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Sustainable rural roads for livelihoods and livability

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Abstract

Of some 33.8 million km. of classified roads that girdle the globe, nearly all unsealed roads and an estimated 85% of paved roads are low-volume roads (LVRs) with ADT of less than 1000 vehicles/day. Rural LVRs have a critical role in economic growth and poverty reduction, and a prominent function in emergency preparedness, disaster relief and rural job creation. This paper discuses the meaning of sustainability and its more practical subset--livability, in relation to rural roads and how the application of context sensitive solutions could help achieve a better balance among the economic, social, and environmental dimensions of sustainability.

Keywords: Rural Roads; Sustainability; Livelihoods; Livability; Workfare, Context Sensitive Solutions.

1. Introduction

Of the estimated 33.8 million km. of classified public roads that girdle the earth's land mass of 148.9 million sq.km. (circa 2010), equivalent to an average 0.23 km of road per sq.km of land area, nearly all the unsealed roads (about 13 million km) and an estimated 85% of paved roads (17 million km) are low-volume roads (LVRs) -- with an Average Annual Daily Traffic (AADT) of 1000 vehicles per day or less [1], [2]. These 30 million km of LVRs have a wide variety of geometric and paving standards ranging from barely motorable earth roads to modern high-speed two-lane paved highways. The global asset value (replacement cost) of these LVRs is conservatively estimated at about US$ 7.6 trillion (a lower-bound estimate) equivalent to about 50% of the estimated 2010 Gross Domestic Product of the United States. Beyond this classified system is another realm of

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designated trails, tracks, and paths as well as minor roads that serve enclave development (mines, industrial estates, agricultural plantations, irrigation schemes, tourism, forestry and so on), and together number into millions of additional kilometres and also contribute to basic access and mobility.

Despite the huge public outlays on asset management and advances in GIS, it is yet not possible to obtain an accurate assessment of the length and condition of rural roads globally, except for the more advanced industrialized countries. Most countries have only a rudimentary inventory of their rural road system.

As one would expect, the geographical distribution of roads is dominated by countries with large land masses and/or large populations—just eight countries (with US in the lead, followed by China, India, Brazil, Japan, Canada, France and Russia), each with at least one million road kilometres, account for about 59% of the global road network. The majority of these countries have a federal (decentralized) system of government, which poses its own peculiar governance challenges related to the funding and management of rural roads.

2. Sustainable Development

The idea of sustainability dates back to nearly 40 years and has its origin in the notion that it is possible to achieve economic growth and industrialization without damage to the environment. The United Nations 2005 World Summit (Outcome Document) reaffirmed the 'interdependent and mutually reinforcing pillars' of sustainable development as economic development, social development, and environmental protection. Over the decades, thinking about sustainability has focused on the interaction among its three key dimensions: economic, environmental and social and the need to better integrate these three dimensions in order to achieve desirable development outcomes.

According to Pears [3], sustainable development has a wide range of interpretations from an operational standpoint. Adams [4] argues that sustainability as a concept is holistic, attractive, elastic but imprecise, and it is precisely this looseness that explains the widespread acceptance of the idea of sustainable development, as it can be used to cover very divergent views. It is assumed that trade-offs are always possible between the environmental, social and economic dimensions. In practice, development programs while allowing for trade-offs, put greater emphasis on the economic dimension, (and in that dimension, growth generally takes precedence over distribution). A distinction is often drawn between 'strong' sustainability (where such trade-offs are not allowed or are restricted) and 'weak' sustainability (where they are permissible).

Marsden, Kimble, Nellthrop & Kelly [5] maintain that there is no agreed and universally accepted metric for defining the extent and level of sustainability achieved in development programs. Sustainability and sustainable development tend to be ethical concepts to express the desirability of good environmental and social outcomes from economic decision-making. Adams [4] notes that 'Often sustainable development ends up being development as usual, with a brief embarrassed genuflection towards the desirability of sustainability. The important matter of principle therefore becomes a victim of the desire to set targets and measure progress.' Nowhere is this more apparent than in the rhetoric of 'green roads' or in the standardized environmental and social safeguard policies of development institutions, that aim to minimize environmental and social harm from development projects, when the objective of such policies should be affirmative action to enhance environmental and social values. As a working proposition, sustainability can be perceived as a condition in which economic, social and environmental factors are optimized, taking into account indirect and long-term impacts.

3. Rural Access and Sustainable Livelihoods

Rural access is central to the alleviation of rural poverty as shown by Fan, Brzeska & Shields [6], Njenga & Davis [7], Edmonds [8], and Chambers [9], and has a close synergy with rural livelihood outcomes such as increased incomes (e.g. tradable agricultural surplus, material goods, and cash), increased social well-being (e.g. non material goods, like self-esteem, health and nutrition status, access to education and other services, sense of inclusion), reduced vulnerability (e.g. better resilience through increase in asset status, access to emergency services), improved food security (e.g. from drought proofing, access to markets, and increased income to buy

food) and a more sustainable use of natural resources (e.g. access to commercial energy, improved management of forests and wildlife resources) [10]. By providing access to opportunity, rural roads contribute to making a livelihood sustainable, so that it is resilient in the face of external shocks and stresses, it is not dependent upon external support, it can maintain or enhance its capabilities and assets both now and in the future, it is able to assure the long-term productivity of natural resources, and it does not undermine the livelihood opportunities of others [11], [12].

The livelihoods approach is concerned first and foremost with people. So an accurate and realistic understanding of people's strengths (here called "assets" or "capital") is crucial to analyze how they endeavour to convert their assets into positive livelihood outcomes. People require a range of assets to achieve their self-defined goals, whereas no single capital endowment is sufficient to yield the desired outcomes on its own. This is particularly true for poor people whose access to any given category of assets tends to be very limited. As a result they have to seek ways of nurturing and combining what assets they do have in innovative ways to ensure survival.

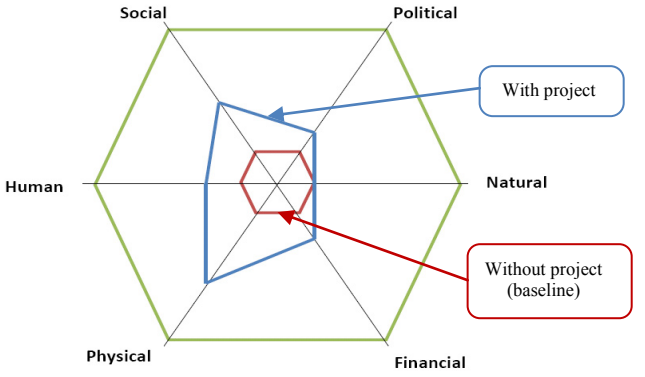
3.1. Asset (capital) polygon

An Asset Polygon (also described as a Capitals Model) provides a basis for understanding sustainability in terms of the economic concept of wealth creation or 'capital' [13]. As shown in Table 1, there are five core asset categories or types of capital upon which rural livelihoods are built, originally defined by UK Department of International Development [11], in the context of its sustainable livelihoods program. 'Political' capital as defined by Casey [14] has been added to the five capitals, given the relevance of political capital to rural road programs. Although the term 'capital' is used, not all the assets are capital stocks in a strict economic sense, with capital defined as the product of investment which yields a flow of benefits over time.

Table 1. Capital Assets for Rural Livelihoods

Type of Asset	Description
Natural Capital	The natural resource stocks from which resource flows useful for livelihoods are derived (e.g. land, water, wildlife, biodiversity, environmental resources).
Social Capital	The social resources (networks, membership of groups, relationships of trust, access to wider institutions of society) upon which people draw in pursuit of livelihoods.
Human Capital	The skills, knowledge, ability to labor and good health important to the ability to pursue different livelihood strategies
Physical Capital	The basic infrastructure (transport, shelter, water, energy and communications) and the production equipment and means which enable people to pursue their livelihoods
Financial Capital	The financial resources which are available to people (whether savings, supplies or credit or regular remittances or pensions) and which provide them with different livelihood options.
Political Capital	This is the sum of political assets, strengths and influence that may be combined with other forms of capital for purposive political action to improve livelihoods... It includes the interactions among the individual, the community, the civil society and the state that may facilitate or hinder progress towards improvement in livelihoods. Political capital is linked to transparency, accountability, representation, and voice. Some analysts consider political capital as a subset of social capital

The six capitals shown in the Asset Polygon (Fig.1) are perhaps best thought of as livelihood building blocks; the term 'capital' is used because this is the common designation in the literature [11]. Some of these assets are not readily substitutable and their consumption might be irreversible (e.g. natural capital in the



Source: Aysha Faiz

Fig.1. Asset polygon: a schematic representation of different types of capital

Form of fragile eco-systems). Substitutability is also constrained by the multi-functionality of many natural resources. Forests, for example, not only provide the raw material for paper and furniture (which have substitutes), but they also help to maintain biodiversity, regulate surface runoff, and serve as a sink for carbon dioxide, the most prevalent of GHGs. The depletion of natural and social capital is often irreversible (such as the loss in biodiversity or cultural diversity) and may have non-linear consequences. Consumption of natural and social capital may have no observable impact until a critical threshold is reached and the loss is partially or wholly irreversible. There is, however, the potential for substitution between different capitals, for instance a replacement of a lack of financial capital through a better endowment with social capital [12].

Among the six categories of assets, financial capital is probably the most versatile as it can be converted into other types of capital or it can be used for achievement of livelihood outcomes (e.g. purchase of food to reduce food insecurity, construction of rural roads to improve access and mobility).It is also the traditional measure of performance and success (the proverbial bottom line), as it reflects the productive power of the other types of assets. Sustainable outcomes require a clear understanding of how economic or financial value is created and its dependence on other forms of capital. . However, it is an asset least available for the poor—and what then makes other capitals important as substitutes.

Increasing access –which can take the form of ownership or the right to use –to these assets can effectively ameliorate poverty. Rural roads facilitate this access and also contribute to capital formation (primarily physical capital, but also human, social and political capital). Conversely, rural roads can accelerate the depletion of natural capital (e.g. due to deforestation occasioned by easier access) and may also contribute to diminution of social (e.g. loss of cultural heritage and diversity, decline in social cohesion) and political capital (e.g. from corruption and misuse of public funds). The Asset Polygon depicted in Figure1 can be used as a conceptual framework for assessing existing assets (different categories of capital) at the household, community or project level and how an intervention such as a rural road project can alter the asset balance. A sustainable rural roads program will maintain and where possible enhance these stocks or capital assets and also apply safeguards to prevent their degradation or depletion. The model (asset polygon) allows an explicit consideration of the environmental and social nexus of sustainable transport programs, especially in developing countries, as discussed by Faiz [15].

4. Livability: A Practical Concept for Achieving Sustainable Outcomes

Despite its conceptual elegance, sustainability as a goal for achieving the right balance among economic, environmental and social objectives remains somewhat elusive and subject to multiple interpretations. Livability

refers to a sub-set of sustainability outcomes that directly affect people's lives [16],[17],[18], such as access to jobs and economic opportunity, durable housing (resistant to natural disasters), provision of potable water, electricity and ICT , quality schools and reliable health services [19],[20]. In rural areas, roads can make many of these outcomes possible. At the community level, livability is concerned with environmental and social quality of an area as perceived by residents, employees, customers and visitors. This includes safety and health (traffic safety, personal security, and public health), local environmental conditions (cleanliness, noise, dust, air quality, and water quality), the quality of social interactions (neighbourliness, fairness, respect, community identity and pride), opportunities for recreation and entertainment, aesthetics, and existence of unique cultural and environmental resources (e.g., historic structures, mature trees, traditional architectural styles), as described in VTPI [18]. Through "green", "eco-friendly" and "people-friendly" rural roads, not only environmental concerns such as water quality, land conservation, and wildlife protection are addressed, but livability in rural neighbourhoods is enhanced by traffic calming and use of design standards to limit speeds, noise and safety hazards, as demonstrated by Cotton [21].

Livability is largely affected by physical location and condition of public facilities and also is influenced by public policy and planning decisions. By incorporating livability objectives into the planning and design of rural roads, communities can maximize the efficiency of rural infrastructure while providing better access and mobility. Livability approaches can also be a catalyst for revitalizing rural communities and small towns. A transportation system that provides reliable, safe access to jobs, education, health care and goods and services is just as important to rural communities as it is to urban areas. Rural communities present unique mobility challenges, and all forms of transportation options, including Non-motorized Transport (NMT) and Intermediate Means of Transport (IMT) are needed in rural areas, especially in developing countries, ensure access for the poor, the elderly, and women and children to basic services and amenities. Linking rural road investments to productive sectors and provision of basic social services can help reduce the pressure on natural and cultural resources, while better preparing communities to mitigate and adapt to the impacts of climate change. As noted by Scoones [10], ensuring that people in poor rural communities have a minimum level of mobility can have a profound impact on the quality of rural life. The key livability challenge in rural areas is the delicate balance between meeting mobility needs and preserving environmental and community values.

4.1. Context sensitive solutions

Translating livability principles into practice is not an easy proposition and requires that human factors take precedence over motor vehicle factors in the provision of rural roads. The design vehicle speed must give way to the needs of NMT/IMT locomotion, and rural roads must hug and not blight natural landscapes. This requires Context Sensitive Design (CSD) that is in sync with local community values and allows a better balance of economic, social, and environmental objectives in roadway design decisions. It allows narrower lanes, lower design speeds, sharper curvature, and special features (such as bus bays, foot and bike paths, and provisions to accommodate the needs of the elderly and the physically handicapped.). By minimizing cut and fill, and with appropriate provisioning for drainage and stable slopes, it can help to make transport infrastructure (particularly rural roads) more climate- resilient. CSD aims to create a more balanced and efficient rural transport system that enhances accessibility, improves mobility and is compatible with community values and needs.

CSD or more broadly termed as 'Context Sensitive Solutions' (CSS) is the art of creating public works projects that meet the needs of the users, the neighbouring communities, and the environment. It integrates projects into the context or setting in a sensitive manner through careful planning, consideration of different perspectives, and tailoring designs to particular project circumstances. U.S. Federal Highway Administration and American Association of State Highway and Transportation Officials (AASHTO) define CSS as a collaborative, interdisciplinary approach that involves all stakeholders in providing a transportation facility that fits in its setting. It is an approach that leads to preserving and enhancing scenic, aesthetic, historic, community, and environmental resources, while improving or maintaining safety, mobility, and infrastructure conditions. Furthermore, CSS requires an early and continuous commitment to public involvement, flexibility in exploring

new solutions, and an openness to new ideas. Community members play an important role in identifying local and regional problems and solutions that may better meet and balance the needs of all stakeholders. Early public involvement can help reduce expensive and time-consuming rework later on and thus contributes to more efficient project development [22], [23], and [24].

As discussed in VTPI [22], CSD/CSS is guided by six key principles:

- Balance safety, mobility, community, and environmental goals in all projects.
- Involve the public and affected agencies early and continuously.
- Use an interdisciplinary team tailored to project needs.
- Address all modes of travel.
- Apply flexibility in design standards.
- Incorporate aesthetics as an integral part of good design.

A detailed taxonomy of CSS goals, strategies, operational principles and key sources of information are provided by Stamatiadis, Kirk, Hartman, and Hopwood & Pigman [23].

4.2. Context sensitive design: an illustrative example

The quality of a rural road is generally judged by the type and condition of the pavement surfacing. There is the perennial question of when to pave a gravel road but seldom is there a detailed inquiry into pavement surfacing alternatives. The answer is generally provided in terms of traffic (ADT) threshold above which paving is economically justified, and most LVR Pavement guidelines and manuals assume a minimum thickness of asphalt concrete or a bituminous surface treatment.

The African Community Access Program (AFCAP) in Tanzania provides a good example of a context-sensitive assessment of pavement surfacing alternatives as reported by Gillett, Conlon & Kalesi [25]. It is based on field research done in Tanzania, with the range of pavement surfacing extended to some 14 alternatives and the advantage and disadvantage of each alternative assessed under nine design and operational contexts. This is not an exhaustive list as other options like roller compacted concrete, brick paving, and stabilization with a variety of binders could be added to the list. Nevertheless this is an uncommon approach to the selection of pavement surfacing ; moreover it allows the possibility of including environmental and social dimensions in the selection decision, such as job creation, use of local materials, labour-based construction and maintenance technologies, aesthetics, and provisioning for NMT/IMT. A more exhaustive catalogue of roadway resurfacing alternatives (including some 50 resurfacing products illustrated in a photo album) is available from FHWA. This practical guide prepared by Maher, Marshall, and Harrison & Baumgaertner [26] also provides a surfacing selection methodology to obtain context-sensitive paving solutions.

The selection of cost-effective and sustainable pavements for rural roads is also influenced by the reliability and quality of road maintenance and the associated funding arrangements. Because rural access roads are of low importance, their maintenance becomes the first casualty of constrained road budgets. In terms of life-cycle costs, it is often more economical to use stronger pavements initially, extending the pavement service life from the usual 10-15 years to 20-30 years or more. This option provides a safeguard against insufficient or poor maintenance, while ensuring a more sustainable outcome for the road users.

Similar context sensitive solutions could be developed and assessed for other dimensions of rural road design and operations. Keller & Sherar [27], Ketcheson and Keller [28], Clarkin, Keller,Warhol &Hixon [29] and the Stream Simulation Working Group [30] have prepared field guides that provide an extensive menu of context sensitive options to reduce storm damage risk and improve the environmental management of rural roads, while making them more climate resilient. Douglas [31] presents the principles and techniques that underpin context-sensitive planning and design of forest and other natural resource access roads.

5. Conclusions

The preceding review of sustainability and livability suggests that a rural road must fulfil two conditions to be sustainable: first, it must contribute to and enhance rural livelihoods and livability, and secondly, its planning and design (as well as construction and maintenance) must be context sensitive to ensure a balance among economic, social and environmental objectives, that is reflective of community values, aspirations, and needs.

Based on the global trends in road development during the first decade of the new millennium, it is not improbable that, on average, between 1- 2 million kilometres of rural roads will be added every decade to the classified public road system between now and 2050. The continued growth in rural roads is predicated by many factors, the foremost being the food requirements of a 9 billion global population by 2050. The required increase in food production will require massive improvements in the agricultural supply and marketing systems, with the rural road providing the first value-enhancing link, as agricultural produce moves up the value chain from the farm to the market and on to the consumer.

A vast majority of the world's chronically hungry live in rural areas, so enabling poor farmers to market their produce more efficiently is an effective means of reducing hunger and poverty. Rural roads help to lower input prices, increase agricultural production, and reduce the monopoly power of intermediaries (middlemen) in agrarian markets. Food security is enhanced with increased purchasing power from rising rural incomes and more diversified employment opportunities. Rural roads improve access to employment opportunities and can also help create jobs through labour-based construction and maintenance.

Public spending on rural roads (especially in economically-lagging areas) contributes significantly to lifting rural people out of poverty. Research shows that public expenditures to promote economic growth and reduce rural poverty have the highest marginal return for investments in agriculture research, rural roads and education. Rural road construction and maintenance has featured significantly in safety-net workfare (also referred to as cash-for-work and public works) programs, aimed at creating employment targeted to the poor. Job creation through rural road construction and maintenance is highly cost-effective in terms of the cost per job created, as compared to other infrastructure interventions.

Sustainability in all its interacting dimensions should be the underlying premise for rural road programs. Conventional roadway design standards define features such as minimum lane and roadway widths and a design speed that locks in place a road geometry that may be in conflict with environmental and social values and needs. The governing assumption is that bigger-and-faster-is-better, resulting in higher traffic speeds, increased costs and irreversible social and environmental damage. A research program to synthesize and document CSS for rural access roads would be a timely and useful endeavour. In this, rural road practitioners must become the champion of livability principles and seek and apply context sensitive solutions to all aspects of rural roads.

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