AFCAP Technical Paper

Institutionalising Rural Transport Knowledge and Research Capacity in sub-Saharan Africa

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ABSTRACT

Despite limited and declining resources since the 1980's (financial, human and capital) there have been many important research projects funded by programmes such as the Africa Community Access Programme (AFCAP), other donor agencies and national budgets that have been undertaken to advance the Africa-specific knowledge-base for the provision of road infrastructure and the associated transport services, especially in rural areas. The problem is that the valuable knowledge generated from the various projects is fragmented and uncoordinated; and resides in different organisations (including donor agencies) in different countries throughout sub-Saharan Africa and beyond.

This paper highlights the economic benefits that can accrue from a holistic approach to knowledge generation, transfer and implementation of research projects. A framework is also proposed that formalises the approach to institutionalising research management and knowledge transfer activities at a national level. In addition, a coordinated approach is presented to harness the vast amount of fragmented information that has been generated throughout the sub-Saharan African region for better use and implementation. In this regard, it is recommended that a structure of national research centres, which would liaise with regional coordinating hubs for more advanced research projects requiring specialist equipment, should be established. The African Road Maintenance Fund Association (ARMFA) is identified as a possible regional representative organisation to oversee the coordination at regional level.

1 Introduction

The Africa Community Access Programme (AFCAP) funded by the UK Department for International Development (DfID) was launched in June 2008 for an initial five years. The aim of the programme was to address the challenges of providing reliable access for poor communities in Africa. As part of its remit, AFCAP provides;

- Advice and support for applied research to address rural access constraints;
- A communications outlet of research findings to stakeholders; and
- Support for the mainstreaming of research results into practice.

The primary goal of AFCAP is sustained economic and social development; poverty reduction; and improved quality of life of the rural poor through more effective, efficient and equitable access to socio-economic opportunities and services such as health and education. To achieve these goals AFCAP strives to deliver an integrated, wide-ranging portfolio of research, dissemination and training activities.

Despite limited and declining resources since the 1980's (financial, human and capital) there have been many important projects funded by programmes such as AFCAP, other donor agencies and national budgets that have been undertaken to advance the Africa-specific knowledge base for the provision of road infrastructure and the associated transport services, especially in rural areas. The problem is that the valuable knowledge generated from the various projects is fragmented and uncoordinated, and resides in different organisations (including donor agencies) in different countries throughout sub-Saharan Africa and beyond.

In addition, the decentralising of decision making and the creation of roads and transport authorities or agencies, allied to the lack of a suitable library structure in most countries, has compounded the situation. The consequence is an increased need for a coordinated structure to generate, capture and transfer appropriate technologies and knowledge for the optimal provision of infrastructure and services for the road transport sector. Without a suitable transfer and feedback mechanism to establish research finding in practice, the value of the research is greatly diminished.

It is, therefore, critically important that relevant organisations and institutions within Africa both at national and regional levels take responsibility for knowledge generation, transfer and implementation. It is only through an established and sustainable institutional structure representing the countries that will benefit from the research investment that returns will be optimised.

In an effort to address the situation; and to both build on the lessons learned from the current AFCAP programme and provide guidance for future phases of AFCAP; this paper will address the following:

- A review of the value of research, knowledge generation and transfer;
- A review of knowledge transfer processes that have been used to successfully implement primary research findings and outputs in practice;
- The need for a sustainable source of African knowledge; and the transfer of that knowledge, through the institutionalising of research and centres of research in Africa.
- A framework for knowledge transfer and implementation of research and technology development findings to maximise the benefits of research investment.

2 AFCAP Research into Practice

Geddes (2013) highlighted several case studies in AFCAP member states that demonstrated the shortcomings of inappropriate design standards and specifications based on mainly European and North American practice. Costs of US$ 1 million per kilometre for a 2-laned paved rural road were quoted in the paper, with even higher costs being experienced in mountainous areas of countries such as Ethiopia where extensive earthworks and difficult terrain add significantly to the already high construction costs.

There is no doubt that if the primary goals of AFCAP outlined in Section 1 are to be achieved, it will be essential for practitioners to adopt more appropriate practices for the provision, upgrade and maintenance of rural access roads. It is also highlighted that existing practice will only change if new standards and specifications are published in official national documents, and client bodies insist that their contracting and consulting organisations are aware of the revised documentation; are trained in their use; and enforce their usage.

As a consequence, one of the main focus areas of the current programme has been on the development and implementation of appropriate design standards for low volume rural roads generally carrying less than 300 vehicles per day. The objective is to minimise the cost of providing all-weather access by utilising local materials in the road pavement layers and surfacings.

Research has shown that in many cases, gravel road surfacings are an unsustainable option due to inappropriate specifications and practice (especially related to oversized materials larger than 37.5 mm); the depletion of suitable gravel reserves; and increasingly longer haul distances to locate materials. In addition, sealed roads have lower life-cycle costs compared with gravel roads due to lower maintenance costs and lower vehicle operating costs. The findings have challenged conventional pavement design approaches and identified a range of surfacing option (including the gravel option that will remain a reality in all African countries for the foreseeable future) that could further reduce construction and maintenance costs to counteract those currently being experienced and mentioned earlier.

To build on this and other previous research findings, and to ensure knowledge transfer and implementation, the Ethiopian Roads Authority (ERA) commissioned the development of a series of Low Volume Roads design manuals as part of AFCAP. The draft manuals, based on a compilation of generally Africa-specific road research and best practice over the past 30 years, were published in 2011. These are now being used in Ethiopia for the US$ 1 billion Universal Rural Roads Access Programme (URRAP) being funded as part of the 4th phase of their Road Sector Development Programme (2011 – 2015).

The experienced gained and framework used for the successful development and implementation of these manuals will provide the basis for the recommendations presented later for developing a way forward in the institutionalising of research and knowledge transfer in other low and middle income countries in Africa.

AFCAP is also commissioning an economic analysis which will focus on the cost/benefits of:

- Adopting the low volume sealed roads (LVSR) approach compared with conventional design approaches;
- Upgrading gravel and earth roads to paved road standards using the LVSR approach;

- Adopting LVSR design standards within participating countries' road sector development programmes; and
- A comparison of the net economic benefits to countries adopting a LVSR approach compared with the cost of research under AFCAP.

As a precursor to the findings of the AFCAP cost/benefit study, a summary of previous cost/benefit studies on the value of research in roads and transport related programmes is presented in Section 3.

It should also be noted that while some of the current implementable findings have related to rural infrastructure provision, AFCAP recognises the independence (and in some cases inter-dependence) between engineering and transport-focussed research. The project portfolio is structured to accommodate both in an effort to ensure that communities can not only access all-weather roads but can also rely on improved transportation services, with a focus on gender equality and poverty alleviation.

3 The Value of Research

If Governments are going to be persuaded to sustain a research capability for improved decision making and delivery, they need to be convinced that the return on the investment is positive and is an important component in providing better road infrastructure and services. The benefits and value of funded research (whether from national budgets or donor partners) and the transfer of the knowledge generated from the research, needs to be quantified and constantly used to motivate ongoing funding.

Jooste et al (2005) showed that while the findings of technology development projects may be quite specific, the manner in which those findings are disseminated and implemented in practice is often more diffuse and general. This effect is illustrated in
Figure 1, which shows that several stages of information transfer as well as a period of implementation are required before benefits are actualized. This process diffuses and obscures the link between the technology development/research project and the benefits thereof. It also demonstrates the need for an inclusive framework to take knowledge generation from research and technology development projects into practice for the realisation of the benefits.

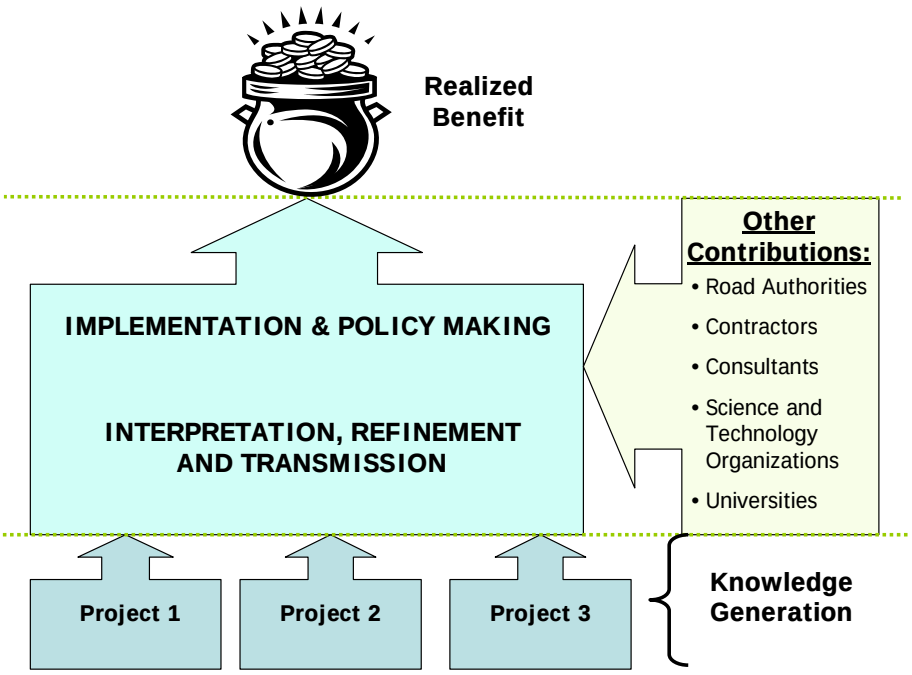


Figure 1: Pattern of Benefit Evolution from Knowledge Created by Technology Development Projects

It is seldom that a single technology development project is solely responsible for a realized benefit. As shown in Figure 1, several other role players and processes are needed to transform technical findings into policy changes that will result in economic benefits. Furthermore, technology development is seldom solely responsible for the technical findings. Rather, technology development projects are often identified based on results of earlier work. As such, these projects often refine and complete a technology that was supplemented by earlier (often informal or anecdotal) evidence, as shown in Figure 2. It is thus essential to ensure that contributions that precede technology development projects, as well as contributions required to refine and implement policy changes, are taken into account in the benefit assessment process.

Because of these difficulties, a purely objective assessment of economic benefits derived from technology development projects is almost impossible to obtain. In order to arrive at the assumptions needed to complete an economic assessment of benefits, a significant amount of subjective input is needed. This is further complicated by the fact that these subjective inputs are sometimes provided by the technology workers who are involved in the technology development project itself. This situation creates a conflict of interest which can impact negatively on the credibility of the assessment. The approach proposed by Zilberman and Heimer (1999), and also implemented in ARRB (1992) and Jooste and Sampson (2004) partly overcomes this challenge by collecting evidence and cost estimates from the users of the system (e.g. client bodies and practitioners), and not from the researchers or technology development workers themselves.

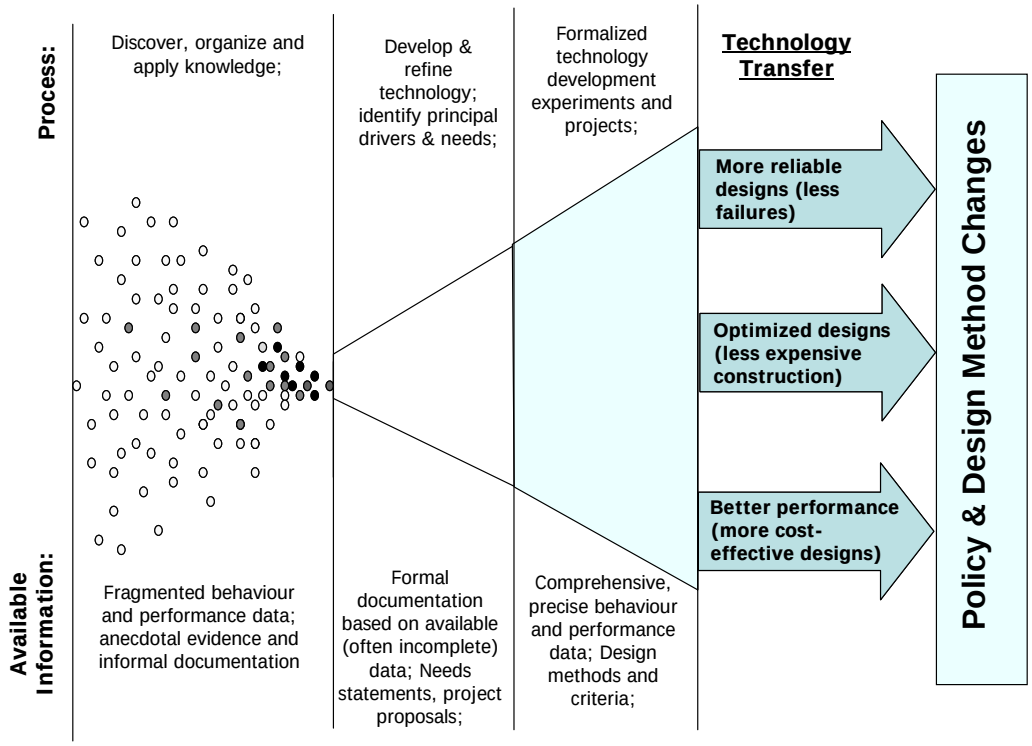


Figure 2: Technology Development to Policy Change (concept after Ounjian and Carne, 1987; and Horak et al., 1992)

A survey of the technical impacts of road-related technology development work showed that the technical impacts of such work can be generalized into the following three categories (ARRB, 1992; Jooste and Sampson, 2004, Gillen et al. 2002):

1. Optimized materials and pavement design, which lead to reduced construction costs;
2. More reliable design and maintenance practices, which reduces the likelihood of costly early failures, and
3. More cost effective materials and pavement design, which optimizes the time between maintenance interventions and reduces pavement life cycle costs.

The example shown in Jooste et al (2005) focused on a four-step approach that compares the life cycle costs of scenarios with and without the benefit of the impacts that stem from research and technology development work related to the reliability of road design practices. Under the controlled test conditions used in typical accelerated pavement tests, modes of deterioration that would otherwise not be detected in service can often be identified. Once identified, these modes of failure can be included as part of design methods and can thus ensure more reliable designs. The example illustrates the potential benefits that can be derived from a technology development project for which the findings result in a modified design or construction method that decreases the frequency of premature failures on a road network.

3.1 Example Outline from Jooste et al (2005)

The example described in Jooste et al (2005) compares the life cycle costs of two scenarios over a 20 year design period. In the benchmark scenario, a heavy rehabilitation is performed in the first year, followed by a resurfacing in year 9, and a light rehabilitation in year 15. The life cycle cost of this situation is compared to the alternative in which a premature failure is assumed to occur after the first two years. It is further assumed that the premature failure requires rehabilitation in year

three, after which the life cycle continues with a light rehabilitation in year 12. By comparing the life cycle cost of these two scenarios, the typical cost of a premature failure can be determined. It is assumed that the findings of a test program such as an Accelerated Pavement Testing (APT) technology development programme are used to reduce the frequency of a specific type of premature failure. Key assumptions relating to this example are defined in the Figure 4. More detailed assumptions relating to treatment costs and network sizes are provided in Jooste and Sampson (2004).

3.1.1 Results and Observations

The calculation of the life cycle costs and unit savings that can be effected by decreasing the likelihood of premature failure is shown in Figure 3 in South African Rands (NB:- at the time of the project exchange rate of US$1 = R6.0 or £1 = R11.0 were in effect) . The scaled total savings and benefit-cost ratios are summarized in Figure 4 for road networks of various sizes.

Evaluation of the Cost of Premature Failure

Benchmark Scenario

Year	0	
Action: Initial Rehabilitation	**R / m²**	**R / lane-km**
Heavy Rehabilitation	R 145.00	R 609,000
Ancillary Works & Contingencies (20%)		R 121,800
Total Cost of Construction		**R 730,800**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 730,800
	8%	R 730,800
	12%	R 730,800

Year	9	
Action: Surface Maintenance	**R / m²**	**R / lane-km**
Surface Seal	R 25.00	R 105,000
Ancillary Works & Contingencies (20%)		R 21,000
Total Cost of Construction		**R 126,000**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 88,526
	8%	R 63,031
	12%	R 45,437

Year	15	
Action: Light Rehabilitation	**R / m²**	**R / lane-km**
Light Rehabilitation	R 70.00	R 294,000
Ancillary Works & Contingencies (20%)		R 58,800
Total Cost of Construction		**R 352,800**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 195,897
	8%	R 111,217
	12%	R 64,455

Scenario with Premature Failure

Year	0	
Action: Initial Rehabilitation	**R / m²**	**R / lane-km**
Heavy Rehabilitation	R 145.00	R 609,000
Ancillary Works & Contingencies (20%)		R 121,800
Total Cost of Construction		**R 730,800**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 730,800
	8%	R 730,800
	12%	R 730,800

Year	3	
Action: Correct Premature Failure	**R / m²**	**R / lane-km**
Medium Rehabilitation	R 100.00	R 420,000
Ancillary Works & Contingencies (20%)		R 84,000
Total Cost of Construction		**R 504,000**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 448,054
	8%	R 400,091
	12%	R 358,737

Year	12	
Action: Light Rehabilitation	**R / m²**	**R / lane-km**
Light Rehabilitation	R 70.00	R 294,000
Ancillary Works & Contingencies (20%)		R 58,800
Total Cost of Construction		**R 352,800**
Discounted Cost per Lane-Km for Discount Rate of	4%	R 220,358
	8%	R 140,102
	12%	R 90,555

Benchmark Scenario

Life Cycle Cost per Lane-Km for a Discount Rate of	4%	R 1,015,223
	8%	R 905,049
	12%	R 840,692

Scenario with Premature Failure

Life Cycle Cost per Lane-Km for a Discount Rate of	4%	R 1,399,212
	8%	R 1,270,993
	12%	R 1,180,092

Summary of Costs Per Lane-Km

Lane-Km Cost for Premature Failure	**4%**	**R 383,989**
	8%	**R 365,945**
	12%	**R 339,400**

Note: A lane width of 3.7 m is assumed, plus an effective shoulder width of 0.5 m. Thus the effective lane width is 4.2 metres.

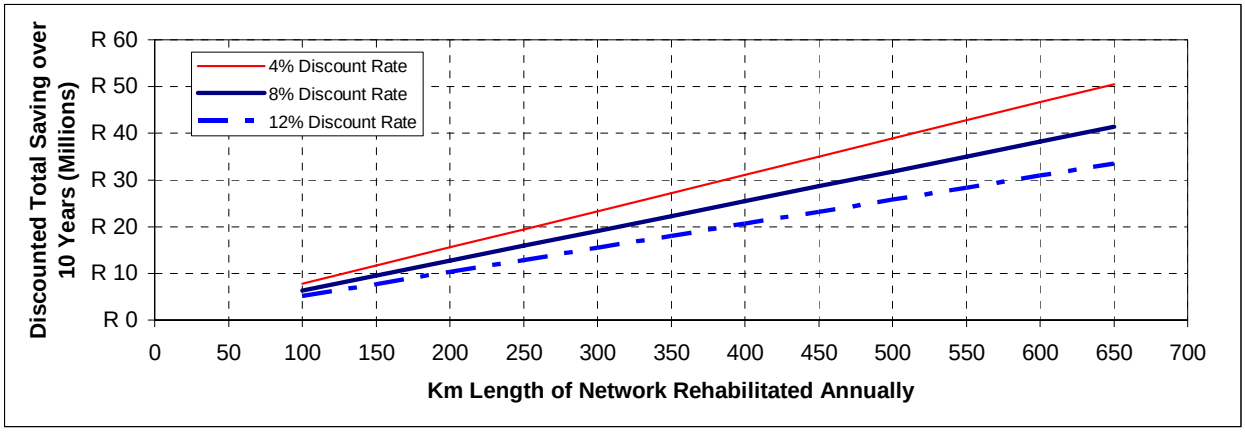
Figure 3: Evaluation of Life Cycle Cost Savings as a Result of More Reliable Design and Construction Processes

Key Assumptions

Percentage of rehabilitated length that failed before Technology Development Project findings were implimented = 5%
Percentage of rehabilitated length that failed after Technology Development Project findings were implemented = 3%
Contribution made by the findings of the Technology Development Project = 60%
Period over which savings are contributed to Technology Development = 10 Years
Annual cost of Technology Development work = R 4 million
Technology Development Period needed to deliver findings = 2 Years

Discount Rate	4%			8%			12%		
Savings / Lane-Km	R 383,989			R 365,945			R 339,400		
Annual	Savings			Savings			Savings		
Annual Km of 2 Lane Road Rehabilitated	Annual	Total Discounted Over 10 Years	Benefit Cost Ratio	Annual	Total Discounted Over 10 Years	Benefit Cost Ratio	Annual	Total Discounted Over 10 Years	Benefit Cost Ratio
100	R 921,573	R 7,773,774	1.0	R 878,267	R 6,364,702	0.8	R 814,560	R 5,154,741	0.6
150	R 1,382,360	R 11,660,661	1.5	R 1,317,400	R 9,547,053	1.2	R 1,221,840	R 7,732,111	1.0
200	R 1,843,146	R 15,547,548	1.9	R 1,756,534	R 12,729,404	1.6	R 1,629,121	R 10,309,482	1.3
250	R 2,303,933	R 19,434,435	2.4	R 2,195,667	R 15,911,754	2.0	R 2,036,401	R 12,886,852	1.6
300	R 2,764,719	R 23,321,322	2.9	R 2,634,801	R 19,094,105	2.4	R 2,443,681	R 15,464,223	1.9
350	R 3,225,506	R 27,208,209	3.4	R 3,073,934	R 22,276,456	2.8	R 2,850,961	R 18,041,593	2.3
400	R 3,686,292	R 31,095,096	3.9	R 3,513,068	R 25,458,807	3.2	R 3,258,241	R 20,618,964	2.6
450	R 4,147,079	R 34,981,983	4.4	R 3,952,201	R 28,641,158	3.6	R 3,665,521	R 23,196,334	2.9
500	R 4,607,865	R 38,868,870	4.9	R 4,391,334	R 31,823,509	4.0	R 4,072,801	R 25,773,704	3.2
550	R 5,068,652	R 42,755,757	5.3	R 4,830,468	R 35,005,860	4.4	R 4,480,081	R 28,351,075	3.5
600	R 5,529,438	R 46,642,644	5.8	R 5,269,601	R 38,188,211	4.8	R 4,887,362	R 30,928,445	3.9
650	R 5,990,225	R 50,529,531	6.3	R 5,708,735	R 41,370,561	5.2	R 5,294,642	R 33,505,816	4.2

Note: The discounted saving over 10 years assumes the saving is realized at the start of each year



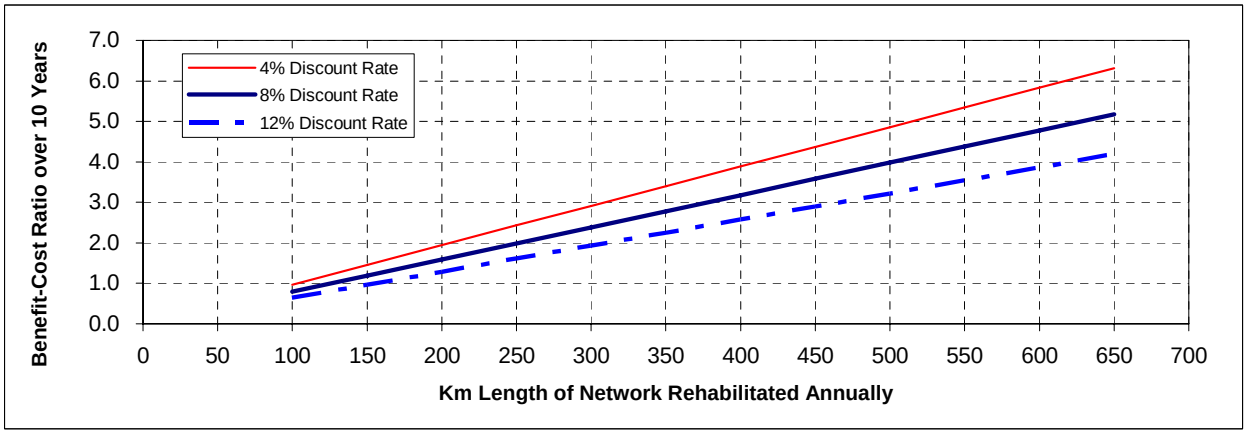


Figure 4: Scaling of Savings Resulting from More Reliable Design and Construction Processes

Table 1 summarises the findings and provides a clear indication that significant benefits can be derived from research and technology development projects in the road-building sector. This fact stems largely from the size of most road networks, which introduces a multiplication factor that greatly amplifies even small benefits resulting from research and technology development projects.

Table 1
Benefits from Research/Technology development projects in the Roads sector (Jooste et al, 2005)

Annual Paved Road Network Rehabilitation (km of lane-km/year)	Benefit/Cost ratio
150	>1.0
250	1.6 to 2.4
500	3.2 to 4.9

It is also important to note that the impacts defined and discussed do not include any of the indirect benefits associated with technology development projects (such as educational benefits). It will thus be appreciated that the benefit assessment represents a lower bound estimate of the potential benefits of road-related technology development work. As suggested by Scott et al (2002), the simple linear benefit assessment process fails to take into account the further downstream benefits and the impact of these benefits on the population at large. This means that the benefits shown in Table 1 probably greatly underestimate the true benefit stemming from the road-related research and technology development programmes.

In addition, the need for a systematic framework to take the knowledge generated by various projects and package it into implementable findings that can be transferred into practice is essential to derive the benefits presented here. This paper will provide further evidence of the successful transfer of knowledge through AFCAP and recommend a framework for ongoing transfer and implementation of research findings. As indicated earlier, the benefits of the AFCAP research programme is currently in progress.

3.2 AFCAP example from Mozambique

A cost/benefit analysis was undertaken in Mozambique to assess whether AFCAP is delivering value for money. A comparison was made of the future return from AFCAP projects with the investment made by DFID. The costs are clear, in that the DFID/AFCAP-funded projects to a value of £2.3m ($3.7m). The benefits were more difficult to assess although running the World Bank's RONET model with various scenarios and assumptions has identified a range of benefit-cost ratios from 1.5 to 3.1. This gives an annual rate of return of 27%-59% which demonstrates a good investment and is very much in line with the ratios shown in Table 1 from an independent study done in South Africa.

The identified benefits from the projects were:

- Cost reductions:
    - Lower construction and maintenance costs;
    - More resilient materials (and therefore lower maintenance needs).
- Higher benefits to road users (road performance improvement) through:

- Fuel savings;
- Reduced damage to vehicles;
- Time savings (faster travel).

4 Knowledge Transfer

The use of well researched and implementable evidence plays an important role in guiding investment decisions (including estimated returns on the investment and the benefits that can accrue) and improved service delivery in the road infrastructure and transport sector. This is of even more importance in low and middle income countries where resources are constrained and informed decision making is paramount, especially when competing for funding with other sectors of the economy such as health, education and safety and security. The provision of basic research and translation/transfer into implementable evidence for improved rural access to promote better connectivity, wealth creation, infrastructure growth and poverty alleviation, is fundamental to AFCAP.

Several knowledge transfer models can be identified from the sector. Their success, or otherwise, in getting research findings into practice and showing tangible benefits to the decision making and delivery process have been mixed. However, whatever the model or framework used, this is normally on an ad hoc basis and there is no formal approach that explains the knowledge transfer system from establishing the research agenda to final implementation and measurement of the impact of the research.

Much of the success of AFCAP over its first five years has been its ability to ensure that appropriate knowledge and solutions generated as part of the programme, or refined/incorporated from previous studies, has been transferred and implemented in practice. It is therefore important to capture and formalise the process into a framework for future use and refinement.

For the purpose of this paper, Knowledge Transfer (KT) is defined as:

> *A dynamic and iterative process that includes analysis, dissemination, exchange and application of knowledge for the roads and transport sector.*

Although very little evidence of KT frameworks specific to the roads and transport sector can be found in the literature, similar problems and parallels can be found in the health sector and summarised in Orem et al (2012) based on a study in Uganda. The following main facilitating factors to KT (or in their context Knowledge Translation) are of relevance:

- **Institutional Strengthening:**
  - There is a need to build the capacity of policy and decision makers in the research process so that they understand the evidence from research that underpins their decision.
  - A formal linkage with all stakeholders is required through an institutionalised platform for systematic dialogue and engagement.
  - There should be a central coordinator of research and evidence generation, dissemination and implementation embedded within the most appropriate government department, agency or authority.
  - Reduction in the bureaucracy of the decision making process is required.

- **Research Findings:**
  - The scientific soundness, relevance, timeliness, comprehensiveness of evidence and the feasibility for implementation are critical.
  - The credibility, standing and reputation of the researcher(s) is important.
  - The organisation that commissions the research tends to dictate how seriously the findings are taken. Generally, if the work is commissioned by the relevant government department or a donor programme linked to the department, the research will have more credibility.
- **Dissemination of Results:**
  - Research evidence should be well packaged, using multiple dissemination channels as appropriate, that are tailored to different audiences.
  - All stakeholders should be part of the dissemination process.
  - Advantage should be taken of existing forums and dissemination channels, both formal and informal.
  - A well-informed and knowledgeable civil society should be included in the dissemination process because of their roots in communities, advocacy and their ability to mobilise communities and pressurise policy makers into implementing evidence.
  - Responsibility for dissemination should be assigned within the relevant government department.
  - Dissemination is a process that should be planned at the beginning of the research process.
  - Funds need to be made available for dissemination.
  - A "champion" of the research within government linked to decision makers greatly enhances the likelihood of dissemination and implementation.
- **Partnerships:**
  - All relevant stakeholders should be involved in the whole research process from setting the research agenda to policy development and implementation of findings.
  - Stakeholders should include representation of the communities who are the likely beneficiaries of the research.

5 The AFCAP Experience of Knowledge Transfer

A survey was undertaken of a representative sample of AFCAP participating countries to investigate the formal processes that are in place nationally to manage research, disseminate the results and implement the findings. The main conclusions from the survey were;

- **Current research management structures**
  - All countries have or are in the process of establishing an organisation for research and knowledge generation. Some countries have research centres as part of government structures or the authority/agency responsible for the national/federal road network; and some have assigned responsibility to established Technology Transfer (T^2) Centres.
  - Only one country surveyed had a formal research management structure to oversee the national research agenda, project approvals, quality assurance and Knowledge Transfer mechanisms.

    - Only one country had a formal advisory structure (Research Steering Committee) to include external stakeholders in deciding the research agenda and assist in the project review process.
- **Research needs identification and prioritisation**
    - Research needs are mainly decided on an ad hoc and informal basis through interactions with the relevant stakeholders and practitioners.
    - Questionnaires and formal meetings were used by one country to provide a more formal structure for needs identification.
    - Only one country had a formal process for prioritising needs in line with agree weighted priority indicators.
- **Knowledge Transfer processes**
    - The main forms of knowledge transfer are through best practice manuals and seminars/workshops. Conferences, training courses and regular research newsletters are also used in one instance.
    - There is no formal library or Knowledge Information Centre for management of knowledge and documentation related to roads and transport in any of the countries surveyed.
    - One country has established formal links with international road research organisations through MoUs to support capacity development; mentorship; and knowledge transfer initiative, and is in the process of developing a Knowledge Information Centre (KIC) as part of its Research Directorate.
    - Technical Assistance from local and international experts is used in some instance.
- **National Roads and Transport research capacity**
    - Most research is managed by the responsible government department or organisation; and through universities where a pavement engineering and/or geotechnical capability exists.
    - Local and international consultants and research organisations also undertake contracted research projects managed by the responsible organisation or department.
    - Basic laboratory equipment suitable for some research activities is available in all countries.
    - Funding for research in some countries is only available from programmes such as AFCAP.
- **Promotion and awareness of the need for road and transport research centres**
    - All countries surveyed identified the need for a national road research centre, or similar, with linkages to similar organisation throughout Africa and globally, for road research coordination, knowledge sharing and transfer.

6 AFCAP Practitioners Conferences

As part of the AFCAP programme and its commitment to knowledge sharing and transfer, two regional conferences were organised; in Ethiopia in November 2010 and in Mozambique in July 2012. The purpose of the conferences was:

- To share knowledge from the various country programmes;
- To create a network of knowledgeable, regional practitioners;
- To promote the uptake of sustainable roads and transport-related research capacity on a national and regional level.

The following outcomes and recommendations from the conferences are highlighted here and impact on the framework and recommendations presented later:

- AFCAP is making significant incremental progress in promoting research and knowledge transfer for improved decision making in member countries and confirmed the positive outcomes from the annual review undertaken by DfID in 2012;
- DFID was urged to continue its leadership role in supporting AFCAP for at least the next 5 years and continue to facilitate the building of research capacity and knowledge sharing throughout sub-Saharan Africa.
- AFCAP should include a balanced portfolio of short, medium and long term projects and ensure that the gains from the research projects are well publicised to practitioners, stakeholders and targeted decision makers.
- Attention needs to be given to promoting the benefits of rural transport related research to policy makers, including through the implementation of research outcomes.
- Any regional coordination structures for research should be developed within current established organisational structures. ASANRA (Association of Southern Africa National Road Agencies) already has a research coordination committee but does not represent all AFCAP member countries. It was therefore suggested that ARMFA (African Road Maintenance Fund Association), as a widely representative organisation, should be considered to provide the broader coordination role. Actions were agreed to approach ARMFA in this regard.
- For research in sub-Saharan Africa to become sustainable, countries must be capable of generating their own research funding and become less dependent on donor funding through programmes such as AFCAP. This could be coordinated through ARMFA. National Road Funds should be encouraged to provide sustainable funding for research from the revenues collected. The future role of development partners will be to support capacity development rather than the direct funding of research.
- Participating countries in AFCAP should be increased to provide a broader knowledge base. However, it was agreed that a transparent process should be adopted for evaluating suitable countries. Expansion of the programme into West African countries was also suggested.
- A central web-based source of reports and information should be developed. However, clear roles and responsibilities need to be assigned as to how this regional knowledge-source would be managed on a sustainable basis.

Feedback from the conferences and the survey of current research and KT practice in AFCAP participating countries have been used to develop recommendations for a sustainable framework to institutionalise and coordinate research and knowledge transfer in sub-Saharan Africa. This presented in Section 7.

7 Framework for Managing Research and KT

It is now a generally accepted fact that implementable and sustainable research specific to the unique conditions of Africa is critical to the provision of an appropriate and well maintained road infrastructure and associated transport services to connect rural areas to national economic centres. The information emanating from research and technology development projects should

be specifically targeted at improving the decision making process; and reducing the risk associated with those decisions; whether they be related to policy development, planning strategies, material selection, design options, construction and maintenances practice or transport service provision. It is also important that any decisions are, where possible, based on appropriate African evidence and knowledge and not from inherited often inappropriate, international practice.

For this to be a reality and institutionalised by governments at national level, a framework needs to be developed and accepted at many different levels to ensure consistent implementation. It is also important to note that the research and technology development process, including knowledge transfer and implementation is non-linear. It is iterative and updatable as new knowledge and information becomes available. The basic process is shown in Figure 5.

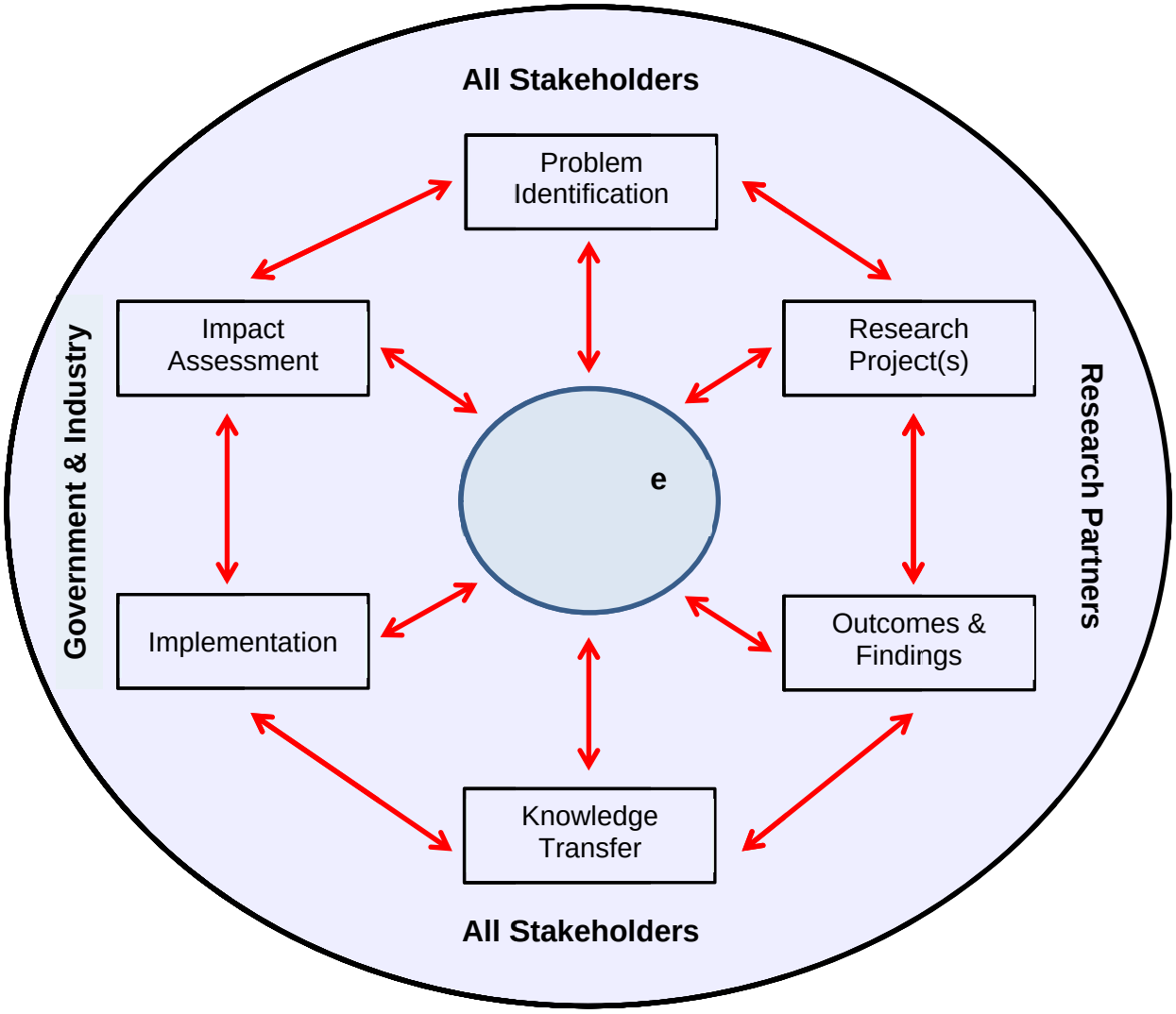


Figure 5: Basic Knowledge Development and Transfer Model

The recommended framework and actions for managing a sustainable national research capacity for knowledge generation and transfer is shown in the following sections and is based on the Ethiopian experience which, based on the survey, is the most advanced and extensive of the AFCAP participating countries.

7.1 Institutionalising Research

Step 1:
Ensure the relevant Government Department, Agency or Authority responsible for the overall management of the roads sector is committed to research and the development or customisation of knowledge to improve decision making for more efficient and effective delivery of infrastructure and services. This commitment and supporting action plans for implementation should be clearly stated in all overarching national strategy and policy documents for roads and transport.

Step 2:
Ensure that there is a specific section, department or directorate within the relevant government department responsible for Research and Knowledge Transfer (R&KT) with clearly defined roles

and responsibilities. It is important to note here that a clear strategy for managing and undertaking research projects (in-house v consultants), coordinating research projects and feedback to decision makers, practitioners and other stakeholders is developed.

Step 3:
Ensure that there is a sustainable source of funding for R&KT from the national budget to build and sustain national capacity in the area. Where Road Funds have been established, discussions and agreements may be required to allocate a percentage of funds from this source for R&KT. It is recommended that future funds from donor programmes such as AFCAP are specifically targeted at capacity building interventions for technical assistance and mentorship rather than the appointment of consultants to undertake specific research projects. The research projects should be managed and undertaken by local researchers (in association with local universities where relevant) supported by experienced international experts to mentor and direct researchers.

Step 4:
Ensure there is a formal structure for stakeholder involvement. Normally this would be through an advisory committee of relevant stakeholders that would meet on a regular basis to assist in needs/problem identification; providing focus to research projects; providing technical comment and review of outcomes from research projects; and to assist in the KT processes.

Step 5:
It is important that there are well documented and inter-linked national policies, strategies, technical guidelines, standards and associated drawings, specifications and bidding documents that support the sector and set out how things are done nationally. Ultimately, it will be the development and updates of these documents and procedures, based on information and knowledge gained from a well-structured research agenda, which will be the foundation for KT and the formal implementation of findings.

7.2 Developing the Research Agenda

Step 1:
Ideas for research projects could arise at any time and from a multitude of sources. Whatever the source, it is important to ensure that formal structures are in place to capture and manage the identification of problems and needs. This could be through several sources both internal for the various government departments responsible for the road network at various levels (eg National, Provincial/Regional and District) and external for the various stakeholders (eg Contracting and Consulting Associations; Representative Industry Bodies; Relevant Statutory Councils or Bodies; Tertiary Institutions; Road User Groups; and Community Bodies).

Step 2:
The organisation responsible for research coordination should compile a list of research titles with short one page summaries of the proposed projects.

Step 3:
Develop a prioritisation process which should include a weighted ranking procedure that allows projects to be prioritised. This will include a relatively subjective assessment of the project against factors such as overall strategic goals, likelihood of success and implementation, available resources, timing and estimated cost. This would be the first filter of ideas and is essential to allow a decision to be made on which projects should be undertaken immediately and which could be phased into a programme over say a 3 or 5 year period to fit into budget allocations.

Step 4:
Develop a 3 to 5 year programme of projects that are phased over the period. Ideally, the programme should contain a balance of short, medium and longer term projects. It is also important that the programme is sufficiently flexible to accommodate new projects and ideas that arise during the tenure of the programme.

Step 5:
Present the agenda or programme for research for agreement and approvals through the formal structures of stakeholders.

Step 6:
Develop detailed project proposals including methodology, resources, budget, KT interventions and implementation plan in line with the agreed programme.

Step 7:
Obtain final approval from the oversight committee of government or client body for funding of the projects.

Step 8:
Manage the project against agreed deliverables in the project proposal with regular feedback through the established formal structures and committees.

7.3 Knowledge Transfer and Dissemination

Step 1:
Assign responsibility for the management of KT to the government department or directorate responsible for research.

Step 2:
Establish a Library and/or Knowledge Information Centre to manage KT within the research department with a suitable database structure and web site. Linkages with other relevant local, regional and international information sources need to be established to access relevant documentation.

Step 3:
Ensure that the methods of KT and implementation of the findings are included in the original project proposal and costed accordingly in the overall project costs.

Step 4:
Identify suitable partners that could be involved in the KT process. This could include existing local and regional networks and organisations; professional bodies, industry associations; or academic institutions.

Step 5:
Ensure that all relevant stakeholders are involved in the KT process. Typical KT interventions are:

- Stakeholder workshops either during a project to gather information and to test ideas; or at the end of the project to feedback findings.
- Regular newsletters to keep the stakeholders apprised of the progress with research projects and to create awareness of latest knowledge;

- An up-to-date web site allowing access to, and downloading of, soft copy of all relevant national documentation such as manuals, guidelines, standards and specifications. Linkages to other information sources should also be provided on the web site.
- Publication and distribution of new manuals, guidelines, standards and/or specifications;
- Amendments to existing manuals, guidelines, standards and/or specifications;
- Publication of papers at conferences and in technical journals;
- Organisation of national and regional conferences for feedback of latest best practice.
- Training courses. This could be funded as part of specific projects or may be required later in the process once the research findings have been tested and modified over a period.
- Inclusion in University curricula.

7.4 Impact Measurement and Review

As indicated in section 3, the competition for funds for research in a climate of strict economic constraints dictates that there is increasing pressure to demonstrate that the research is effective and providing "value-for-money". Decision makers increasingly need to know that their support of research is contributing to the national well-being in measurable and demonstrable ways with benefits that are greater than those which would accrue from similar investments in other areas. It is also noted that supplying the necessary information for measuring the impact is difficult because of the complexities between research, KT, application and the overarching socio-economic environment into which the findings are applied. Despite this the following steps are recommended in the measurement process.

Step 1:
Identify a suitable method of measuring impact. It should however be noted that while there are many possible measures of impact of research, none will provide undisputable results and evaluations carried out at different times can produce widely varying results and conclusions. It is therefore necessary to select a method(s) best related to the purpose of the assessment exercise and the level at which the information will be used. Possible methods are:

- Measurable output criteria/indicators and benchmarking;
- Expert/Peer Review;
- Anecdotal evidence;
- Case studies;
- Cost-benefit analysis;
- Stakeholder and commercialisation surveys.

Step 2:
Develop specific methodologies and indicators related to the chosen method(s).

Step 3:
Collect and analyse appropriate indicator data.

Step 4
Identify suitable feedback mechanisms of the impact of research to politicians, decision makers, clients and stakeholder groups.

8 Regional coordination

There is a vast amount of information and best-practice knowledge specific to sub-Saharan Africa than can be customised for national use in manuals, guidelines, design standards and specifications. However, for this to be effective it is recommended that a formal structure be established to facilitate knowledge transfer throughout the region and optimise the resources required to provide a workable and efficient KT infrastructure.

The coordination process presupposes that there are supportive national governments and champions within those departments that are committed to innovation and improvement through the implementation of appropriate technologies and research findings for better delivery and maintenance of the road infrastructure and associated transport services.

Based on discussions with AFCAP participating countries, there is no doubt that one of the major constraints to the development of national research centres and programmes is the lack of qualified and experienced individuals to manage and undertake research projects. This is compounded by the lack of post-graduate pavement engineering qualifications at most African universities outside South Africa and the inability of government structures to provide competitive packages to attract talented and committed individuals required for successful research organisations.

Hence, in the short to medium term there seems to be little option but for funders such as AFCAP to provide technical assistance from suitably qualified individuals (either local or international) and established international roads and transport research organisations for mentorship and capacity building interventions. Shared assistance to more than one country could also be an option.

The following regional structure is proposed and summarised in Figure 4:

- Establish national road research units. In some countries this could be based on existing materials testing laboratories or Technology Transfer (T^2) Centres or both. The reason being that basic equipment required for some research project will already exist and it is a workable option to retain and build important materials testing capacity within government structures. The loss of technical capacity within government is seen as a major constraint to managing infrastructure delivery.
- Create a regional coordinating structure through existing organisations such as ARMFA.

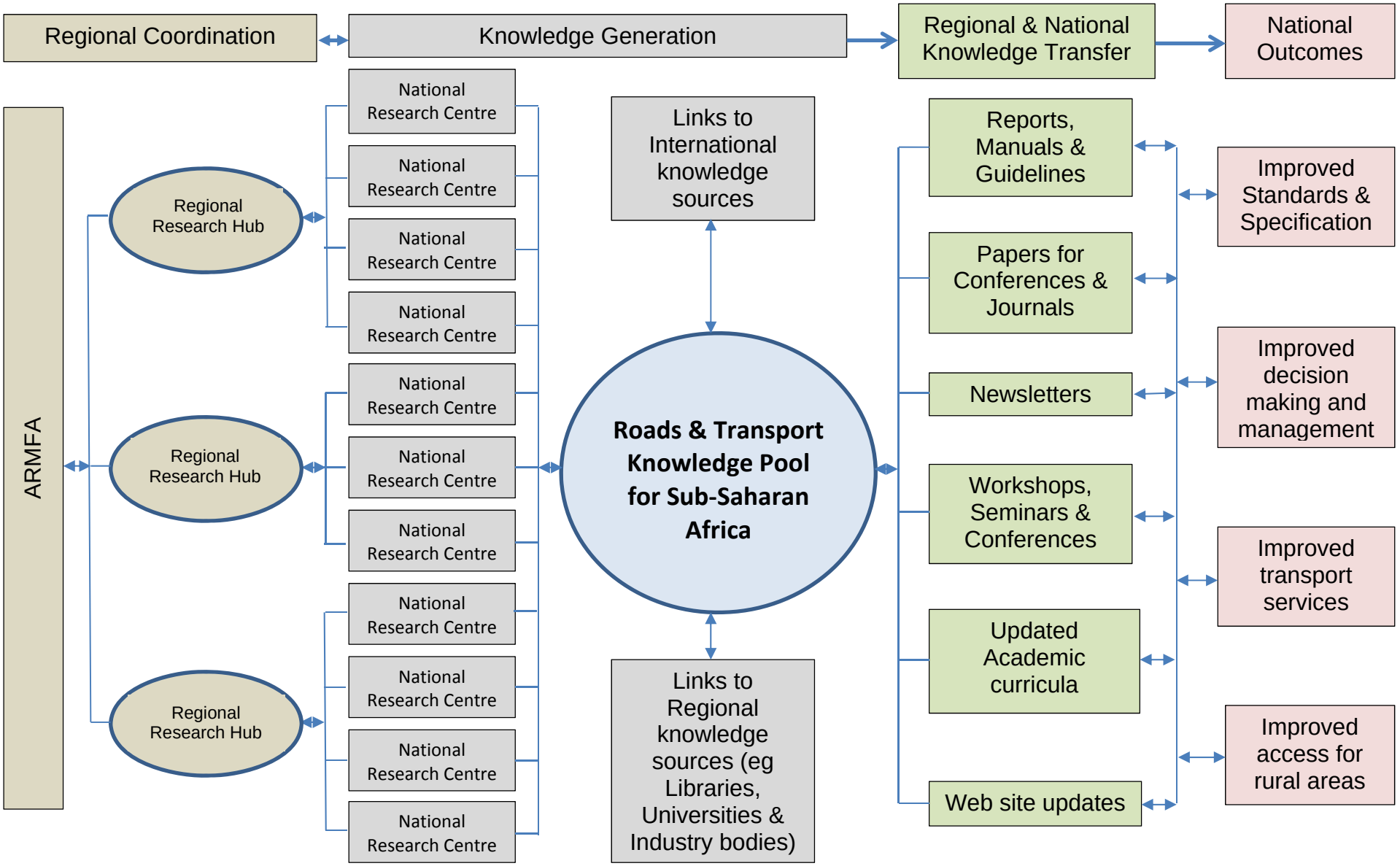


Figure 4: Regional Coordination Framework for Knowledge Generation and Transfer

- Establish regional research hubs for Southern, Eastern and Western Africa and link national research centres to the regional hubs. The hubs would provide specialist equipment which could be used for national projects within the hub or for coordination of joint regional projects. The regional hubs would also provide a consolidated list of projects and outcomes within their region and coordinate KT initiatives. In this regard, regional training and education hubs aligned to specific Universities and Centres could also be developed (as suggested by Brushett el al in 2004) for KT.
    - The Southern Africa hub would probably be based around the existing Council for Scientific and Industrial Research (CSIR) facilities in South Africa and linked to existing structures within the Association of Southern Africa National Road Authorities (ASANRA). The member states of ASANRA would establish national research centres to link into the hub.
    - The Eastern Africa hub could possibly be based at the Ethiopia Road Research Centre which is currently being established by the Ethiopian Roads Authority. Construction of the new facility is expected to be completed by the end of 2015. Countries that could be linked through national research centre would be Kenya, Uganda, South Sudan and Rwanda.
    - The Western/Central Africa hub still needs to be investigated and developed. It could also satisfy the needs of francophone countries in the region.
- Current funders of regional research programmes such as AFCAP, the EU and the World Bank will be required to facilitate the process in the short to medium term both at regional and national levels.

9 Conclusions

Without a defined framework for a coordinated approach to knowledge generation and transfer, the benefits that could accrue from investments in research will become sub-optimal. In low and middle income countries, where competition for scarce resource is high, it is important that sectors of the economy such as roads and transport are well placed to motivate and promote the benefits of a coordinated approach to research and knowledge transfer for improved decision making and delivery of infrastructure and services.

With this in mind, and based on 5 years of experience with AFCAP, a framework is presented that formalises the approach to institutionalising research management and knowledge transfer activities at a national level. Fundamental to the framework presented here is the development of national research centres (or similar, such as T^2 Centres which exist in some countries) to coordinate knowledge generation and transfer relevant to the national policies and strategies.

It is also important to harness and coordinate the vast amount of fragmented information that has been generated throughout the sub-Saharan African region for better use and implementation. This approach would also minimise duplication of effort and availability of scarce resources irrespective of the economic climate. It is recommended that a structure of national research centres, which would liaise with regional coordinating hubs for more advanced research projects requiring specialist equipment, should be established. ARMFA is recommended to oversee the coordination at regional level.

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