

PIARC COMMITTEE C20: APPROPRIATE DEVELOPMENT

**Standards and specifications for rural accessibility**

**The Various Dimensions of Sustainable Low-Volume Sealed Road  
Provision in Developing Countries**

by

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### **The various dimensions of sustainable low-volume road provision in developing countries**

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#### **Abstract:**

The effective and efficient provision of low-volume roads (LVRs) in many developing countries requires a major departure from traditional practice. Documentation relating to the provision of such roads is often based on technology emanating from Europe and the USA. Although these standard approaches have been revised to some extent, they are still often inappropriate for situations where locally prevailing conditions are very different from those for which the traditional approaches were developed. Traditional approaches have also tended to focus on the technical environment with inadequate consideration to the other inter-related environments. The result often has been lack of responsiveness to various stakeholders' requirements and a reduced likelihood of achieving sustainable solutions.

It is now patently clear that new, more holistic, approaches, requiring a paradigm shift in thinking, are required if LVRs are to be provided on a more sustainable basis. It is also clear that there is a critical need to satisfy a variety of criteria operating within multi-dimensional environments. To be sustainable, LVRs need to be:

- Politically supported
- Socially accepted
- Institutionally possible
- Technically appropriate
- Economically viable
- Financially attainable
- Environmentally sustainable

During the past 20 - 30 years, research has been carried out on low volume roads in developing countries, resulting in many innovative approaches that can provide highly beneficial and cost effective solutions. Unfortunately, less success has been achieved in promoting the uptake of the research results, which has led to a lack of awareness, technology transfer and implementation. All too often, new ideas and approaches are ignored by the foreign consultants and contractors appointed to design and build these roads. Even more disappointingly, local practitioners, all too readily, also fall back on stereotyped and often costly recommendations in out-dated Road Design manuals.

The purpose of this paper is to highlight a more holistic, innovative and sustainable approach to the provision of LVR's, which are likely to increase the cost-effectiveness and efficiency of LVR provision, facilitate investment in road projects, enhance economic activity and contribute to poverty reduction in many developing countries.

# **The Various Dimensions of Sustainable Low-Volume Sealed Road Provision In Developing Countries**

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## **1. BACKGROUND**

Many of the approaches, standards and specifications in documentation on low-volume road provision in developing countries stem from technology and research carried out in Europe and the USA some 30 – 40 years ago. They are often being applied in vastly different environments from which they were derived. This documentation has been modified to some extent in the intervening years but the basic philosophy of road provision has remained essentially the same.

Traditional approaches to LVR provision focus on the technical environment with inadequate consideration to the other inter-related environments (political, social, institutional, etc), which critically impact on the provision of LVR's. It is now clear that new, more holistic approaches, requiring a paradigm shift in thinking, are required if LVRs are to be provided on a sustainable basis for the rural poor.

The results of research have also led to questioning of many of the accepted paradigms on low-volume roads. Poor uptake of research results has led to a lack of awareness, technology transfer and implementation. Foreign consultants and contractors appointed to design and build these roads and local practitioners, all too readily fall back on the stereotyped and often costly recommendations found in many out-dated Road Design manuals.

The purpose of this paper is to provide examples of a more holistic, innovative and sustainable approach aimed at improving the cost-effectiveness and efficiency of LVR provision, facilitate investment in road projects, and contribute to economic enhancement and poverty reduction in developing countries.

## **2. APPROACH**

More holistic approaches need to be pursued that recognise the various dimensions of sustainability, encourage the implementation of innovative solutions, facilitate the application of appropriate technological standards and specifications for the expected level of service and are empathetic with the prevailing environment. The seven key dimensions of sustainability that should be satisfied on all low-volume road projects are illustrated in Figure 1.

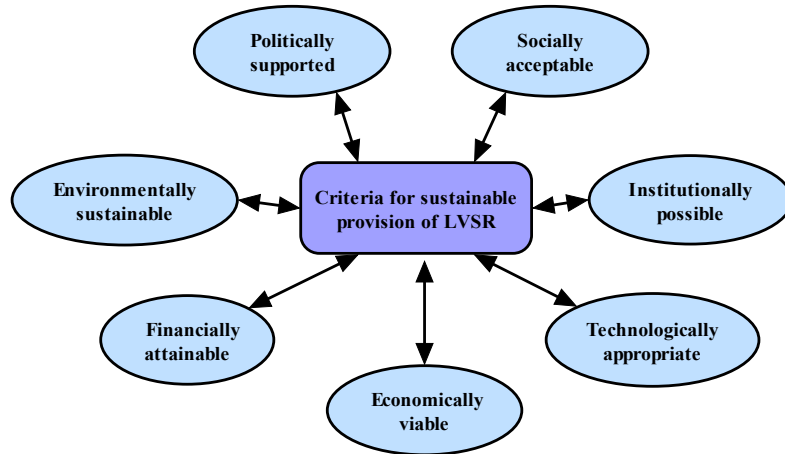


FIGURE 1 Key Dimensions of Low Volume Road Sustainability

## 2.1 Dimensions of sustainability

- **Political:** There is a tendency to favour conventional approaches and standards. Obtaining support for more appropriate standards is difficult both from politicians and the general public. Consequently, there is a strong need to engage in continuous dialogue with political and public stakeholders in order to convince them of the merits of alternative proven, non-standard, often innovative, solutions on the basis of their quantified benefits.
- **Social:** The social benefits of LVR's tend to be neglected or to be treated in a subordinate manner compared to technical and economic issues. There is therefore a need to adopt strategies that ensure community participation in mainstream policy and decision-making and eliminate gender biases and promote participation by women in labour-based activities.
- **Institutional:** Within the prevailing, mostly bureaucratic government departments, roads generally tend to be provided in a relatively inefficient and costly manner. There is therefore a need to promote a more commercialized approach with less involvement by Roads Authorities in works execution and increased outsourcing of construction and maintenance works to local contractors.
- **Technical:** A wide range of options is available for planning, designing, constructing and maintaining LVRs which can have vastly differing impacts. In order to support the over-arching goal of poverty reduction, there is a need to adopt strategies that: employ appropriate, affordable standards; create employment opportunities, and provide opportunities for greater involvement by local contractors.
- **Financial:** Funding, particularly for maintenance, is often inadequate to meet minimum requirements for sustainability. Traditional approaches which rely on

government allocations for maintenance have generally failed. Financing proposals need to look increasingly at the establishment of off-budget mechanisms, such as dedicated Road Funds.

- **Economic:** Traditional methods of investment appraisal are ill-suited for quantifying the multiple benefits of LVRs. Where traffic volumes are low it is necessary to employ methods designed to capture the non-economic benefits.
- **Environmental:** The environment has been regarded as the price to be paid for development and has often resulted in solutions that are environmentally unsustainable. Gravel sources are being depleted at an alarming rate and the sustainability of gravel roads in the long term is questionable. Sealing them at an affordable cost is a more sustainable option.

## 2.2 Technical aspects of road provision

There is scope for improved approaches in all the facets of low-volume road provision following the lessons learned from past experiences.

- **Planning:** Traditional approaches to the planning roads tend to be undertaken in a predominantly “technical” environment, typically centred in public works departments in which public consultation is minimal. Experience from successful programmes (1) suggests that multi-tiered planning allowing participation of local communities is the preferred approach. Consultations with stakeholders at all stages of the project cycle is of paramount importance.
- **Appraisal:** The benefits arising from the provision of LVRs are mainly social. The beneficiaries include non-motorised traffic and pedestrians – factors that are typically not captured in conventional cost-benefit analyses models. Improved approaches are being developed in the World Bank’s HDM4 (2) and the Roads Economic Decision models(3). Research has shown that bitumen sealing of gravel roads can be economically justified at traffic levels below 100 vehicles per day (4). This contrasts with outdated “rule-of-thumb” traffic levels in excess of 200 vehicles per day, which are still used by some decision-makers and international funding agencies.
- **Environment:** Many developing countries have tended to focus on the potential benefits from improved road facilities with environmental problems considered to be the price to be paid for development. Awareness is increasing of the potential environmental damage caused by the indiscriminate extraction of road building materials (5). The rapid and accelerating depletion of gravel resources are not adequately represented in current appraisal procedures. This needs to be recognized and environmental management extended through the use of environmental audits.
- **Geometric Design:** Many of the geometric design standards used in developing countries are often a direct translation from overseas practice. (6). The use of these conventional standards is clearly inappropriate and results in LVRs being unnecessarily expensive to build and maintain, particularly where

substantial earthworks are required. Substantial savings can be achieved by using more appropriate techniques and standards such as the “design by eye” approach (6) and the Design Domain Concept (7).

- **Road Safety:** Accidents in developing countries are some 30-50 times higher per capita than in developed countries (8). Road users on LVR's involve a mixture of pedestrians and both motorised and non-motorised traffic. Measures to improve the situation include the use of road safety audits in the road design process. (8,9).
- **Pavement Design:** Environmentally induced distress dominates performance of LVR's. Very few pavement design methods cater for this mode of deterioration. The in-service environment of the road pavement is particularly important. The results of research in Southern Africa have been incorporated in a pavement design method that adequately reflects the importance of local environmental factors (10). The use of such methods in the design of LVRs can yield high savings from the greater use of local resources.
- **Materials:** Materials make up some 70% of the cost of a typical rural road. Many of the traditional design criteria preclude the use of local naturally occurring materials perceived as being sub-standard. Research work carried out in the southern African region has shown that these local, “non-standard” materials can be used successfully by deriving specifications for their use in local environments and applying appropriate design and construction techniques (10).
- **Surfacing:** For many years, surface dressing has been used as the standard seal used for surfacing low-volume roads. However, there are alternative options available which are often more appropriate, allow the use of local materials and are cost-effective and easier to apply than surface dressings. These include graded aggregate (Otta) seals (11), sand seals and slurry seals that can be constructed by labour based methods.
- **Compaction:** It is widely accepted that with modern plant, higher densities than are usually specified can be achieved with relatively few additional passes of compaction equipment, resulting in increased pavement stiffness and longer pavement life. Deep compaction techniques using high energy impact compactors can also be used to achieve similar results (12). Considerable long-term benefits can be achieved using these methods for a relatively small additional cost.
- **Labour Based Methods:** The devolution of responsibility for rural roads to district councils is a trend in many countries in the region. In these circumstances, the construction and maintenance of these roads can be carried out more cost-effectively using labour-based methods and plant and equipment that are better suited to small-scale contractors.

- **Drainage:** Drainage plays a particularly important role in the performance of LVRs. Experience in many developing countries has highlighted the importance of maintaining a minimum crown height, especially through cuttings. Measures such as sealing shoulders, deepening side drains, raising embankments to create a drier environment for the road pavement, can increase opportunities to use locally available materials and reduce costs.
- **Maintenance:** The consequences of inadequate resources for maintenance have been all too evident. In recent years, there have been fundamental changes in approaches to road maintenance. The re-structuring of road authorities, involvement of the private sector and the setting up of road funds is designed to ensure dedicated funding for road maintenance. In this changed environment more appropriate and innovative solutions in the provision of low-volume roads can be implemented with greater confidence.
- **Overload Control:** Traditional approaches to overload control have generally been ineffective and suffer from a number of short-comings. New radically different approaches are required including the operation of a *self-regulatory* system which places the onus on overload control on transport operators and freight forwarders. Other measures include *decriminalization* of offences for overloading by handling them administratively and imposing an economically-based overloading fee and *outsourcing* of weighbridge operations to the private sector. (13).

### 3. TECHNOLOGY TRANSFER

In some developing countries, local consultants and contractors often have little involvement in road projects. Technology transfer in either direction is stifled, long-term sustainability is not achieved and the foreign consultants and contractors appointed often apply solutions inappropriate to the local environment.

Further research is still needed but implementation of the results already available, have invariably been highly beneficial and cost effective. Resistance to change remains an obstacle but the implementation process can be accelerated by adopting a strategy to mitigate these as shown in Figure 2

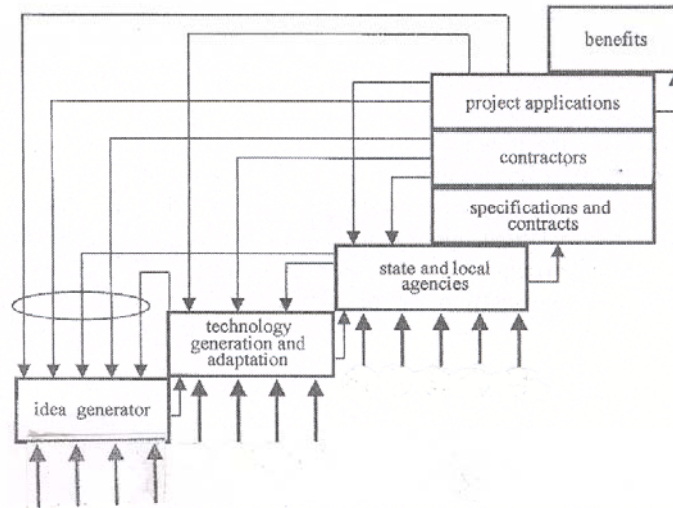


Figure 2 – Stages in the pathway to implementation (14)

#### 4. RISK

For some practitioners, innovation in the form of proven unconventional designs, materials and techniques implies increased risk, which is used as the reason for not embracing change. The level of risk should be commensurate with the project undertaken. A high price is paid for an unnecessarily high margin of safety; it unnecessarily increases costs, diminishes return on investments and impedes development.

Risks are mitigated by ensuring that standards/specifications apply to local environments. Low-cost measures that change the road environment (e.g. sealed shoulders and deeper side drains) enable appropriate designs and local resources to be safely exploited.

Many roads constructed with so-called non-standard materials perform well even under adverse conditions of overloading and poor maintenance. This raises questions about the basis on which materials are classified as sub-standard in local environments. The recommendations from this research make it possible to utilize local resources with greater confidence.

The perceived risks associated with the use of non-standard materials and non-traditional designs can now be sensibly managed and a larger proportion of unsurfaced roads can be economically surfaced without additional risk.

#### 5. SUMMARY

The approach to LVR provision has tended to be pre-dominantly technically focused with inadequate consideration to other key dimensions of sustainability. Traditional approaches have been based on documentation developed abroad in vastly different environments.



Research has catalysed the rethinking of the whole approach to LVR provision and shown that there are very large potential savings to be made from the application of research findings.

Practitioners, whether in donor agencies, finance departments, roads authorities or consulting and contracting firms, need to be far more flexible in all aspects of low-volume road provision if the benefits of the investment in research are to be fully realized by the rural poor. The penalty for not adopting new ideas and technologies is that progress through development will be impeded.

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