

THE ROLE OF R&D IN TRANSPORT INFRASTRUCTURE IN SOUTH AFRICA

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ABSTRACT

The current status of South Africa's infrastructure is analysed with emphasis on transport infrastructure. The role of Science, Engineering and Technology as well as associated Research and Development in supporting the development of sustainable infrastructure for South Africa is discussed. World-wide questions are asked about the status of infrastructure and the required actions towards sustainable infrastructure provision. The current poor state of infrastructure in South Africa and the lack of skilled professionals in the infrastructure sector demand an increased focus on the development of new knowledge, engineering technologies and skilled human resources. In spite of current government policy in South Africa that R&D expenditure must be increased to a minimum of one per cent of GDP, there is currently a lack of focus in the national R&D agenda and in government departments on transport-related research. A list of potential focus areas for future transport research in South Africa was compiled from local and international information. The stumbling blocks in the process of R&D procurement and co-ordination are discussed and some recommendations made to improve the current situation.

1 WHY IS A TRANSPORT INFRASTRUCTURE DISCUSSION RELEVANT?

1.1 Importance of transport infrastructure

There is no doubt that infrastructure in general and specifically transport infrastructure plays a major role in economic development (Weisbrod G 1997, Chapman P et al 2002) as well as in social development (UNCDF 2007). In addition, construction activities form a significant part of a country's GDP. In South Africa the construction industry contributes only 2.8% to the GDP, although it is currently growing three times as fast as the total South African economy. Ferreira and Khatami (1996) argue that investment in social and economic infrastructure will play an important role in increasing the productivity of labour and business. The importance of social development had been particularly highlighted in striving towards achieving the Millennium Development Goals (MDG 2007).

The South African government recognised the importance of transport and transport infrastructure in policies such as the Reconstruction and Development Programme (RDP 1994), the Growth Employment and Redistribution (GEAR 1996) and the Accelerated Shared Growth Initiative for South Africa – Asgisa (Mlambo-Ngcuka 2006). GEAR specifically states a requirement for “an increase in infrastructural development and service delivery making intensive use of labour-based techniques.” The Asgisa strategy refines the objectives of GEAR by placing specific emphasis on “*[aligning] economic growth with improvements to the well-being of the poor. In terms of political economy, this requires developmental strategies enabling the poor to participate in economic growth, as well as benefit from it. For example, giving the poor better access to economic*

opportunities (employment, assets and markets), as well as to basic public services (education, health, housing, water, sanitation, etc), would contribute significantly to growth." (Yemek E 2006)

This recognition has recently also been manifested in the South African Government's decision to make a special budget allocation of R320 billion towards infrastructure development (EN 2005). This figure was later increased to more than R400 billion. The strive for improved infrastructure in South Africa is of course also currently fuelled by the expectations around a world-class soccer world cup event in 2010. Transport features significantly in this investment as well as in mega-events such as the world cup. However, South Africa's growth is currently hampered by two key constraints: lack of skilled manpower and lack of appropriate infrastructure (Bruggemans 2005).

1.2 Sustainability

The balance between economic development, environmental sustainability and socially acceptable infrastructure is critical:

"By promoting economic growth strategies based on expanded infrastructure which are environmentally responsible and socially acceptable we are bringing a sustainable future closer to today's reality."

Katherine Sierra, Vice President for Sustainable Development, (World Bank 2007)

In South Africa the transport sector accounts for 26.5 per cent of total energy usage (DSAS 2005). This places special emphasis on sustainability aspects of the transport sector.

1.3 The importance of SET in transport

In general Science, Engineering and Technology (SET) have a broad impact on society, including the stimulation of economic growth (Bresnahan and Trajtenberg 2003) and socio-economic impact (Goldman SL 1989). SET and innovation relating to disciplines related to transport is therefore one of the major factors in ensuring that transport systems and infrastructure is of the desired quality and impacts optimally on both the economy and society. The National Research and Development Strategy of South Africa (DST 2002) specifically states:

"Innovation is the key process by which products, processes and services are created, and by which businesses generate jobs and wealth. In addition, in the social sphere, effective innovation has a direct impact on the reduction of poverty and the improvement of the quality of life of our people. It is critical, therefore, to increase the rate and quality of innovation in South Africa."

The SET base in the transport disciplines is diverse and there are specific gaps in knowledge especially pertaining to local issues such as local environmental conditions, local construction materials, the urban form relating to the apartheid legacy (which impacts on transport systems), rural development requirements etc.

1.4 Status of infrastructure and remaining questions

Some investigations have been done recently into the status of South Africa's infrastructure and related policy and technology questions (SAICE 2006, Milford et al 2001). It has also been stated that South Africa has been living off a legacy of good infrastructure in the past decade since the election in 1994 (Bruggemans 2005). However,

infrastructure is now in dire need of upgrading and maintenance as is reflected in the recent injection of funds into infrastructure projects by the South African government. This has however, placed renewed emphasis on a critical assessment of South African infrastructure, specifically relating to the following questions:

- What is the current state of infrastructure in South Africa and how well is South Africa geared to improving infrastructure?
- How sustainable will future infrastructure provision be?
- What are the most important underlying drivers for ensuring sustainable infrastructure provision?
- What can be done to ensure that the underlying drivers are addressed and that they support national imperatives on infrastructure provision?
- What are broad themes for developing new knowledge and technology development to support the provision of a sustainable infrastructure system?

The purpose of this paper is to explore the above questions, particularly as they pertain to infrastructure related to the transport sector in South Africa.

2 THE STATUS OF INFRASTRUCTURE IN SOUTH AFRICA

2.1 General status

There is concern about the ageing status of infrastructure all over the world. The Urban Land Institute in the USA states that:

"The United States, in particular, and most of Europe stumble to repair and retool aging roads, plants, and levees that may no longer serve a changing paradigm for how people will live and work in the future." (ULI 2007)

The ULI also refers to the estimation by the World Bank that the projected funding gap for infrastructure in the USA is ominously huge at \$1.6 trillion over the next five years. Asia's needs are estimated at \$1 trillion over the next five year period.

The South African Institute for Civil Engineers (SAICE) recently assessed the status of infrastructure in South Africa and developed an infrastructure report card (SAICE 2006). SAICE reports that, although the South African government has embarked on a programme of increased infrastructure spending, there is still a failure to invest in the maintenance and renewal of infrastructure.

According to SAICE infrastructure in South Africa fall into the following categories of grades (see Table 1). Thus according to SAICE most of the infrastructure in South Africa is in a fair, poor or very poor state.

Some examples of the reasons for this status are quoted by SAICE as:

- accommodation needs in the nation as a whole but, more importantly, population movements across the nation, together with new household formation is faster than population growth;
- a long history of neglect of maintenance of infrastructure;
- the hugely successful rollout of new infrastructure, but generally without concomitant growth in the resources (principally skills and budgets) allocated to looking after the infrastructure;
- an overall skills shortage, especially of engineers and artisans, and a slow rate of new entry to the profession;
- institutional changes (for example in local government); and

- a number of unsustainable investments that have been made.

Table 1: Summary of infrastructure status according to SAICE report card

Rating	Sector
Very Good	No infrastructure
Good	Heavy haul freight railway lines; airports owned by the Airports Company of South Africa
Fair	Water, sanitation and solid waste management in major urban areas; national roads; Transnet owned ports; general freight railway lines; national and local energy distribution networks; hospitals
Poor	Bulk national water infrastructure; non-urban solid waste management; non-national roads; passenger railway lines; non-urban electricity distribution networks
Very Poor	Non-urban sanitation; some uneconomical general freight railway lines.

Prior to 2005, public sector investment in South Africa as a percentage of GDP dropped to less than half of that of previous levels. Thus adequate maintenance levels were not maintained in many areas (particularly roads and railways) and new capacity additions were kept to a minimum with emphasis shifting to other social objectives (Bruggemans 2006). This is exacerbated by the fact that the previous government did not acknowledge the infrastructure needs of the majority of South Africans. This resulted in eventual bottlenecks and unnecessary shortages (e.g. electricity, municipal infrastructure), congestion (e.g. ports, roads), overloading (roads), damage (roads, harbours), underutilisation and loss of relative importance (railways) and technology shortcomings (communication). In addition, the consequential erosion of construction capacity was extremely detrimental eventually halving the industry's size relative to GDP compared with the preceding decades. The loss of critical engineering skills was severe.

Bruggemans furthermore states that effectively the size of the construction industry has to double relative to GDP, and there needs to be substantial further capacity additions in related material supply industries. Crucially he also acknowledges the outdated nature of the technology knowledge and application base within South Africa's construction sector. Consequently South Africa faces a R170-billion backlog of essential infrastructure (2003 figure), including dams, sanitation, roads, clinics and police stations (World Bank 2003).

2.2 Logistics

The generally poor state of infrastructure in South Africa, particularly transport infrastructure, also leads to high costs in logistics. In South Africa the cost of logistics as a percentage of GDP is more than double that of developed countries (DOT 2005). The National Freight Logistics Strategy, NFLS (DOT 2005) considers the system to be "*structurally incapable of appropriately allocating costs and raising efficiency*". Elements of the system perform well, but the overall system performance and especially the state of infrastructure constitutes the bulk of the problem. The view of the NFLS is that an integrated system-level approach is required, that shifts the system's emphasis from a

focus on supply towards the demand-driven delivery of freight logistics services. The concise summary of the problem statement that the NFLS responds to is:

"The freight system in South Africa is fraught with inefficiencies at system and firm levels. There are infrastructure shortfalls and mismatches; the institutional structure of the freight system is inappropriate and there is a lack of integrated planning. Information gaps and asymmetries abound; the skills base is deficient and the regulatory frameworks are incapable of resolving problems in the industry."

2.3 Current expenditure levels

Although expenditure on infrastructure is increasing, so is the demand for infrastructure and services not only in South Africa but throughout the African continent. Some \$40 billion investment in infrastructure is needed in sub-Saharan Africa, of which \$8 billion is required for electricity. By contrast, total infrastructure investment since 1985 has amounted to around \$12 billion (EN 2007).

The black middle class pushed internal consumption to unprecedented rates, particularly in motor vehicle sales. About 5 million South Africans claim to own, use or maintain a motor vehicle, and drive approximately 5.6 billion kilometres per month (AMPS 2006). In addition, sales of motor vehicles are heading towards the 1 000 000 mark per year which will add significantly to current traffic volumes and road use.

South Africa aims to spend R409 billion – up from an earlier R372 billion – in building and refurbishing infrastructure (power infrastructure, roads, commuter rail, housing and bulk infrastructure) and other projects to 2010 (EN 2005). Included in this amount is the Gautrain, R97 billion on power plants, R19 billion on the Airports Company, and R100 billion on nuclear plants (SAHF 2007).

Government has stated that expenditure on public investment would grow by a further R150 billion a year by 2010 (EN 2007). This is to support a broader capital-investment programme, focussed on creating economic opportunities for businesses and individuals, and progressive improvements in household living conditions. However, while the increase in government infrastructure spending would increase by about 15% per annum to 2010, it would reduce to about 10% in the long term.

3 DRIVERS, TRENDS AND ISSUES IN THE TRANSPORT INFRASTRUCTURE SECTOR

A recent study investigated the current drivers, trends and issues related to transport infrastructure provision in South Africa (Rust and Venter 2004). This study highlighted the following as important issues to be considered:

Institutional drivers

Institutional capacity

Low levels of institutional capacity impact seriously on service delivery.

Decision making and integrated planning

The integration of government planning of infrastructure remains problematic and is particularly related to capacity problems and systems incompatibility

Economic drivers

Continued growth in of the South African economy

The targeted growth rate of 6 per cent for South Africa will certainly lead to increased investment into infrastructure (ASGISA 2006).

The second economy

Transport and transport infrastructure is a major driver in facilitating the stimulation of growth in the second economy (Yemek 2006).

Continued globalization of markets and production

The process of globalisation has drawn attention to the productive potential of cities (Rust and Venter 2004). Increasing economic interdependence is reducing the ability of national governments to regulate or govern their own economies with a consequent greater vulnerability to global slowdowns.

Growing regional cooperation in Africa and SADC

Initiatives such as the New Partnership for Africa's Development (NEPAD) provide a platform for common markets and harmonized standards and procedures for infrastructure provision thus making it easier to integrate operations across borders.

Human resource drivers

Skills shortage

Whereas Western Europe, North America, India and China have between 130 and 450 people per engineer, only one of every 3200 South Africans is an engineer, a ten to twenty-fold disadvantage (SAICE 2006). South Africa is also steadily losing skilled manpower, especially civil engineers (Creamer 2007). The shortage of professionals in infrastructure-related disciplines can be associated with reduced knowledge-generation activity and R&D (DST 2002). Civil construction companies continue to struggle to procure sufficient skilled labour in order to cope with current work volumes. No less than 94% of respondents to the civil construction survey during the 2nd quarter of 2007 indicated that shortages of skilled labour were "hampering" their activities and "impairing" their ability to complete contracts on time (Bruggemans 2007).

Environmental issues

Amidst world-wide recognition of the "peak oil" crisis as well as the emphasis on climate change it is pertinent to consider the energy and resource consumption of the transport sector. Cement production is, after the burning of fossil fuels, the biggest anthropogenic contributor to greenhouse gas emissions (Du Plessis 2002). The cement industry world wide emits more than 1.37 billion tons of carbon dioxide per year (Humphreys and Mahasenan). Although cement makes up only 12-14% of the final concrete mix, additional embodied energy comes from the transportation and extraction of aggregates and, in the case of reinforced concrete, the manufacturing of steel. The Department of Mineral and Energy affairs reported that, in 2004 transport consumed 25.7 per cent of energy in South Africa (DME 2006). This is second only to the 36 per cent of energy consumed by industry.

Societal drivers

Continued population growth and urbanisation

Some 3.3 billion people – more than half of humanity – will be living in cities by 2008 (UNPF 2007). By 2030, cities will be home to almost 5 billion people with 81% located in developing countries. Many of the new urbanites will be poor, and probably unlikely to afford infrastructure service costs. However, unlike other cities where birth rates are driving urban population growth, migration from rural areas is largely driving urban population growth in South Africa (STATS SA 2007).

Operational drivers

Logistics

Logistics is recognised as a very important driver in the South African industry. The ASGISA strategy recognises the importance of the removal of six constraints to economic growth. One of these constraints is "the cost, efficiency and capacity of the national logistics system, which was pushing up the price of moving goods and conveying services over long distances" (Mpahlwa 2006).

Traffic congestion

The current traffic congestion experienced in cities will increase as the economy grows and as demand for private transport increases.

Law enforcement

In a scenario of increased population growth and increased traffic growth, law enforcement becomes an increasingly important issue.

Safety and security

In South Africa security, especially personal security remains a major issue. This factor impacts on the design of the urban environment as well as transport systems.

SET drivers

The main Science, Engineering and technology drivers for the broader transport sector are discussed below.

Materials technology

The main issues relating to traditional construction materials include the scarcity of natural materials for road building, the increasing cost of bitumen due to rising oil prices, the potential future scarcity of cement, the fact that cement manufacturing causes a significant amount of greenhouse gasses and the need for innovative construction materials with enhanced performance.

Information and communication technologies (ICTs)

ICTs and related technologies will play a significant part in the future transport sector, particularly relating to intelligent systems for traffic control, intelligent construction processes and the monitoring and control of the performance of transport infrastructure assets.

Energy optimisation

The current focus on the importance of energy use optimisation is of major importance to the design, construction and operation of the transport environment due to the fact that in South Africa this sector consumes a major portion of the available energy in the country.

Environmentally-friendly solutions

As indicated above, environmental issues are becoming increasingly more important in the transport sector. In the future more emphasis will be placed on mitigating these impacts with specific solutions.

Alternative fuels

The drive towards finding hydrogen-based and other alternative fuels for transport and energy creation will continue to impact on the design, construction and operation of the transport environment.

4 PROPOSED FUTURE SCIENCE AND TECHNOLOGY FOCUS AREAS

The proposed research agendas from a number of local and international sources were analysed. These include:

- Agenda 21 for Sustainable Construction in Developing Countries (Du Plessis 2002)

- South African Department of Transport innovation and technology research strategy(DOT 2005b)
- Transportek foresight study(Rust and Venter 2004)
- A review of the South African Construction Industry(CSIR 2005)
- The state of logistics survey 2005 (CSIR 2005b)
- Construction 2020 – a Vision for Australia’s Construction and Property Industry (Hampson and Brandon 2004)
- Strategic Research Agenda for the European Construction Sector - Implementation Action Plan(ECTP 2007)
- Infrastructure 2007 - A global perspective (ULI 2007)
- The Strategic Highway Research Programme in the USA(TRB 2007)

From these reports as well as a number of technical discussions in the CSIR Built Environment Unit (one of five research units in the CSIR), the main R&D themes relating to transport infrastructure as shown below were distilled. The topics cover most of the important issues currently being viewed as important in terms of the need for R&D. These topics are at a fairly strategically high level and therefore they do not contain project-level detail.

It is also important to emphasise that the active pursuit of new knowledge generation in the areas below will lead to significant human resource development which will assist in the imperative to create built environment professionals that can satisfy the current need for high quality technical skills in South Africa.

4.1 Main themes, sub-themes and focus areas for R&D

4.1.1 Sustainability of infrastructure provision and operation

- Environmentally responsive transport infrastructure
Recycling of road building materials, recycling of waste, recycling of construction materials
- Sustainable neighbourhoods
Community access roads, improved services such as public transport
- Infrastructure investment decision
Integrated infrastructure planning, geo-spatial planning, and technology selection to unlock social impact

4.1.2 Climate change mitigation

- Resource efficient infrastructure
Energy efficient construction and materials, energy efficient road building materials (e.g. cool asphalt)
- Resource efficient transport
Alternative fuels and energy sources, traffic management systems

4.1.3 Advanced construction practice

- Improved construction methods
Modern methods of construction, labour-intensive construction methods, rapid construction methods

4.1.4 *Advanced construction materials*

- Advanced materials for roads
Bitumen replacements, aggregate replacements, advanced road surfacings (e.g. thin concrete road pavements), optimisation of road materials design, nano-phosphor materials

4.1.5 *Advanced infrastructure design*

- Pavement design (roads, airports, terminals)
Advanced analysis methods including finite element analysis, accelerated pavement testing, dynamic road pavement performance evaluation and design methods, long-life road pavement design
- Port design
Advanced modelling, analysis and design of ports

4.1.6 *Advanced infrastructure operations*

- Logistics
Small business logistics, humanitarian logistics, logistics modelling, solutions for improved supply chain efficiency
- Intelligent transport systems
Sensorweb systems, advanced traffic control systems
- Asset management systems
Road asset management, road pavement overload control
- Traffic safety
Road accident prevention, pedestrian safety

4.1.7 *Poverty alleviation through rural infrastructure provision*

- Rural service provision
Rural mobility and access roads for communities, rural development strategies

5 **CREATING AN ENABLING ENVIRONMENT**

5.1 The current status

Transport infrastructure provision and operation is important to a number of government departments in South Africa. These include:

- The Department of Transport (DoT)
- The Department of Provincial and Local Government (DPLG)
- The Department of Public Works (DPW), and
- From an SET point of view, the Department of Science and Technology (DST),

In order to understand the national situation regarding research into transport infrastructure-related topics, the medium term economic framework (MTEF 2007) budgets of these departments as well as that invested by the DST in the form of a grant to the CSIR was analysed. The result is shown in Table 2.

Table 2: Medium term economic framework budgets for R&D activity (R x 1000)

Department	2007/08	2008/09	2009/10
DoT	3 000	4 000	4 000
	15 857 923	19 576 364	21 454 558
	0.02%	0.02%	0.02%
DPLG	30 649	32 181	36 096
	28 844 175	32 477 946	39 262 113
	0.11%	0.10%	0.09%
DPW	0	0	0
	3 693 120	4 122 101	4 708 448
	0.00%	0.00%	0.00%
CSIR	11 000	11 000	11 000
TOTAL	44 649	47 181	51 096
	48 395 218	56 176 411	65 425 119
	0.09%	0.08%	0.08%

In the MTEF budgets shown above, the figures are usually listed under Policy, Planning and Research, thus indicating that the full amount listed here is not available for research. In the case of the Department of Transport for example, only about 10% of the budgeted R30 million is currently available for actual research projects. The total amounts invested into R&D are extremely low. The South African National Research and Development Strategy (DST 2002) provides a target of one percent of GDP for R&D funding and in some circles a figure of two percent is touted as the required figure to ensure that South Africa continues to develop the knowledge and human resources required for the future. It is clear that, on average, the relevant government departments are not investing nearly enough funds into this important activity.

A second problem currently experienced in R&D is the means of procurement of R&D services by government. Most departments follow the route of a strict tender process to procure R&D services. However this leads to a number of problems:

- A strict tendering process leads to over-emphasis of the lowest price, which in-turn can lead to ever decreasing project sizes with a resultant fragmentation of the research effort and associated under-delivery (Rust 2007).
- The dilemma that if a solution to a particular problem is so clear that it can be specified in a strict tendering process then the process is probably not R&D-intensive, but rather of a nature of routine service provision.
- In a call for proposals as part of an open tendering process, the R&D organisation has to put a significant amount of prior work and thinking into the development of such a proposal. Sometimes government departments then take these proposals and ask alternative organisations to provide a "quote" for doing the work. This leads to major issues relating to the intellectual property associated with the prior thinking conducted by the original organisation.
- The above often hampers the research organisation in terms of conducting proper innovative R&D that will have significant impact.

A third problem is that, in spite of the importance of infrastructure and infrastructure-related technology, the National R&D Strategy (DST 2002) of South Africa does not address this

issue clearly. The strategy does not highlight transport or transport infrastructure as an important research theme nor does it place any focus on the related professional disciplines such as civil engineering and planning. This implies that grant funding from the Department of Science and Technology is not specifically aimed at solving problems in the transport infrastructure sector.

According to the National R&D Strategy of South Africa, government line departments are mainly responsible for R&D that pertains to the solving of problems in their respective sectors – so called Type 2 research. The Department of Science and Technology is responsible for more basic research (Type 1) and facilitates Type 2 research at line departments. However, the above problems as a combination put a significant hold on R&D directed at solving problems in the transport and transport infrastructure sector. This scenario leaves the sector in a position where funds for specific infrastructure-related R&D are diminishing with the consequent loss in local knowledge, expertise and skills that the country cannot afford.

5.2 Alternative approaches

There are many international and some local examples of alternative approaches to the procurement of R&D services by government. These usually involve dedicated medium to long-term funding for centralised R&D organisations such as the Australian Road Research Board, the Belgian Road Research Institute, the Transport Research Laboratory in the UK etc. In the interest of brevity, this paper will not cover the operation of these organisations in detail. However, in order to address the above scenario, the following points are offered for consideration:

- *Transport and transport infrastructure as a theme* – in view of the discussion in this paper it is concluded that R&D into infrastructure-related science and technologies in South Africa should receive a high priority in the national research agenda including those of relevant line departments such as transport as well as public works.
- *Transport foresight studies* – there is a dire need for a comprehensive transport technology foresight study that will assist in finalising the national research agenda.
- *A comprehensive national transport R&D strategy and agenda* should be developed, prioritised and funded.
- *A national forum for transport R&D co-ordination* could assist in ensuring synergy between government departments and between government and private sector in terms of developing and managing the R&D portfolio for South Africa.
- *Partnerships with private sector* are extremely important to ensure that the full innovation chain from invention to commercial application is addressed, particularly in the current scenario where the infrastructure sector is growing rapidly.
- *Improved processes for R&D procurement* need to be put in place to ensure that there is a holistic non-fragmented effort to address R&D in the infrastructure sector.
- *A centre of excellence in transport and transport infrastructure research* should be considered to ensure that critical mass in the diverse fields discussed above can be developed.

6 CONCLUDING REMARKS

From the above analysis the following can be concluded:

- transport is an important driver for socio-economic development and plays an essential role in poverty alleviation;

- science, engineering and technology (SET) plays an essential role in the sustainable provision of transport and transport infrastructure;
- in the South African environment there are specific SET challenges relating to transport and transport infrastructure that are not researched elsewhere in the world;
- transport-related R&D does not feature significantly in the national R&D agenda;
- funding from government departments for transport-related R&D is very low – less than 0.1 per cent of total budget compared with the target of 1 per cent in the National R&D Strategy;
- R&D activity leads to the development of new human resources, and a lack of investment into transport-related R&D in the recent past has contributed to the lack of skilled transport professionals in South Africa, and
- the current system of transport-related R&D management needs to be reviewed to allow for proper co-ordination between stakeholders (government and private sector), for ease of administration and to ensure that a comprehensive R&D agenda is developed.

The transport sector, both government and private sector, should seriously consider strategic interventions to change the current situation. Such interventions are critical for providing a sustainable transport infrastructure system and transport infrastructure that are going to be under serious pressure from the strongly growing economy and the increasing role that South Africa is playing on the continent. In addition, if South Africa wants to be a successful host of events like the soccer world cup, the desperate situation in the transport R&D scenario that also contributes to the lack of transport professionals can no longer be ignored.

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