

# HARNESSING INNOVATION IN PASSENGER TRANSPORT RESEARCH IN AFRICA

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## ABSTRACT

Operational aspects of passenger transport in South Africa are proving to be a challenge in terms of implementing the country's passenger transport mandate. These challenges often arise largely from the underlying assumptions made in the planning stages of the various transport projects. Examples of these challenges include public transport service design and impact appraisal techniques. These challenges are however not unique to African countries but extend even to the most resourced of countries and regions. It is through providing proper platforms to harness innovation that these challenges can be systematically addressed for the benefit of Africa. Such contributions do not have to be original in the strictest sense but could be through innovative packaging of existing technologies and past and recent research work through collaborative networks.

The paper provides the framework proposed by the newly established Built Environment Unit of CSIR, a public institution, to provide foresight driven research input into the passenger transport domain. This is modelled on the mandate of the CSIR of improving the quality of life through directed multidisciplinary research and technological innovation. Examples of the research initiatives currently underway in this area are provided. The paper concludes by reaffirming the need to establish collaborative relationships founded on a foresight approach, and also defines the scope for specialist in-depth passenger transport operations research opportunities in Africa.

## 1. INTRODUCTION

The Southern African Transport Conference (SATC) has over the years provided a platform in Africa and beyond, for a wide range of researchers and transport related practitioners to widely share their findings and views. The quality of input has also grown from strength to strength illustrating the increasingly open society that Southern Africa is becoming. In the true nature of research, some of the past work has been critically reviewed, often by the very researchers and professionals who created it in the first place. However, it is important that a research community should not create a self-implosive system and that demonstrable progress of growth be self evident. Such progress is usually possible once research networks are fully established with the aim of growing the research output to ultimately improve the quality of lives of the general public.

The passenger transport domain, particularly in South Africa, has over the recent years received attention in the light of the momentum generated since the adoption of the White Paper on national transport policy (RSA, 1996). The subsequent formulation of transport plans in the local sphere government, for example, as envisaged in the National Land Transport Transition Act (NLTTA) (RSA, 2000) has created a backbone from which to implement transport proposals. The implementation of these proposals has, however, been

faced with practical problems ranging from technical to governance related problems. One of the major problems has been the assumption of the existence of reservoir of technical solutions that could readily be incorporated into the implementation of the plans. Such a reservoir could only exist under the environment where active research continuously creates a knowledge base. In the absence of such a reservoir, authorities had no choice but to resort to trial and error tactics amidst the pressing political delivery mandate of government.

The paper provides the framework proposed by the newly established Built Environment Unit of CSIR, a public institution, to provide foresight driven research input into the passenger transport domain. This is modelled on the mandate of the CSIR of improving the quality of life through directed multidisciplinary research and technological innovation. The paper further provides examples of the research initiatives currently underway in this area. Previous research work hinting for the need for specialised research in passenger transport is reviewed. Furthermore, the opportunities that exist for collaborative networks are also highlighted. Although the passenger transport domain is very extensive in terms of potential areas of research, very few themes form the basis of this framework in order to provide an environment where in-depth multiyear research can be completed.

## **2. BACKGROUND**

Transport research in South Africa has been formally active as early as the 1950's. However, emphasis and resources in transport research have tended to be infrastructure oriented with special attention on road building materials and road geometric design. As a result numerous road design manuals were produced and refined over the years through in-depth research. This body of research has contributed substantially in the development of infrastructure in South Africa and other African countries. While the positive contribution of this body of research is acknowledged, the operational aspects of transport were largely ignored, apart from developments in traffic engineering. To this day in South Africa, there is no design manual for public transport services, despite having more than two-thirds of the households dependant on public transport. Furthermore, despite all the investment that was made into road network building, the nature of the travel demand over time is such that it defies the original design logic in some of the metropolitan areas. It is also not consistent with the drive to exploit tourism opportunities in Africa that insufficient research is made into business and leisure travel, including air travel.

The point of departure of the paper is that infrastructure investment needs to at least be informed by scientific research in order for it to be effective and efficient. Moreover, it is important to consider the total life cycle of the infrastructure, from needs analysis through design and operation to recycling or phasing out during its conceptual phases. With specific reference to passenger transport, the paper makes a case for in-depth research focus in Africa, founded on collaborative networks, which will in turn make some contribution into transport infrastructure design and operations.

Passenger transport in the paper refers to mobility across all modes of travel, including non-motorised travel, used by people to satisfy any purpose. Although emphasis is on South African operations, it is the intention of the research agenda to extent to the rest of the African continent in the medium term.

### **3. A CASE FOR IN-DEPTH PASSENGER TRANSPORT RESEARCH**

A number of transport researchers and practitioners have recently identified research opportunities and gaps that exist in passenger transport domain in South Africa and continent wide. A few of these contributions are cited in this section under relevant subheadings that follow. It is through the contributions of these authors that the paper illustrates the dire need for in-depth passenger transport research focus in Africa.

#### **3.1 Data Management**

Developing countries have often been associated with poor transport data for research and planning purposes. The general absence of reliable timeseries data on transport demand and supply in Africa remains a stumbling block in monitoring performance as well as formulating intervention strategies. In their paper addressed to the Commission for Africa, Beaven and Martini (2004) illustrate how improving data availability in Africa can improve policy formulation, mobilise and strengthen civil society and political accountability as well as to attract much needed investment. On the other hand, the use of secondary data although it has some short term benefits, creates problems in the long term such as poor professional credibility. In South Africa, the NLTTA (RSA, 2000) has attempted to address this problem by legislating the collecting of timeseries public transport demand and supply data through the preparation of numerous transport plans. This process has often been reported to have some fundamental problems as reported elsewhere in the paper. Moreover, the data needed for research purposes is often not administrative in nature and not restricted to specific dimensions. There have been reports elsewhere in the world where collaborative networks have improved data availability and quality tremendously. Appropriate institutional and funding models for these data sharing collaborative networks need to be established in Africa.

#### **3.2 Understanding Travel Market Profiles**

A significant number of authors have promoted the urgent need to understand disaggregated behaviour and needs of different travel markets and associated evolutionary profiles in order to avoid perpetual segregationist policy. Behrens (2003) argues that in South Africa although child and scholar travel is of significance, little data is available for planning services for this market segment. Mashiri et al. (2005) argue for the need to establish a gender sensitive passenger transport research agenda in South Africa. An attempt to comprehensively profile various South African travel market segments was made through the Moving South Africa Action Agenda (NDoT, 1998). However, there has been general lack of follow up to monitor the evolution of these travel markets apart from a few household travel surveys. This further calls for research work to be completed for optimal sampling strategies in order to monitor specific performance indicators.

Timmermans (2003) concludes that if land use and transport policies of a country are primarily concerned with the optimum performance of existing infrastructure as opposed to increasing physical capacity of infrastructure, then activity based models offer advantage over four-step approaches. However, he further notes that activity based models still need further development in order to become more useful to practitioners. Timmermans (2003) also identified areas that require further development such as longer timeseries evolution of activities, the influence of communications and Intelligent Transport System technology on activities, household decision making contexts as well as integrating of these models with other decision making tools used by other stakeholders.

Little is known in South Africa about the night travel needs of the population. With cities increasingly operating on a 24-hour basis, it becomes important to ensure that transport services are able to respond to this demand, in line with economic growth and potential

employment opportunities that arise from supporting the demand. It is through research that the design of such services should be explored.

### 3.3 Data Collection

Cameron (2005) questions the methodology currently adopted in South Africa for the completion of Current Public Transport Records (CPTRs), which are status quo records on public transport supply and demand in municipalities and the consequent use of these datasets in policy and decision making. He recommends research to be undertaken to assess the potential of new technology for efficient data collection based on scientific reasoning. Cameron (2005) is further supported by Moodley et al. (2005) who demonstrate the prohibitive costs of collecting public transport performance monitoring data as provided for in the NLTTA. In order to illustrate some of the alternative efficient data collection methods, Letshwiti and Lamprecht (2004) completed a technology scan of equipment that could be used for counting boarding and alighting public transport passengers. They also demonstrated the accuracy of some of the technologies through a pilot study. Through dedicated research, such equipment could improve the efficiency of public transport demand data collection as well as public transport assignment models.

Krysmann and Schmitz (2005), through a pilot study, demonstrated the potential of using cellphone technology to provide more accurate records of space and time elements of travel patterns. Scott et al (2004) show how the demand for mobile phones in Africa, especially in the rural areas, has exceeded market expectations. It is this proliferation of cellphone technology that prompts Krysmann and Schmitz (2005) to use them reliably for collecting data that would have otherwise been difficult to obtain. Further opportunities for collecting data and improving transport services using information and communication technology need to be explored.

### 3.4 Service Design

Public transport service design in South Africa has never enjoyed scientific and engineering attention. This has also been exacerbated by the unplanned substantial growth of the historically deregulated minibus taxi industry. However with the deliberate policy shift of government from private to public transport focus, a sudden emergence of public transport plans occurred, which were not largely formulated on the basis of locally researched interventions. In desperation, Kingma (2004) recommends the use of almost "radical" approaches in addressing public transport service backlogs, similar to the approach adopted in the 1960's in South Africa where tramlines were buried and walking spaces were replaced with parking bays to illustrate some of the failures of these interventions. Willumsen and Lillo (2005), however, illustrate how the introduction of improved bus technology, improved understanding of traffic at bus stops, improved payment systems, use of low cost control systems, efficient boarding and alighting facilities and modelling techniques to assist in the design process, all contribute to improved public transport service design by using Transmilenio system in Bogota as a case study. Research input into service design components such as park and ride, modal integration, feeder and distribution services alternatives need further development.

### 3.5 Aviation

Norval (2003) illustrates the complexities involved in designing flight paths in the aviation industry, in the light of the increased competitiveness and travel demand. Within the context of advancing initiatives such as the New Partnership for Africa's Development (NEPAD) objectives, Ssamula and Del Mistro (2004) through exploring a cost model for airline services note that there is a lack of calibrated service costing models in Africa and insufficient base data from which to design optimal air transport networks in Africa, in a bid to lowering operational costs. Ssamula and Venter (2005) however acknowledge the

governance complexities involved in the African aviation industry emanating from the implementation of the Yamoussoukro Decision.

### 3.6 Alternative Transport Service Designs and Modes

Green et al (2005) explored the use of mobility brokering alternatives in Central Karoo, a low density poverty stricken rural area, as solution to improving accessibility to essential services. Other benefits included improved efficiency of services and transport supply information and in turn improved profitability of services resulting in potential affordability of transport services. However, they acknowledge the location dependent nature of this type of service and recommend the investigations into similar models in other rural areas of South Africa. There is also an opportunity to provide improved service designs through improved public participation techniques.

Some parts of Africa, notably Uganda, have adopted non-motorised transport modes from which countries such as South Africa could learn valuable lessons, for example bicycle taxis. These modes are built from technology that presents lower maintenance burden and hence tend to be safer than motorised modes that are more expensive to operate leading to poor maintenance history. There is therefore scope for passenger transport research to investigate the effectiveness of alternative transport modes and their associated user requirements.

### 3.7 Transport Funding

Wosiyana (2005) illustrates some of the root causes of unsustainable transport funding in South Africa. He questions unfunded mandate created by the NLTTA (RSA, 2000) and the views expressed by National Treasury that the legislative mandate in respect of funding is its exclusive competency. It therefore remains a task that should be addressed through research efforts to demonstrate alternative transport funding mechanisms and to support these through cost:benefit models.

## **4. PROPOSED FOCUS AREAS**

The proposed passenger transport research framework hinges on the mandate of the CSIR of improving the quality of life through directed multidisciplinary research and technological innovation. The accepted approach of defining a research agenda in the CSIR is through a formal framework referred to as the "Technology Tree". The background of this approach is not formally provided in this paper, only the essence of the proposed research agenda. In brief, however, the approach attempts to use existing infrastructure and existing technology coupled with knowledge generation research to develop tools that are needed by the end users. Most of the resources are however expended on the knowledge generation aspects within the context of the technology tree. It should further be noted that the research agenda proposed is not short term in nature and therefore does not attempt to address all the passenger transport problems identifiable. The aim is to ensure that the CSIR is able to create an environment that encourages in-depth multi year research. In the light of resource constraints and the identified needs, it is proposed that in-depth passenger transport research be conducted under three headings, namely:

- Passenger transport service design
- Low cost data collection techniques
- Transport data warehousing

Each of these is explained as follows.

#### 4.1 Passenger Transport Service Design

The point of departure for this focus area is to incorporate principles of service design in passenger transport similar to essential services such as electricity and water. The aim is to create a platform where the dynamics of passenger transport service are quantified. One example of research output would be the investigation into the feasibility of demand responsive public transport systems in developing countries.

#### 4.2 Low Cost Data Collection Techniques

It was shown in section 3.3 how emerging technology has been successfully used in South Africa to efficiently collect data that would have otherwise required considerable resources. The point of departure for this focus area is to exploit sensor technology as well as information and communication technology to improve data collection efficiency. The development of a "blue box" system is under way, which is a small vehicle mounted control unit consisting of data capturing terminals and display for trial use in various transport modes. Its use could be extended to capturing the geographic position of boarding and alighting movements, passenger information dissemination, etc.

#### 4.3 Transport Data Warehousing

In order to monitor trends, prepare cost:benefit studies or appraise impact of various schemes, it is essential that such analysis be based on reliable data. The aim of this focus area is to create passenger transport databases that would facilitate aforementioned analyses. In the immediate future it is proposed to produce a state of the passenger transport report in South Africa, which would be updated on a regular basis.

### **5. RELATIONSHIP WITH STAKEHOLDERS**

Blanchard and Fabrycky (1981) define a system as a set of interrelated components working together toward some common objective or purpose. They further describe attributes of a system as follows:

- Properties and behaviour of each component of the set has an effect on the properties of and behaviour of a set as a whole.
- Properties and behaviour of each component of the set depends on the properties and behaviour of at least one other component in the set.
- Each possible subset of components has the above properties and the components cannot be divided into independent subsets.

Passenger transport research as described in the paper would be only one component within a system whose purpose is to improve the quality of life. Section 3 of the paper, for example, illustrated the contribution that has recently been made by South African transport researchers and practitioners in advancing knowledge in the passenger transport research domain. It was through these contributions that the state of passenger transport and more importantly gaps in passenger transport research were revealed. It is in this spirit of interdependency that the passenger transport research agenda described in the paper is presented.

Some of the envisaged outputs of the passenger transport research agenda would include the following:

- Promotion of relevant and appropriate technology transfer.
- Participation in pilot projects driven by different stakeholders.
- Joint research papers with different stakeholders.
- Information sharing with different stakeholders.
- Practical application of academic advances.
- Minimise the risk of private sector in research and development.

## **6. CONCLUSIONS**

Life-cycle management of infrastructure warrants in-depth research into passenger transport operations in Africa. The paper highlighted a number of research opportunities and gaps that exist in passenger transport domain through citing recently published contributions by researchers and practitioners through work completed in South Africa and continent wide. This was further used to make a case for in-depth passenger transport research in Africa.

In the light of resource constraints of the CSIR and identified needs, it was proposed that passenger transport research agenda focus on the following three generic areas:

- Passenger transport service design.
- Low cost data collection techniques.
- Transport data warehousing.

It was concluded in line with systems thinking that that the research agenda proposed in the paper can only thrive in a collaborative environment. The nature of relationships with stakeholders was identified through illustrating the expected outputs of the research agenda.

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