

ENHANCING SUSTAINABLE TECHNOLOGY TRANSFER (T2) CENTRE OPERATIONS FOR QUALITY TRANSPORTATION ENGINEERING EDUCATION

Adewole Simon Oladele

Morgan State University, Baltimore, Maryland, USA; adewolesimon.oladele@morgan.edu; asoladele@yahoo.co.uk

Abstract: Transportation engineering education enhanced through sustainable technology transfer (T2) centre operation and research collaboration are integral to our society, but there are persistent challenges to their sustainability. This necessitated an international innovative strategy of collaborations among academia, industry, and the transport sector. The solution has been enhanced through the establishment of transportation Technology Transfer (T2) centres that have emerged in many countries all over the world as sustainable agents and catalysts for improvements in disseminating experiences, technologies, best practices and innovations. There is a generally perceived link between the state of development of a country's transportation systems and the extent of technology usage and availability of technical information in that country. To keep pace with the new technologies, transportation engineering education needs information and knowledge that will enable it to advance its processes, incorporate new products into existing programmes, and increase technical know-how that produces positive change and economic development. This paper intends to discuss the innovative strategies adopted in operating transportation technology transfer centres globally. Strategies adopted to achieve the objective were establishing and maintaining a transportation database and website accessible by transportation engineering professionals; publishing and disseminating quarterly (T2) newsletters; hosting Africa (T2) conferences; and identifying training programs for the stakeholders. In conclusion, the paper highlighted the outcome of operating (T2) centre to enhance quality transportation engineering education through effective technology transfer operations for economic development.

Keywords: Sustainable transportation, Engineering education, Innovative technology transfer, International collaboration, Capacity building

1. INTRODUCTION

The Ministry of Transport and Communications through its Botswana Transportation Technology Transfer Centre (Botswana T2 Centre) in collaboration with the Association of Southern African National Roads Agencies (ASANRA), Transportation Technology Transfer (T2) Centres in SADC region and other local and international stakeholder institutions has been sustaining the Africa Transportation Technology

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Transfer (T2) Centres' operation in southern African countries through hosting of bi-annual conference and training for quality transportation engineering education.

The main objectives:

- i) To promote Technology Transfer for Developing Sustainable Transportation Systems in Africa,
- ii) To promote establishment and operations of Technology Transfer Centres as means for facilitating appropriate effective technology transfer in the transport sector,
- iii) To provide a forum for discussion and exchange of views as well as learn experiences of best practices and innovative solutions in the Transportation Industry.

To meet its objective the conference and training featured various presentations, panel discussions, workshops pertaining to the conference thematic-areas and topics. Moreover exhibition of technologies, products and services – a show case for all related industries were held in conjunction with the conference. Local and foreign firms and institutions which are stakeholders in the transport sector were able to exhibit their products, services and technologies.

The Africa Transportation Technology Transfer (T2) Conference which is being held after every two years since its inception in May 2001 when the 1st Africa T2 Conference was held at the Arusha International Conference Centre, Arusha, Tanzania is a forum intended to share, exchange and debate experiences, best practices, and new technologies in the provision, maintenance and management of all modes of transport. It is also a forum for sharing and exchange of existing and new approaches on technology transfer that enables countries to develop effective management of transport infrastructure, integrated transportation systems, which are safe, efficient, reliable and affordable. Since year 2001, ASANRA through its sixth Standing Committee on Regional Technology Transfer Centre in collaboration with Ministries and Agencies responsible for the transport sector in the member states of the Southern Africa Development Community (SADC) has been organizing Africa T2 Conferences. So far nine Africa T2 Conferences have been held. The Themes addressed by the past nine Africa Transportation Technology Transfer (T2) Conferences were as follows:

- 1st Africa T2 Conference held in Arusha Tanzania from 23rd – 25th May 2001 and hosted by Tanzania Transportation Technology Transfer Centre: "Technology Transfer in Road Transportation in Africa"
- 2nd Africa T2 Conference held in St. Pietermaritzburg, KwaZulu Natal, South Africa from 20th – 23rd September 2005 hosted by KwaZulu Natal Department of Transport: "Transportation Technology Transfer in Africa's Renaissance"

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- 3rd Africa T2 Conference held in Mangochi, Malawi from 23rd – 25th May 2007 hosted by Ministry of Transport and Public Works in Malawi: “Technology Transfer for Africa’s Sustainable Transportation System”
- 4th Africa T2 Conference held in Windhoek, Namibia from 31st August to 4th September 2009 hosted by Roads Authority of Namibia: “Capacity Building Opportunities in the Transport Sector”
- 5th Africa T2 Conference held in Arusha Tanzania from 21st - 25th November 2011 and hosted by Ministry of Work in Tanzania through TanT2 Centre: “Developing Safe, Reliable and Sustainable Transportation Systems for Socio-Economic Development in Africa”
- 6th Africa T2 Conference held in Gaborone Botswana from 4th – 8th March 2013 and hosted by University of Botswana through BwT2 Centre: “Effective Management of Transport Infrastructure for Economic Recovery in Africa”
- 7th Africa T2 Conference held in Bulawayo, Zimbabwe; the 8th Africa T2 Conference held in Livingstone, Zambia and the most recent 9th Africa T2 Conference was held in Maputo, Mozambique on

2. LITERATURE REVIEW

It becomes incumbent upon road engineers to gain from the technology transfer developments of colleagues rather than “re-inventing the wheel” or making the same mistakes that others have made. In other words, the extent and efficiency of a country’s technology transfer system could reveal the extent of that country’s development. The benefits of advancing innovative transportation technology exchange in pulling resources and commonly addressing the major issues of building resilient transportation infrastructure for socio-economic development. This will proffer solutions to challenges in the transport sector toward more sustainable development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Biancardi et al 2023). There has been recognition that informal sharing of experiences may no longer be the best approach to improve road transportation as the travel demands of modern society have increased exponentially. Technology transfer in the transportation sector is aimed at using the benefits of someone else’s successful research, development, or experience to benefit roads locally – often at a fraction of the original development cost (PIARC, 2000).

The primary objective is to systematically and actively facilitate acquisition and dissemination of technology, practice and policy knowledge and know-how that is relevant to a local operating transportation environment. Technology transfer was explained by PIARC (2000) as the process of openly gaining and freely sharing experiences, workable solutions, technologies, and innovations. It was also

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emphasized by Logie (2007) that technology transfer occurs in many ways and different forms. Technology transfer happens at its simplest form, when someone reads about a “new” technique in a report or a technical magazine from another place. Furthermore, technology transfer operations were described by Pinard (2007) as a process of developing appropriate technology transfer mechanisms and activities (newsletters and fact sheets; technical reports; news releases; journal and magazine articles; electronic bulletin boards); conveying well quantified success stories highlighting benefits over competing alternatives; carrying out well designed field tests, demonstration and pilot projects; producing well illustrated guidelines, reports and manuals in reader-friendly format; holding interactive conferences, workshops and seminars tailored to the differing requirements of segmented audiences at various stages of the technology transfer process.

3. METHODOLOGY

The 6th Africa Transportation Technology Transfer (T2) Conference was a major event that took place in the Tourist City of Gaborone, Botswana. The conference was officially opened by the then Minister of Transport and Communications Honourable Nonofo Molefhi, and closed by the then Permanent Secretary for Ministry of Transport and Communications, Ms. Tsaone R. Thebe. Two hundred and twenty-five (225) delegates officially registered from 17 countries in Africa and other countries worldwide attended the 6th Africa T2 Conference. Delegates who attended the conference were from Botswana, DRC, Lesotho, Ethiopia, Ghana, Malawi, Mozambique, Namibia, Nigeria, South Africa, South Sudan, Tanzania, Norway, UK, USA, Zambia, and Zimbabwe. A total of 28 papers were presented with discussions during plenary sessions at the conference. During breakaway sessions of the conference the following five (5) workshops were conducted by various international institutions and individual experts: -

- i) AFCAP Workshop on Rural Accessibility and Mobility
- ii) Workshop on Gravel Road Maintenance
- iii) Workshop on Effective, Efficient and Sustainable Technology Transfer in the Transport Sector
- iv) Workshop on Minimizing Fraud and Corruption on Transportation Projects
- v) Workshop on Integrated Road Asset Management System

Also six (6) firms and institutions from South Africa, Namibia, Botswana, Malawi exhibited their products, technologies and services at the conference namely Kaytech, Roads Authority Namibia, Botswana T2 Centre, Vivo Energy, Footprints Africa Safaris, and ASANRA.

4. KEY OBSERVATIONS AND FINDINGS

- i) In order to develop safe, reliable and sustainable transportation systems for Socio-Economic Development in Africa, it is imperative that the development of transport infrastructure in the cycle by considering the environmental, social and economic consequences of: design; non-renewable material use; manufacture and production methods; distribution and commercialization; operations and/or user life; disposal, reuse and recycling options; and suppliers' capabilities to address these consequences throughout the value chain.
- iv) Conference delegates indicated lack of awareness and expertise as one of the challenges for an effective implementation of Sustainable Public Procurement (SPP)/Green Public Procurement (GPP). Setting up dedicated SPP/GPP Units, training of officials and information campaigns were pointed out as the kind of support needed to ensure taking up of SPP/GPP.
- v) Program/project management is vital for successful execution of capital projects. There is a serious need for Capacity Development for African transportation professionals in Project/Program Management, Project Development, Finance and Procurement, and Delivery.
- vi) Key challenges in Africa are not technical issues, are soft issues of leadership, mindset (that hinders good ideas and that mitigates).
- vii) Leadership is more than just ability. It is a combination of courage, determination, commitment, character, and ability that makes people willing to follow a leader (Singapore experience).
- viii) Fully integrated Asset Management approach should be utilized in managing transportation assets because it will address the challenges of preserving the huge investments; integrated maintenance policies; cost effective programs; and meeting policy goals with respect to the Level of services.
- ix) Understanding that the Asset Management Systems used by developed countries may or may not work in an African or developing country environment and care needs to be taken in selecting suitable systems. Taking an off-the-shelf system and implementing it in developing countries without following the methodology/life cycle has proven to be a failure in most countries.
- x) In any successful Road Management System (RMS) implementation a champion and a driving force is required. The support of the top management and Boards is essential to making any RMS successful. Support of the Board and top executives is a pre-requisite for any successful RMS.
- xi) It is very important to place the RMS high in the organisation so that it can have an impact.
- xii) The contradictory needs and approaches of Network Analysis and Project Analysis has been also the core cause of many failures of RMSs in many organisations. RMS is a strategic, network-based system, in some cases a

programme or tactical based system. Project Engineers have been bogged down with details trying to make the RMS systems project oriented instead of network oriented, and once they start developing the systems they never finish it because the number of details required has no ending.

- xiii) The RMS of Namibia which is integrated and matured is a success and needs to be shared with everyone so that lessons are learned, the same mistakes not repeated, and it is hoped that this can be used as a model or a good example for a developing country.
- xiv) Applied correctly, asset management can have a marked positive impact on the operations of public authorities, and lives of the people. This is however dependent on the adherence to appropriate policies, standards and guidelines that ensure quality and consistency, the lack of which has contributed to the current state of infrastructure mismanagement in developing countries.
- xv) The implementation of pavement maintenance system to optimize pavement rehabilitation expenditures in Arizona Department of Transportation saved over US\$ 200 million over a five-year period.
- xvi) Performance Based Maintenance Contracts (PBMCs) have many advantages over the traditional contracts such as reduced maintenance costs by 15-40%, innovation, and being customer focused.
- xvii) For Performance Based Maintenance Contracts, it is very important to select the appropriate Key Performance Indicators (KPIs). Failure to select a comprehensive set of KPIs that satisfies essential criteria will lead to undesired outcomes.
- xviii) Effective transportation decision-making depends upon recognizing, responding to, and properly addressing the unique needs, cultural perspectives, and financial limitations of different socioeconomic groups.
- ixx) Traditional public involvement techniques can be inadequate, effectively limiting meaningful involvement by traditionally underserved populations in transportation decision-making processes. That said, meaningful involvement means that potentially affected community stakeholders and residents have an opportunity to participate in decisions about a proposed activity that will affect their environment, safety or health.
- xx) Environmental justice in transportation is being recognized as an important element for improving the quality of the transportation decision making process. There is a need to integrate environmental justice thinking in the planning and implementation process.
- xxi) Environmental Justice in Transportation is a prerequisite for fair and balanced economic growth. It's implementation results in a high level of consumer satisfaction, it supports a fair deployment of infrastructure resources, and it is a key ingredient for fairly balancing the distribution of transportation resources.

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- xxii) African transportation professionals in Project/Program Management, Project Development, Finance and Procurement, and Delivery are not actively deploying the concepts of environmental justice.
- xxiii) Technical and scientific approaches can save approximately one in every three fatalities on the roads through the systematic application of proven road safety engineering improvements.
- xxiv) Regional programmes such as the study on financial and management options of the North South Corridor from Durban to Dar es Salaam by TradeMark Southern Africa can contribute to regional connectivity and long-term solutions for long distance international road transport.
- xxv) The use of a PET-grid as asphalt reinforcement results in economic and environmental benefits. The economic benefits include thinner road structures, cost-effective solution for rehabilitation, longer life cycles, and reduction in maintenance costs, while environmental benefits cover savings in natural resources due to prolonged service intervals.

5. KEY CRITICAL CHALLENGES

- i) Key challenges in Africa are not technical issues, are soft issues of leadership, mindset (that hinders good ideas and that mitigates). We (Africans) should change our mind set and have good leadership to enhance development.
- ii) Transport sector must be changing agents.
- iii) African diaspora to assist in developing Africa economy through research and providing advice.
- iv) Despite the gains of institutional reforms undertaken in the past in the transport sector such as establishment of road agencies and road funds, we are currently observing greater political involvement in technical processes which the reforms were geared at doing away with. The semi-autonomous for road agencies is gradually being eroded. This must be avoided.
- v) Political interference is a constraint in consolidating ongoing reforms in the transport sector. We need to review the institutional reform process and may be change of direction with lesser political involvement.
- vi) It has been observed that the government, academia and industry work independently in addressing challenges of transport sector which has proved not to be effective. Systems whereby the academia, government and industry work together have proved to be effective and therefore should be put in place.
- vii) African countries should adopt capacity building initiatives of long-term nature in a systematic approach and demand driven.
- viii) For facilitating capacity building of the local contractors and consultant, contracts must be packaged in small packages to be accessible by local contractors and consultants.

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- ix) There is a strong need to develop domestic capability for the medium to large contracts to avoid the risk of cartel behaviour by a few dominant contractors. This capability can only be built if a market for local contracting services is provided. Integrated Supply Chain Management would provide a good mechanism to provide such a market.
- x) Regional approaches that are demand driven rather than supply driven be considered for institutional capacity building programme.
- xi) With regard to life cycle management of capital projects, there is a need to develop long term master plans as well as develop mechanism to demarcate and protect areas for future development.
- xii) Human behaviour is the main cause of road accidents and that during design of roads human behaviour element should be considered.
- xiii) Establishment of proper policy governing technology transfer is inevitable for effective and efficient performance of the technology transfer Centres in African countries.
- xiv) Delegates commended the previous Africa T2 Conference organizers for a well-balanced conference in terms of plenary session, discussions as well as skills transfer through conducting of workshops and courses in hot topics agenda in the transport sector. It is recommended for future Africa T2 Conferences to adopt/incorporate similar conference organisation approach.

6. SUSTAINABLE SOLUTIONS AND CONTRIBUTIONS TO BODY OF KNOWLEDGE

The African Transportation Professional Networking Group (AFTraP) came up to enhance sustainable Technology Transfer (T2) centre operations for quality transportation engineering education made up of transport professionals from the academic, business, and government sectors with a commitment to proffer solutions to critical challenges facing transport in Africa. The goal of the group was to organise transportation professional conferences such as from country to country in Africa annually to provide a platform for experts and scholars to exchange ideas with each other and share the development and products in the field as shown in Figures 1 and 2 where the participants indicated high rating for the conference organising.

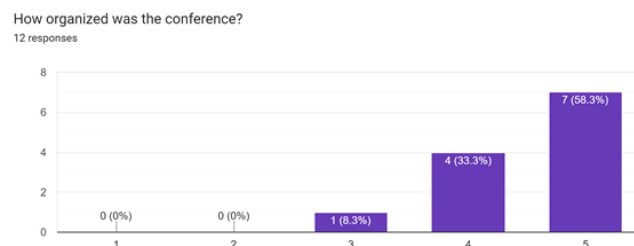


Figure 1. Few ICTA participants' responses to the conference evaluation.

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Figure 2. ICTA participants at recent 9th International conference at Arusha, Tanzania, 2024.

The goal of African Transportation Professional Networking Group (AFTraP) being achieved in multiple steps marked by three major deliverables:

Deliverable 1 – Current challenges, practices, and issues in international transport research cooperation

Deliverable 2 – Research areas, capabilities, and future priorities for international collaboration

Deliverable 3 – Towards a framework and implementation for international transport dissemination.

The beneficiaries of the African Transportation Professional Networking Group (AFTraP) covered in a collective way all necessary aspects for the successful execution of an international cooperation in transport research project. As African Transportation Professional Networking Group (AFTraP) between the academia, government and the transport sector take shape and strength, international transport research collaboration can both help its further strengthening and internal cohesion as well as boost Africa's competitiveness in the global economy. However, enacting and fostering international research collaboration is faced with significant problems and difficulties today which should be researched, to provide the means of enacting solutions such as issues related to research infrastructures, intellectual property rights, and researchers' mobility.

The main objective was to produce a general framework related to international transport research cooperation, based on the reports of the three recent international conferences on transportation in Africa organised and the outcomes of related research topics presented. Other initiatives in the recent past as well as on the outcome of a thorough investigation of all different aspects of international cooperation such as current practices and more specifically gaps and barriers confronted in other international cooperation like European Transport Research Area International Cooperation activities (EUTRAIN, 2016) and Transportation Research Board of the National Academies (TRB, 2005) with the same field of interest, common

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characteristics, priorities and needs for international transport research and alternative models and tools for such research cooperation.

More specifically the AFTraP aimed:

- (i) To contribute towards the establishment of a framework for international transport research cooperation and dissemination to be built upon the principles of knowledge sharing of transportation developments within African countries.
- (ii) To investigate country research capabilities, future priorities, and potential for cooperation with the host countries in the prospect of mutual interest, in major regions of importance to AFTraP.
- (iii) To consider and discuss current practices for research governance and management as well as barriers, gaps, and diversions for international transport research cooperation.
- (iv) To assess the benefits or added value to AFTraP, as well as the prospective synergies from such closer international cooperation.
- (v) To investigate alternative models and tools for carrying out such cooperation in the most effective and productive way and finally,
- (vi) To disseminate, while doing the above activities, African know-how and practices in transport research.

7. CONCLUSIONS AND RECOMMENDATIONS

During the past Africa Transportation T2 Conferences, various presentations were made to address various themes. The Events have facilitated bringing together Member States, Ministries responsible for transport infrastructure, Roads Agencies and Authorities and Technology Transfer Centres in the region. In addition, among other things, the events have facilitated the following:

- i) Exchange and sharing of technological information for transport infrastructure development
- ii) Conducting of Technical Site Visits that enables professionals to learn from each other regarding application of appropriate materials in road construction, technologies, operations of various transportation modes such as roads and ports,
- iii) Carried out Capacity Building Programmes such as training courses and workshops that were conducted concurrently with the conference,
- iv) Exhibitions on various products, technologies, and services applied by companies, organizations and institutions from within and outside Africa,
- v) Formulation of collaborations and partnerships between institutions from Africa and those outside Africa.
- vi) Gathering of professionals from various countries inside and outside Africa and sharing experiences and innovative solutions,

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vii) Visiting natural resources and sightseeing in host countries.

In this respect, the 6th Africa Transportation T2 Conference has been an event that has put Botswana as a country on the global map. In consideration of the above said, Botswana through the Ministry of Transport and Communications accepted the recommendation by ASANRA to host the 6th Africa Transportation Technology Transfer Conference that included Technical Presentations, Panel Discussions, Workshops as well as Exhibitions on Products, Technologies and Services.

The Botswana 6th Africa Transportation Technology Transfer (T2) Conference was a major event that took place in the Tourist City of Gaborone, Botswana with a total of two hundred and twenty-five (225) delegates from 17 countries in Africa and other countries worldwide in attendance. Delegates who attended the conference were from Botswana, DRC, Lesotho, Ethiopia, Ghana, Malawi, Mozambique, Namibia, Norway, Nigeria, South Africa, South Sudan, Tanzania, UK, USA, Zambia, and Zimbabwe. A total of 28 papers were presented with discussions during plenary sessions at the conference. During breakaway sessions of the conference five (5) workshops were conducted by various international institutions and individual experts. Also six firms and institutions from Tanzania, South Africa, Namibia, Botswana, United Kingdom and Germany exhibited their products, technologies and services at the conference.

To meet its objective the conference featured various presentations, panel discussions, courses and workshops pertaining to the conference thematic-areas and topics. There were special sessions on fascinating topics arranged to enable each participant to optimise their stay and take part in as many of the activities as possible. Being fully aware of the current trends, the conference agenda addressed the followings; issues ranging from the handling of traffic in urban areas, management of urban traffic congestion, adequacy of Transport Policies and their Impact, How Transportation Infrastructure Planning and Implementation is coordinated and integrated; Adequacy of Intermodal and Multimodal Transportation Cooperation and initiatives, Involvement of Public in the Transportation Decision Making Process, Escalation of Construction Costs, Quality Assurance of Construction and Maintenance and Value for Money. Other issues included Capacity Building in the Transport Sector including Capacity Building of Local Construction Industry, Road Safety, Financing of Transport Infrastructure including Public Private Partnerships, Innovations in Management of Public Transport, Overcoming Challenges on Workforce Development for Transportation, Environmental Impact of Transport, Rural Accessibility and Mobility, Governance in Transportation, and a whole host of further issues. Moreover exhibition of technologies, products and services – a show case for all related industries were held in conjunction with the conference. Local and foreign firms and institutions which

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are stakeholders in the transport sector were able to exhibit their products, services and technologies.

Updated, increased and exchanged know-how and experiences among professionals, researchers, users and other interested parties in the transport sector. Increased knowledge shared about break-throughs in the managing of roads and other modes of transport, the introduction of brand-new construction techniques, exchange experiences related to maintenance systems, all of which aims at optimising construction and conservation costs and to achieve the lowest possible transportation costs. Increased knowledge shared about the latest technologies in terms of project, construction and management of pavements, basic works, traffic, transportation, the environment and road safety. Exchanges in opinions on the most convenient alternatives to generate economic resources and financing strategies.

Issues of road safety raised and integrated into the social and political agenda of the community. Solutions which may allow permanent road access to rural areas discussed and their impact on the productive and logistic national system analysed. The ordering, planning and management of transport, be it freight or passengers, both in rural and urban areas discussed. Exchanged experiences about transport inter-modality and about its logistic management. Technology Transfer for Developing Sustainable Transportation Systems in Africa promoted. Establishment and operations of Technology Transfer Centres as means for facilitating appropriate effective technology transfer promoted.

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