one of the public transportation projects. The high income respondents scored the NMT with lower LSS than the two public transportation projects. However, the low income group scored the NMT project higher than the Tema Beach Road BRT, which is one of the public transportation projects. This means the NMT was considered more sustainable by this group than the Accra-Tema Beach Road BRT. The NMT project is more appealing to the low income respondents because walking or cycling is cheaper than any form of paid transportation services, even public transportation. This difference reflects the impact of including different system user groups in the participatory process as this helps to give different perspectives to the transportation problem.

Figure 6.14. Age And Public Transportation Importance.
Table 6.1. Summary of LSS Scorings for High Income Respondents

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Motorway Extension Project (P1)</th>
<th>Lashibi Road Project (P2)</th>
<th>Winneba Road BRT (P3)</th>
<th>Accra-Tema Beach Road BRT (P4)</th>
<th>Nima-CBD NMT Project (P5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job access</td>
<td>0.006</td>
<td>0.003</td>
<td>0.006</td>
<td>0.007</td>
<td>0.003</td>
</tr>
<tr>
<td>Market Access</td>
<td>0.003</td>
<td>0.001</td>
<td>0.003</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Education access</td>
<td>0.003</td>
<td>0.002</td>
<td>0.003</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.010</td>
<td>0.006</td>
<td>0.011</td>
<td>0.009</td>
<td>0.005</td>
</tr>
<tr>
<td>Affordability</td>
<td>0.007</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roadside commerce</td>
<td>0.003</td>
<td>0.003</td>
<td>0.004</td>
<td>0.005</td>
<td>0.004</td>
</tr>
<tr>
<td>Safety</td>
<td>0.025</td>
<td>0.022</td>
<td>0.031</td>
<td>0.031</td>
<td>0.039</td>
</tr>
<tr>
<td>NMT</td>
<td>0.004</td>
<td>0.005</td>
<td>0.006</td>
<td>0.006</td>
<td>0.012</td>
</tr>
<tr>
<td>Transit</td>
<td>0.011</td>
<td>0.009</td>
<td>0.018</td>
<td>0.015</td>
<td>0.004</td>
</tr>
<tr>
<td>Healthcare access</td>
<td>0.019</td>
<td>0.010</td>
<td>0.018</td>
<td>0.021</td>
<td>0.008</td>
</tr>
<tr>
<td>Activity access</td>
<td>0.014</td>
<td>0.007</td>
<td>0.014</td>
<td>0.016</td>
<td>0.006</td>
</tr>
<tr>
<td>Neighborhood preservation</td>
<td>0.008</td>
<td>0.008</td>
<td>0.010</td>
<td>0.012</td>
<td>0.009</td>
</tr>
<tr>
<td>Personal security</td>
<td>0.021</td>
<td>0.013</td>
<td>0.024</td>
<td>0.022</td>
<td>0.011</td>
</tr>
<tr>
<td>Stress free travel</td>
<td>0.011</td>
<td>0.007</td>
<td>0.013</td>
<td>0.012</td>
<td>0.006</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0.027</td>
<td>0.018</td>
<td>0.038</td>
<td>0.035</td>
<td>0.055</td>
</tr>
<tr>
<td>Noise pollution</td>
<td>0.015</td>
<td>0.010</td>
<td>0.022</td>
<td>0.019</td>
<td>0.031</td>
</tr>
<tr>
<td>Calculated project priority</td>
<td>0.187</td>
<td>0.13</td>
<td>0.241</td>
<td>0.225</td>
<td>0.213</td>
</tr>
<tr>
<td>Idealized project priority</td>
<td>0.776</td>
<td>0.539</td>
<td>1.000</td>
<td>0.934</td>
<td>0.884</td>
</tr>
<tr>
<td>Localized Sustainability Score (LSS)</td>
<td>78</td>
<td>54</td>
<td>100</td>
<td>93</td>
<td>88</td>
</tr>
</tbody>
</table>

More interestingly, there are sharp differences in the details of the results from the two groups. Scores for safety from the high income group for all the projects range from 0.022 to 0.039, and the low income group scores were 0.006 to 0.009, an indication that the high income group is more concerned about safety than the other group. The same trend was repeated for personal security. On the other hand, the low income group seemed to have more concern for environmental pollution than the high income group. Similarly, the poor show more concern for NMT across all the projects, scoring 0.007 to 0.020 as opposed to 0.004 to 0.012 from the higher income respondents. In addition, the low income group considered the Winneba Road BRT to contribute more to affordability, healthcare access, activity access, neighborhood preservation and stress free travel than the Accra Tema Beach Road BRT. This result shows how the LSS can
be used to bring out the needs and concerns of different groups and communities for informed decision making.

Table 6.2. Summary of LSS Scorings for Low Income Respondents

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>Motorway Extension Project (P1)</th>
<th>Lashibi Road Project (P2)</th>
<th>Winneba Road BRT (P3)</th>
<th>Accra-Tema Beach Road BRT (P4)</th>
<th>Nima-CBD NMT Project (P5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job access</td>
<td>0.007</td>
<td>0.004</td>
<td>0.007</td>
<td>0.008</td>
<td>0.003</td>
</tr>
<tr>
<td>Market Access</td>
<td>0.005</td>
<td>0.003</td>
<td>0.005</td>
<td>0.005</td>
<td>0.002</td>
</tr>
<tr>
<td>Education access</td>
<td>0.009</td>
<td>0.005</td>
<td>0.009</td>
<td>0.010</td>
<td>0.004</td>
</tr>
<tr>
<td>Reliability</td>
<td>0.009</td>
<td>0.006</td>
<td>0.010</td>
<td>0.008</td>
<td>0.005</td>
</tr>
<tr>
<td>Affordability</td>
<td>0.006</td>
<td>0.005</td>
<td>0.016</td>
<td>0.008</td>
<td>0.015</td>
</tr>
<tr>
<td>Roadside commerce</td>
<td>0.005</td>
<td>0.005</td>
<td>0.006</td>
<td>0.007</td>
<td>0.005</td>
</tr>
<tr>
<td>Safety</td>
<td>0.007</td>
<td>0.006</td>
<td>0.009</td>
<td>0.009</td>
<td>0.011</td>
</tr>
<tr>
<td>NMT</td>
<td>0.007</td>
<td>0.009</td>
<td>0.011</td>
<td>0.010</td>
<td>0.020</td>
</tr>
<tr>
<td>Transit</td>
<td>0.012</td>
<td>0.009</td>
<td>0.018</td>
<td>0.016</td>
<td>0.004</td>
</tr>
<tr>
<td>Healthcare access</td>
<td>0.014</td>
<td>0.007</td>
<td>0.013</td>
<td>0.015</td>
<td>0.006</td>
</tr>
<tr>
<td>Activity access</td>
<td>0.011</td>
<td>0.006</td>
<td>0.011</td>
<td>0.012</td>
<td>0.005</td>
</tr>
<tr>
<td>Neighborhood preservation</td>
<td>0.004</td>
<td>0.004</td>
<td>0.005</td>
<td>0.005</td>
<td>0.004</td>
</tr>
<tr>
<td>Personal security</td>
<td>0.010</td>
<td>0.006</td>
<td>0.012</td>
<td>0.011</td>
<td>0.005</td>
</tr>
<tr>
<td>Stress free travel</td>
<td>0.013</td>
<td>0.008</td>
<td>0.015</td>
<td>0.014</td>
<td>0.006</td>
</tr>
<tr>
<td>Air pollution</td>
<td>0.034</td>
<td>0.023</td>
<td>0.049</td>
<td>0.044</td>
<td>0.069</td>
</tr>
<tr>
<td>Noise pollution</td>
<td>0.031</td>
<td>0.021</td>
<td>0.045</td>
<td>0.040</td>
<td>0.064</td>
</tr>
<tr>
<td>Calculated project priority</td>
<td>0.184</td>
<td>0.127</td>
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<td>0.222</td>
<td>0.228</td>
</tr>
<tr>
<td>Idealized project priority</td>
<td>0.763</td>
<td>0.527</td>
<td>1.000</td>
<td>0.921</td>
<td>0.946</td>
</tr>
<tr>
<td>Localized Sustainability Score (LSS)</td>
<td>76</td>
<td>53</td>
<td>100</td>
<td>92</td>
<td>95</td>
</tr>
</tbody>
</table>

Table 6.3. Summary of LSS Scorings for Candidate Projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Localized Sustainability Score (LSS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original</td>
</tr>
<tr>
<td>Motorway Extension Project (P1)</td>
<td>79</td>
</tr>
<tr>
<td>Lashibi Road Project (P2)</td>
<td>54</td>
</tr>
<tr>
<td>Winneba Road BRT (P3)</td>
<td>100</td>
</tr>
<tr>
<td>Accra-Tema Beach Road BRT (P4)</td>
<td>93</td>
</tr>
<tr>
<td>Nima-CBD NMT Project (P5)</td>
<td>86</td>
</tr>
</tbody>
</table>

Table 6.3 summarizes the original LSS scores that were computed from all responses along with the results from low and high income respondents only. Considering the original scores, the public transportation projects Winneba Road BRT and Tema Beach Road BRT...
projects were scored highest, receiving the LSS of 100 and 93 respectively. This result reflects the significance of public transportation to all the respondents who believed that such projects have the potential to promote transportation sustainability in Accra. It is interesting to note how the low income respondents scored the Nima - CBD Project. This project is a non-motorized transport route that serves as a link between an impoverished community (Nima) and the central business district and is utilized mostly by the low income commuters. What is even more interesting is that the respondents were selected from all across Accra (not merely Nima) and yet all the low income respondents attached high significance to this project. This result again shows how unbiased the LSS process could be, capturing the true need of the people.
CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

A framework for screening urban transportation projects according to a locally-specific set of sustainability criteria was developed and presented in the form of a case study. The following sections present the primary conclusions gleaned from the research and recommendations for future work on which to further develop the LSS framework as a transportation planning tool for developing countries.

7.1 Conclusions

The following conclusions from the limited (i.e., five projects) case study are evidence that the LSS Framework produced a prioritized list of candidate projects that adequately represent the needs and expectations of the public and the professional judgment of local transportation professional. Hence, it can be concluded that there is a benefit to indigenous knowledge in transportation planning.

The LSS rankings determined for the roadway projects matched the rankings that had been developed previously using the standard conventional method, as did the LSS rankings calculated for the BRT projects.

The locally-specific relative rankings among different projects allow transportation planners and policy makers to prioritize and/or eliminate candidate projects for further consideration. In addition, determination of the LSS fosters objectivity and accountability in the
overall urban transportation decision-making process. Development and application of the proposed LSS framework does not require extensive collection of quantitative data. Instead, project priority lists can be generated by engaging stakeholders in series of dialogues that are guided by carefully designed questionnaires, and analyzed using multi-criteria decision-making methods.

In its current form, the LSS framework is a spreadsheet-based application that is relatively easy to use, understand/explain and does not require sophisticated computational capabilities or specialized software. As such, it can be easily integrated into the planning process as a cost-effective means of screening projects for further study and development, and can be used in lieu of quantitative data. It can also be used as a tool to document a part of the project selection process, specifically stakeholder participation, to funding agencies and donor organizations, thus directly using indigenous knowledge to enhance urban transportation delivery in developing countries.

The limited demographic analyses presented herein showed different responses among different types/groups of system users. For example, the results indicate that levels of car ownership in Accra are still low enough that public transportation is the primary alternative by which majority of residents meet their mobility needs. In Accra public transportation is a very important mode irrespective of income, age, car ownership or employment status. This means an unsustainable public transportation could have a negative impact on the economic and social development of numerous residents, particularly on young work/study adults who make more work and school related trips. The study has also shown that men have more strict mobility needs than women and the elderly place more value on an efficient public transportation system. Identification and documentation of such specific findings will improve the decision-making
process and may ultimately lead to more sustainable transportation systems in developing countries.

7.2 Recommendations for Future Research

There are few important recommended future efforts to further the development and applicability of the LSS framework. It is recommended that a software-based dialogue tool be developed to enhance the knowledge capture step. Specifically, it is recommended that an application be developed for use on a handheld device (tablet PC, iPad, etc.) that facilitates further interactivity during the dialogue. A software application could be developed such that both parties in the dialogue could interact with the questions/responses. Instead of a strict discrete set of choices (i.e., 1 = most important, 5 = least important), the software could allow even more qualitative responses (e.g., sliding scales where respondents point to or move a cursor to indicate their responses).

A carefully design software application could ease the process of capturing knowledge and thus make it more feasible to increase the complexity of the framework application by:

- Increasing the number of individuals engaging in dialogues. The process would flow more smoothly, allowing for more interviews to be performed during a given knowledge capture timeframe.

- Increase the quality of the dialogue by designing interactive questions/response mechanisms that foster more thoughtful responses.

- Increasing the number of candidate projects for consideration/comparison as a result of an improved dialogue interface.
Of particular usefulness would be the inclusion of an interactive map into the dialogue that allowed respondents to indicate where they live, where they travel for different purposes, etc. using a simple touchscreen interface. While such information would not be captured for the purposes of developing origin-destination patterns, it would provide spatial richness to the qualitative needs and perceptions identified through the knowledge capture from system users. Candidate projects could be mapped and then the system user information could be overlain to enhance the knowledge integration provided by the system providers as to the predicted impacts candidate projects.

The most significant opportunity for future research is to refine the LSS framework and test it under different applications. For example, it needs to be tested in other urban areas with different demographics, cultures and transportation challenges. Specifically, a sample of test locations should be identified and the LSS framework (based on the basic form presented herein) should be developed and applied in each. The ability of the framework to adequately represent past decisions and the extent to which it captures a range of system user/provider knowledge in each location can then be evaluated. Common aspects from each application can then be worked into a core framework that serves as the basis for a generalized decision-making and documentation tool. Examination of the differences among the varied applications could then be developed into guidance for how the tool can be customized for use in individual cases.

Finally, although the LSS has been primarily presented as a tool for use in urban areas within developing countries, there is considerable potential for its use at the regional, or even national, levels to facilitate project screening and prioritization. Such applications could encompass rural locations or larger, more diverse populations where indigenous issues may be more acute. Consideration and documentation of such conditions in the transportation planning
process could greatly enhance both the sustainability of transportation projects in developing countries and the perception thereof.
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APPENDIX A
REQUEST FOR EXPRESSION OF INTEREST (REI)

Country/Region: Worldwide
Publication Date: Jul 31, 2009
Contract Award Add Contract Award
Notice/Contract Number: WB3235-757/09 P117267

Project Summary

Country: World Bank
Project: SUSTAINABILITY AUDIT OF TRANSPORT PROJECTS
Financing: World Bank
Abstract: SELECTION OF CONSULTANTS BY THE WORLD BANK
Sector: Consultants
Loan/Credit
Number: P117267 (Sustainability audit of transport project)

Contract/Bid
Number: REQUEST FOR EXPRESSIONS OF INTEREST
Deadline: 30 August 2009

Assignment Country: World
Assignment Description:
For many years development banks and donor agencies have been involved with implementing transport projects in low
and middle income countries. Some projects have been a successful in achieving the stated objectives with services continuing and infrastructure existing and maintained many years after construction. Long-term monitoring of a projects outcome and long-term sustainability is scarce and more information is needed on the components that reinforce a projects long-term viability and those components that do not. Donor agencies support projects and programs in the transport sector with the main goal of promoting the recipient country's development agenda. Such support often aims to transfer knowledge, increase awareness and mainstream new technologies and methodologies that will make a positive and lasting impact in solving transport problems in developing countries. The objective is to contribute to poverty reduction in general and help achieve the Millennium Development Goals (MDGs). The donor support phase usually has a limited time frame with the expectation that the host nation will become aware of the potential benefits of the project and will embed the initiatives into national policies and strategies. When this does happen, the initiatives can be said to be mainstreamed with high prospects of their continuance and resulting long-lasting benefits. Unfortunately, some initiatives, however potentially beneficial they may be to the recipient country, often fall away within a relatively short period after donor support is withdrawn. When this happens, the substantial human and financial investment in the research or development initiative by both donor and recipient country agencies is often wasted. Even more damaging for local poor communities are circumstances where improvements in livelihoods, which began under the initiatives, are reversed when they fail. Some lessons have been learnt and the WB document "Assessing Development Effectiveness" provides guidance on assessing reliable feedback from projects. However, it would be preferable to have a more comprehensive framework for assessing the prospects for sustainability before projects are implemented such as by undertaking a Project Sustainability Audit. Some of the factors under which an assessment could be made are given below in sustainability diagram but other factors could also emerge from the study. It is expected that various recommendations could also emerge for improving sustainability such as increasing the role of communities, increasing the spread of political commitment, increasing the contractual commitment by DC's for sustainable funding, improved commitments for capacity building, setting targets for the technology transfer and training components in projects and monitoring progress, etc. The project would build on the work of the IEG and the evidence contained in the PPAR's together with consultation with developing country partners. Seven components that impact on sustainability of projects in the transport sector will be examined. Other factors such as culture or gender affecting knowledge transfer and sustainability may also be relevant and these and others may be related specifically to local circumstances.

Deliverables
- The development of a Project Sustainability Audit. This would be a framework of indicators to assess the potential for the project to be sustainable into a longer-term. These indicators will cover the expected opportunities and constraints related to sustainability.
- A procedure will be developed which will enable projects to be ranked expeditiously under each of the appropriate indicators before projects are initiated.

Funding Source:
The World Bank intends to finance the assignment/services described below under a budget allocation for the Bank's administrative budget.

Eligibility:
There are no eligibility restrictions.

Individual/Firm Profile: The consultant will be a firm or consortium.

Submission Requirements:
The World Bank now invites eligible consultants to indicate their interest in providing the services. Interested consultants must provide information indicating that they are qualified to perform the services (brochures, description of similar assignments, experience in similar conditions, availability of appropriate skills among staff, etc.).
Consultants may associate to enhance their qualifications.

Interested consultants are hereby invited to submit expressions of interest.


Notes:
Consultants will be selected in accordance with the procedures set out in the current edition of the World Bank's Guidelines: Selection and Employment of Consultants by World Bank Borrowers.

Following this invitation for Expression of Interest, a shortlist of qualified firms will be formally invited to submit proposals. Shortlisting and selection will be subject to the availability of funding.

Relevant Qualifications:
1. Interested consultants should provide information showing that they are qualified in the field of assignment.
2. Interested consultants should provide information on the technical and managerial capabilities of the firm.
3. Interested consultants should provide information on their core business and years in business.
4. Interested consultants should provide information on the qualifications of key staff.
5. Interested consultants should provide information on how the consultancy would undertake this work and what they would deliver.

Contact: Peter O'Neill
(202) 458-5185.
poneill@worldbank.org
May 22, 2012

Moses Tefe
Dept of Civil Engineering
College of Engineering
Box 870205

Re: IRB#: 11-OR-141-R1 "Integration of Indigenous and Scientific Knowledge for Sustainable Urban Transportation Planning in Developing Countries: A Case Study of Accra, Ghana"

Dear Mr. Tefe

The University of Alabama Institutional Review Board has granted approval for your renewal application.

Your protocol has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on May 20, 2013. If your research will continue beyond this date, complete the relevant portions of the IRB Renewal Application. If you wish to modify the application, complete the Modification of an Approved Protocol Form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, complete the appropriate portions of the IRB Request for Study Closure Form.

Should you need to submit any further correspondence regarding this proposal, please include the above application number.

Good luck with your research.

Sincerely,

Carpaneto T. Myles, MSM, CIM
Director & Research Compliance Officer
Office of Research Compliance
The University of Alabama

358 Rose Administration Building
Box 870127
Tuscaloosa, Alabama 35487-0127
(205) 348-9861
fax (205) 348-9189
TOLL FREE (877) 820-3066
UNIVERSITY OF ALABAMA
INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

I. Identifying information

Principal Investigator: Moses Tefo
Second Investigator: Steven Jones PhD
Third Investigator

Names: Moses Tefo
Department: Civil, Constr & Env. Eng.
College: Engineering
University: Alabama
Address: Box 870205
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FAX:
E-mail: kwamtef@yahoo.com

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Box 870205
sjones@eng.ua.edu

Title of Research Project: Integration of Indigenous and Scientific Knowledge for Sustainable Urban Transportation Planning in Developing Countries: A Case Study of Accra, Ghana

Date Submitted: May 7, 2012
Funding Source: None

Type of Proposal: □ New  □ Revision  ☑ Renewal
Please attach a renewal application
☐ Completed  ☐ Exempt
Please attach a continuing review of studies form
Please enter the IRB # at the top of the page

UA faculty or staff member signature:

II. NOTIFICATION OF IRB ACTION (to be completed by IRB):
Type of Review: _______ Full board  ☑ Expedited

IRB Action:
☐ Rejected  Date:
☐ Tabled Pending Revisions  Date:
☐ Approved Pending Revisions  Date:
☐ Approved - this proposal complies with University and federal regulations for the protection of human subjects.

Approval is effective until the following date: 5/20/2013

Items approved: ☑ Research protocol (dated________)
☐ Informed consent (dated________)
☐ Recruitment materials (dated________)

Approval signature  Date 5/22/2013
APPENDIX C

LEVEL I QUESTIONNAIRE FOR ALL RESPONDENTS

Integration of Indigenous and Scientific Knowledge for Sustainable Urban Transport Planning in Developing Countries: A Case Study of Accra, Ghana

Please help us answer a few questions about transport in Accra. Some of the questions may look quite repetitive, so please think about them a minute before answering. Thanks.

Transport affects economic activities such as the ability to travel easily to work, market, school, etc. Transport affects social issues such as allowing access to friends and family, church, leisure activities, etc. Transport can also have effects on the environment such as air pollution, noise and impacting water quality.

1.1. Considering how transport affects economic activities and social issues, which is more important to your daily life?

- [ ] Economic activities are extremely more important
- [ ] Economic activities are more important
- [ ] They are the same
- [ ] Social issues are more important
- [ ] Social issues are extremely more important

1.2. Considering how transport affects economic activities and environmental issues, which is more important to your daily life?

- [ ] Economic activities are extremely more important
- [ ] Economic activities are more important
- [ ] They are the same
- [ ] Environmental issues are more important
- [ ] Environmental issues are extremely more important
1.3. Considering how transport affects social issues and environmental issues, which is more important to your daily life?

- Social issues are extremely more important
- Social issues are more important
- They are the same
- Environmental issues are more important
- Environmental issues are extremely more important
APPENDIX D

LEVEL II QUESTIONNAIRE FOR SYSTEM PROVIDERS

Regional Mobility - Potential for transport project to improve overall ability to move throughout the GAMA area (e.g., commuting from suburbs, going to market on other side of town). Which local transport project would you consider better in providing/improving regional mobility?

1.5. The Motorway Extension Project or the Lashibi Road Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better
- Lashibi Road extremely better

1.6. The Motorway Extension Project or the Winneba Road BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.7. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.8. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.9. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.10. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better
1.11. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
   - Lashibi Road Project extremely better
   - Lashibi Road Project better
   - Accra-Tema Beach Rd BRT better
   - Accra-Tema Beach Rd BRT extremely better
   - Both are same

1.12. The Winneba Road BRT Project or the Nima-CBD NMT Project?
   - Winneba Road BRT extremely better
   - Winneba Road BRT better
   - Nima-CBD NMT better
   - Nima-CBD NMT extremely better
   - Both are same

1.13. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
   - Winneba Road BRT extremely better
   - Winneba Road BRT better
   - Accra Tema Beach Rd BRT better
   - Accra Tema Beach Rd BRT extremely better
   - Both are same

1.14. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
   - Nima-CBD NMT extremely better
   - Nima-CBD NMT better
   - Accra Tema Beach Rd BRT better
   - Accra Tema Beach Rd BRT extremely better
   - Both are same

1.15. The Motorway Extension Project or the Lashibi Road Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Lashibi Road better
   - Lashibi Road extremely better
   - Both are same

1.16. The Motorway Extension Project or the Winneba Road BRT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Winneba Road BRT better
   - Winneba Road BRT extremely better
   - Both are same

1.17. The Motorway Extension Project or the Nima-CBD NMT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Nima-CBD NMT better
   - Nima-CBD NMT extremely better
   - Both are same

1.18. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Accra-Tema Beach Rd BRT better
   - Accra-Tema Beach Rd BRT extremely better
   - Both are same

Local Access - Potential for transport project to provide/improve overall accessibility to individual land uses and destinations (places of employment, markets, schools, churches, etc.). Which local transport project would you consider better in providing/improving local access?
1.19. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.20. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better

1.21. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
- Lashibi Road Project extremely better
- Lashibi Road Project better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.22. The Winneba Road BRT Project or the Nima-CBD NMT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.23. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

1.24. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
- Nima-CBD NMT extremely better
- Nima-CBD NMT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

Reliability - Potential for transport project to improve consistency of departure/arrival times, travel time duration (e.g., knowing that it takes 30 minutes to get to work each morning without significant variation).

Which local transport project would you consider better in ensuring/improving transport reliability?

1.25. The Motorway Extension Project or the Lashibi Road Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better
- Lashibi Road extremely better

1.26. The Motorway Extension Project or the Winneba Road BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better
1.27. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.28. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.29. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.30. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better

1.31. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
- Lashibi Road Project extremely better
- Lashibi Road Project better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.32. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road Project extremely better
- Lashibi Road Project better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.33. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

1.34. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
- Nima-CBD NMT extremely better
- Nima-CBD NMT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better
Affordability - Potential for transport project to reduce overall travel costs for system users while maintaining quality services. Which local transport project would you consider better in providing affordable transport for the most users?

1.35. The Motorway Extension Project or the Lashibi Road Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better

1.36. The Motorway Extension Project or the Winneba Road BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better

1.37. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Nima-CBD NMT better

1.38. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Accra-Tema Beach Rd BRT better

1.39. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better

1.40. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better

1.41. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Accra-Tema Beach Rd BRT better

1.42. The Winneba Road BRT Project or the Nima-CBD NMT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Nima-CBD NMT better
<table>
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<td>1.43</td>
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<td>- Both are same</td>
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Environmental Impact - Potential for transport project to reduce environmental impact such as vehicle emissions (local air pollution and greenhouse gas), noise and impacts to water systems and other local ecosystems. Which local transport project would you consider better in reducing emissions, noise and other environmental impacts?

<table>
<thead>
<tr>
<th>Q</th>
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1.51. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
   - Lashibi Road Project extremely better
   - Lashibi Road Project better
   - Both are same
   - Accra-Tema Beach Rd BRT better
   - Accra-Tema Beach Rd BRT extremely better

1.52. The Winneba Road BRT Project or the Nima-CBD NMT Project?
   - Winneba Road BRT extremely better
   - Winneba Road BRT better
   - Both are same
   - Nima-CBD NMT better
   - Nima-CBD NMT extremely better

1.53. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
   - Winneba Road BRT extremely better
   - Winneba Road BRT better
   - Both are same
   - Accra Tema Beach Rd BRT better
   - Accra Tema Beach Rd BRT extremely better

1.54. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
   - Nima-CBD NMT extremely better
   - Nima-CBD NMT better
   - Both are same
   - Accra Tema Beach Rd BRT better
   - Accra Tema Beach Rd BRT extremely better

1.55. The Motorway Extension Project or the Lashibi Road Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Both are same
   - Lashibi Road better
   - Lashibi Road extremely better

1.56. The Motorway Extension Project or the Winneba Road BRT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Both are same
   - Winneba Road BRT better
   - Winneba Road BRT extremely better

1.57. The Motorway Extension Project or the Nima-CBD NMT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Both are same
   - Nima-CBD NMT better
   - Nima-CBD NMT extremely better

1.58. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
   - Motorway Extension extremely better
   - Motorway Extension better
   - Both are same
   - Accra-Tema Beach Rd BRT better
   - Accra-Tema Beach Rd BRT extremely better

Land Use Impacts - Potential impacts a transport project will likely have on existing or future land use in its immediate vicinity (including roadside commerce, residential displacement and relocation of roadside properties etc.). Which local transport project would you consider to have better impact on existing land use in the immediate vicinity?

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better
- Lashibi Road extremely better

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better
1.59. The Lashibi Road Project or the Winneba Road BRT Project?

- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.60. The Lashibi Road Project or the Nima-CBD NMT Project?

- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better

1.61. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?

- Lashibi Road Project extremely better
- Lashibi Road Project better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.62. The Winneba Road BRT Project or the Nima-CBD NMT Project?

- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.63. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?

- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

1.64. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?

- Nima-CBD NMT extremely better
- Nima-CBD NMT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

Transport Safety - Potential that transport project will reduce crashes and improve overall safety for the most system users (e.g., passenger cars, trotro, bus, walking, cycling, etc.). Which local transport project would you consider better for crash reduction and improvement of overall safety?

1.65. The Motorway Extension Project or the Lashibi Road Project?

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better
- Lashibi Road extremely better

1.66. The Motorway Extension Project or the Winneba Road BRT Project?

- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better
1.67. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same

1.68. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Accra-Tema Beach Rd BRT better
- Both are same

1.69. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Winneba Road BRT better
- Both are same

1.70. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Nima-CBD NMT Project better
- Both are same

1.71. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
- Lashibi Road Project extremely better
- Accra-Tema Beach Rd BRT better
- Both are same

1.72. The Winneba Road BRT Project or the Nima-CBD NMT Project?
- Winneba Road BRT extremely better
- Nima-CBD NMT better
- Both are same

1.73. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
- Winneba Road BRT extremely better
- Accra Tema Beach Rd BRT better
- Both are same

1.74. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
- Nima-CBD NMT extremely better
- Accra Tema Beach Rd BRT better
- Both are same
### Transport System Quality - Potential for transport project to improve overall quality of transport experience for users (enhanced comfort, improved personal security, reduced stress, enhanced usability for disabled persons, etc.). Which local transport project would you consider better for improving overall transport system quality?

1.75. The Motorway Extension Project or the Lashibi Road Project?
- Motorway Extension extremely better
- Motorway Extension better
- Lashibi Road better
- Lashibi Road extremely better
- Both are same

1.76. The Motorway Extension Project or the Winneba Road BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Winneba Road BRT better
- Winneba Road BRT extremely better
- Both are same

1.77. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Nima-CBD NMT better
- Nima-CBD NMT extremely better
- Both are same

1.78. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better
- Both are same

1.79. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Winneba Road BRT better
- Winneba Road BRT extremely better
- Both are same

1.80. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better
- Both are same

1.81. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?
- Lashibi Road Project extremely better
- Lashibi Road Project better
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better
- Both are same

1.82. The Winneba Road BRT Project or the Nima-CBD NMT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Nima-CBD NMT better
- Nima-CBD NMT extremely better
- Both are same

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1.83. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?
- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

1.84. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?
- Nima-CBD NMT extremely better
- Nima-CBD NMT better
- Both are same
- Accra Tema Beach Rd BRT better
- Accra Tema Beach Rd BRT extremely better

Non-Motorized Transport (NMT) - Potential for transport project to provide/improve accommodations for NMT (pedestrians (especially children), bicycles, pull carts, etc.). Which local transport project would you consider better for enhancing non-motorized transport?

1.85. The Motorway Extension Project or the Lashibi Road Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Lashibi Road better
- Lashibi Road extremely better

1.86. The Motorway Extension Project or the Winneba Road BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.87. The Motorway Extension Project or the Nima-CBD NMT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Nima-CBD NMT better
- Nima-CBD NMT extremely better

1.88. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?
- Motorway Extension extremely better
- Motorway Extension better
- Both are same
- Accra-Tema Beach Rd BRT better
- Accra-Tema Beach Rd BRT extremely better

1.89. The Lashibi Road Project or the Winneba Road BRT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Winneba Road BRT better
- Winneba Road BRT extremely better

1.90. The Lashibi Road Project or the Nima-CBD NMT Project?
- Lashibi Road extremely better
- Lashibi Road better
- Both are same
- Nima-CBD NMT Project better
- Nima-CBD NMT Project extremely better
1.91. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?

☐ Lashibi Road Project extremely better
☐ Accra-Tema Beach Rd BRT extremely better
☐ Lashibi Road Project better
☐ Accra-Tema Beach Rd BRT better
☐ Both are same

1.92. The Winneba Road BRT Project or the Nima-CBD NMT Project?

☐ Winneba Road BRT extremely better
☐ Nima-CBD NMT extremely better
☐ Winneba Road BRT better
☐ Nima-CBD NMT better
☐ Both are same

1.93. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?

☐ Winneba Road BRT extremely better
☐ Accra Tema Beach Rd BRT extremely better
☐ Winneba Road BRT better
☐ Accra Tema Beach Rd BRT better
☐ Both are same

1.94. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?

☐ Nima-CBD NMT extremely better
☐ Accra Tema Beach Rd BRT extremely better
☐ Nima-CBD NMT better
☐ Accra Tema Beach Rd BRT better
☐ Both are same

Public Transport - Potential that transport project will provide/improve public transport operations.

Which local transport project would you consider better for enhancing public transport?

1.95. The Motorway Extension Project or the Lashibi Road Project?

☐ Motorway Extension extremely better
☐ Lashibi Road better
☐ Motorway Extension better
☐ Lashibi Road extremely better
☐ Both are same

1.96. The Motorway Extension Project or the Winneba Road BRT Project?

☐ Motorway Extension extremely better
☐ Winneba Road BRT better
☐ Motorway Extension better
☐ Winneba Road BRT extremely better
☐ Both are same

1.97. The Motorway Extension Project or the Nima-CBD NMT Project?

☐ Motorway Extension extremely better
☐ Nima-CBD NMT better
☐ Motorway Extension better
☐ Nima-CBD NMT extremely better
☐ Both are same

1.98. The Motorway Extension Project or the Accra-Tema Beach Rd BRT Project?

☐ Motorway Extension extremely better
☐ Accra-Tema Beach Rd BRT better
☐ Motorway Extension better
☐ Accra-Tema Beach Rd BRT extremely better
☐ Both are same
1.99. The Lashibi Road Project or the Winneba Road BRT Project?

- Lashibi Road extremely better
- Lashibi Road better
- Both are same

1.100. The Lashibi Road Project or the Nima-CBD NMT Project?

- Lashibi Road extremely better
- Lashibi Road better
- Both are same

1.101. The Lashibi Road Project or the Accra-Tema Beach Rd BRT Project?

- Lashibi Road Project extremely better
- Lashibi Road Project better
- Both are same

1.102. The Winneba Road BRT Project or the Nima-CBD NMT Project?

- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same

1.103. The Winneba Road BRT Project or the Accra Tema Beach Rd BRT Project?

- Winneba Road BRT extremely better
- Winneba Road BRT better
- Both are same

1.104. The Nima-CBD NMT Project or the Accra Tema Beach Rd BRT Project?

- Nima-CBD NMT extremely better
- Nima-CBD NMT better
- Both are same
APPENDIX E

LEVEL III QUESTIONNAIRE FOR SYSTEM USERS

System User Relative Sustainability Ratings

Economic issues - The effect of transport on economic activities such as the ability to travel easily to work, market, school, etc.

1.105. How important to your daily life do you consider travelling to your place of work with ease?

☐ Very important. To go to work is the primary reason I travel.

☐ Somehow important. It is also quite important for me to travel for other reasons.

☐ Important. Travelling to and from work is only one of many trips I make each day.

☐ Somehow unimportant. I have many other important places to go in addition to work.

☐ Unimportant. I do not travel to and from work.

1.106. How important to your daily life do you consider the ease of travelling to the market/for shopping?

☐ Very important. It is essential that I travel to and from the market everyday

☐ Somehow important. It is also quite important for me to travel for other reasons.

☐ Important. Travelling to and from the market is only one of many trips I make each day.

☐ Somehow unimportant. I have many other important places to go in addition to the market.

☐ Unimportant. I do not travel to and from the market regularly.

1.107. How important to your daily life do you consider the ease of travelling to school (for you or children in your family)?

☐ Very important. Travel to and from school is difficult. It just concerns me very much.

☐ Somehow important. I am concerned about travel to and from school but also worry about travel for other reasons.

☐ Important.

☐ Somehow unimportant. I am not so concerned about travel to and from school because I worry more about travel for other reasons.

☐ Unimportant. Travel to and from school is easy. It does not concern me very much.
1.108. How important to your daily life is it for you to have your regular means of transport be on time and for you to be able to rely on how much time each journey will take?

- Very important. My travel demands are quite strict. I currently cannot rely on transportation to be consistent.
- Somehow unimportant.
- Somehow important.
- Important.

1.109. Do you think it is important to make transport affordable for all?

- Very important. Because transport is key to development.
- Somehow unimportant.
- Somehow important.
- Unimportant. People must pay economic rates to ensure the best transport system possible can be provided and maintained.

1.110. What importance to your daily life do you attach to onstreet selling in Accra?

- Very important. It provides income for sellers and convenience for travellers.
- Somehow unimportant.
- Unimportant. It is unsafe and slows down traffic.

1.111. How important to your daily life do you consider traffic safety when travelling around in Accra?

- Very important. The roads are unsafe and there is much to worry about.
- Somehow unimportant.
- Unimportant. Travelling in Accra is very safe.

1.112. How important to your daily life do you consider the ability to walk, ride a bicycle or use a pull cart in Accra?

- Very important. There is too much traffic and public transport is very unreliable.
- Somehow unimportant.
- Unimportant. Those activities are very unsafe. So I do not think at all about using them.

1.113. How important to your daily life do you consider a good public transport in Accra (trotro, bus, taxi, train, etc.)?

- Very important. That is the only means available for me to travel around.
- Somehow unimportant.
- Unimportant. I don't use it.
Social issues - The effect of transport on social issues such as allowing access to friends and family, church, leisure activities, etc.

1.114. How important to your daily life do you consider the ease of travelling to the hospital?

☐ Very important. When I am sick, I cannot wait any long to get to the hospital

☐ Somehow unimportant

☐ Unimportant. Travelling to the hospital is a rare occurrence, there are more pressing travel needs.

☐ Important

1.115. How important to your daily life do you consider the ease of travelling for other activities apart from work, market and school (e.g., church, visiting friends and family, leisure activities)?

☐ Very important. Those activities are important for my social life.

☐ Somehow unimportant

☐ Unimportant. Those activities are less crucial and so leave more room to manoeuvre

☐ Important

1.116. How important do you consider safety from criminals when travelling within Accra?

☐ Very important. It is a huge concern, particularly for night travel

☐ Somehow unimportant

☐ Unimportant. You only have to be careful when you travel

☐ Important

1.117. How important do you consider a stress free travel within Accra?

☐ Very important. Travel should be fun and not be under stress

☐ Somehow unimportant

☐ Unimportant. What is important is getting to your destination

☐ Important

1.118. How important do you consider the effect of transportation projects on roadside properties and the relocation of affected people?

☐ Very important. Transport projects should not have negative effect on anybody

☐ Somehow unimportant

☐ Unimportant. When people follow the rules, they should not be affected by projects

☐ Important

1.119. How important do you consider the quality of public transportation in Accra?

☐ Very important. That will attract many car owners to use public transport.

☐ Somehow unimportant

☐ Unimportant. Quality is not much of an issue, once I can be transported to my destination.

☐ Important
Environmental issues - The effect of transport on the environment such as air pollution, noise and impacting water quality.

1.120. How important do you consider having reduced exposure to air pollution from vehicles?
- Very important. This is a health issue and that is what makes it important
- Somehow important
- Unimportant. It is not an issue, because I do not live too close to the road.
- Important

1.121. How important will you consider reduced noise from transportation sources?
- Very important. It is a social nuisance that should be avoided
- Somehow important
- Unimportant. I just do not have to live close to the route.
- Important

Socio-economic and demographic characteristics of respondents

2.1. Gender?
- Male
- Female

2.2. Age?
- Below 18 yrs
- 19 yrs - 30 yrs
- 31 yrs - 40 yrs
- 41 yrs - 50 yrs
- 51 yrs - 60 yrs
- Over 60 yrs

2.3. Employment status?
- Business owner
- Employee
- Student
- Unemployed
- Student/worker

2.4. In which income group will you put yourself or your family?
- Low income
- Middle income
- High income

2.5. Which of the following best describes your home situation?
- Full time student
- Single person
- Single parent family with children
- Unmarried couple with children
- Married couple without children
- Married couple with children

2.6. Car availability?
- I own a car
- There is a car in the house, that is available to me some of the times
- don't have access to any private car

2.7. Which suburb of Accra do you live?
APPENDIX F

EXCEL SPREADSHEET FOR AHP COMPUTATIONS
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Group Result Summary for 100 Respondents
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123
<p>| Level III Responses: Comparison Matrix for Selected Transportation Professional Responses |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| <strong>Reliability</strong> | <strong>Roadside Commerce</strong> | <strong>Transport safety</strong> | <strong>Summary</strong> | <strong>Priorities</strong> |
| P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | CR | 0.00 |
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| 1.0 | 1.0 | 0.2 | 1.0 | 3.0 | 0.3 | 0.3 | 0.1 | | | | | | | | | |
| 1.0 | 0.2 | 1.0 | 3.0 | 1.0 | 0.2 | | | | | | | | | | |
| 1.0 | 5.0 | 5.0 | 0.6 | | | | | | | | | | | | |
| 1.0 | 1.0 | 1.0 | 0.1 | | | | | | | | | | | | |
| P5 | 1.0 | 0.1 | | | | | | | | | | | | | |
| CR | 0.00 | | | | | | | | | | | | | |
| <strong>Summary</strong> | <strong>Affordability</strong> | <strong>Environment Impact</strong> | <strong>Roadside Commerce</strong> | <strong>Transport safety</strong> |
| P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | CR | 0.07 |
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| 1.0 | 1.0 | 0.2 | 1.0 | 0.2 | | | | | | | | | | | | |
| 1.0 | 1.0 | 3.0 | 0.2 | | | | | | | | | | | | |
| 1.0 | 1.0 | 3.0 | 4.4 | | | | | | | | | | | | |
| 1.0 | 1.0 | 0.1 | | | | | | | | | | | | | |
| P5 | 1.0 | 0.2 | | | | | | | | | | | | | |
| CR | 0.00 | | | | | | | | | | | | | |
| <strong>Summary</strong> | <strong>Affordability</strong> | <strong>Environment Impact</strong> | <strong>Roadside Commerce</strong> | <strong>Transport safety</strong> |
| P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | CR | 0.07 |
| 1.0 | 1.0 | 3.0 | 0.4 | | | | | | | | | | | | |
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| 1.0 | 1.0 | 1.0 | 0.2 | | | | | | | | | | | | |
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| 1.0 | 1.0 | 0.1 | | | | | | | | | | | | | |
| P5 | 1.0 | 0.2 | | | | | | | | | | | | | |
| CR | 0.00 | | | | | | | | | | | | | |
| <strong>Summary</strong> | <strong>Affordability</strong> | <strong>Environment Impact</strong> | <strong>Roadside Commerce</strong> | <strong>Transport safety</strong> |
| P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | P1 | P2 | P3 | P4 | P5 | CR | 0.07 |
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| 1.0 | 1.0 | 3.0 | 1.0 | 0.2 | | | | | | | | | | | | |
| 1.0 | 1.0 | 0.2 | 1.0 | 0.2 | | | | | | | | | | | | |
| 1.0 | 1.0 | 3.0 | 4.4 | | | | | | | | | | | | |
| 1.0 | 1.0 | 0.1 | | | | | | | | | | | | | |
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### Overall Project Ratings for System Users

| Projects | Job access | Market Access | Education access | Reliability | Affordability | Roadside commerce | Safety | NMT | Transit | Healthcare access | Activity access | Neighbourhood preservation | Personal security | Stress free travel | Air pollution | Noise pollution | Sum of Rows | Priority |
|----------|------------|---------------|------------------|--------------|---------------|-------------------|--------|-----|---------|------------------|---------------|-----------------------|------------------|------------------|--------------|-----------|
| P1       | 0.012      | 0.009         | 0.012            | 0.012        | 0.006         | 0.004             | 0.009  | 0.005| 0.010   | 0.015             | 0.015         | 0.007                 | 0.014            | 0.014           | 0.027        | 0.022     | 0.193       |
| P2       | 0.006      | 0.005         | 0.006            | 0.007        | 0.005         | 0.004             | 0.008  | 0.006| 0.008   | 0.008             | 0.008         | 0.008                 | 0.009            | 0.018           | 0.013        | 0.129     |
| P3       | 0.012      | 0.009         | 0.012            | 0.013        | 0.016         | 0.005             | 0.011  | 0.008| 0.016   | 0.015             | 0.015         | 0.010                 | 0.016            | 0.017           | 0.038        | 0.031     | 0.243       |
| P4       | 0.013      | 0.010         | 0.013            | 0.010        | 0.007         | 0.006             | 0.011  | 0.007| 0.014   | 0.017             | 0.017         | 0.011                 | 0.015            | 0.016           | 0.034        | 0.028     | 0.228       |
| P5       | 0.005      | 0.004         | 0.005            | 0.006        | 0.014         | 0.004             | 0.014  | 0.004| 0.006   | 0.006             | 0.006         | 0.008                 | 0.007            | 0.054           | 0.044        | 0.204     |

**Overall Project Ratings for System Users**

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**Calculated project priority**

| Calculated project priority | 0.193 | 0.129 | 0.243 | 0.228 | 0.204 |

**Idealized project priority**

| Idealized project priority | 0.796 | 0.530 | 1.000 | 0.940 | 0.839 |

**Localized Sustainability Score (LSS)**

| LSS | 80 | 53 | 100 | 94 | 84 |