INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES FOR SUSTAINABLE ROAD TRAFFIC MOVEMENT IN MTHATHA

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ABSTRACT

Road transportation plays a crucial role in providing access for people for various socio-economic activities, such as business, education, employment, recreation, health care etc., especially in the cities. However, with the growth of population, socio-economic activities and consequent urban functions, as well as enhancement of vehicular travel created sustainable mobility challenges in the cities. The scenario of such challenges in the cities of South Africa are observed to be serious. In this context, arguments have emerged that significant use of Information and Communication Technology (ICT) in socio-economic and travel activities can contribute significantly to alleviate the road transportation and traffic related challenges and contribute to sustainable road transportation. Therefore, the study examined how ICT can positively influence the road transportation system and engender sustainable road traffic movement systems in the cities of South Africa. The study was conducted by using the town of Mthatha, of South Africa as a case study. The study relied on the data collected from both primary sources such as road user survey, and transportation parameter survey by using systematic and stratified random sampling process and secondary sources such as published and unpublished statistical data from reliable sources. Quantitative statistical analyses and empirical analyses were conducted to examine the status of the sustainable transportation variables that includes factors influencing mobility, use of ICT, congestion, travel time delay and speed changes among others. Findings with respect to ICT integration, and its effective use will help reduce the urgency for travel, reduce traffic volume, and enable appropriate route planning, which will help to reduce traffic congestion, travel distance and travel time in the town.

Keywords: Cities; Information and Communication Technology (ICT), Sustainable Road Transportation, Mobility, Socio-economic activities.

1. INTRODUCTION

Over the years, various initiatives towards achieving reduction of traffic for sustainable road transportation system have been considered in many cities across the world. Some of the important ones such as controlling car use, integrated rapid transit, and increasing the opportunities for cycling and walking, to name but a few (Thynell, Mohan and Tiwari, 2010; Tiwari, Cervero, and Schipper, 2011). Furthermore, car sharing, congestion pricing, and off

street parking system have also been attempted across the world (Adler and Blue, 1998; Bajpai, 2016; Hameri, and Paatela, 2005; Kanninen, 1996; Thynell, Mohan and Tiwari, 2010). Nonetheless, the question still remains, whether sustainable solutions for road traffic related challenges can be attained by such policy interventions. In this regard, it is evident that despite such measures, many cities across the world face traffic and associated socio-economic, environmental and road infrastructural challenges (Thynell, Mohan and Tiwari, 2010). Similarly, cities of Africa, particularly in South Africa are no exception (Das and Emuze, 2014; Deakin, 2001; Emuze and Das, 2015). Sustainable road transportation in the cities of South Africa has been a challenge for a long time. The challenges include lack of efficient public transportation, traffic congestion, traffic accidents, travel delay, fuel consumption among others. (Elkington, 2004). Similar problems are being experienced in a town - Mthatha in the Eastern Cape Province of South Africa.

2. PROBLEM STATEMENT

In the case of Mthatha, the conditions of the existing national road N2 passing through the town and the conditions of internal municipal roads are very poor, mostly with potholes and no lines. Mthatha is the economic hub of the Transkei area in the Eastern Cape, with hundreds of people from surrounding small towns like Ngqeleni, Libode, Port St Johns and Lusikisiki amongst others coming to the town for their shopping, employment, education and health facilities. These roads cater for mixed modes of travel that include heavy vehicles, cars and pedestrians. As a result, severe traffic related challenges such as traffic congestion, travel time delay, reduced speed, on street parking and occurrence of traffic accidents are experienced on these roads in and around the central area of the town. Traffic is often gridlocked by slow moving heavy vehicles and accidents occur on regular basis particularly during peak traffic periods. For example, during the peak periods of the day it can take over an hour to get through the town (Bews, 2008) despite the two most heavily laden streets such as Madeira Street and Sprigg Street being turned into one-ways in the year 2013. Further developments were done during the year 2018 on the Transkei roads, as traffic law enforcement agencies installed state of the art cameras to monitor traffic moments and dissuade potential traffic offenders. The cameras are on the N2 linking Mthatha to big cities like Durban and East London. All road users entering and exiting Mthatha through the N2 are monitored 24 hours, but there are still other roads like the R61 that cater to the traffic challenges in Mthatha that also require such traffic monitoring

Further, Mthatha has both social and economic importance at the regional and national level but the poor road transportation system is observed to be a barrier for development of the town (Bews, N.2008). Further, upgrading of road infrastructure such as expansion of old roads and building of new road infrastructure are major challenges. It is therefore necessary to explore how traffic movement challenges can be alleviated in the town without incurring much investment. It is also envisaged that integration of ICT in the day to day socio-economic, professional and travel activities of people would be able to meet the challenges and contribute to sustainable road transportation in the town.

3. OBJECTIVE

The objective of the study was to investigate the influence of using ICT in socio-economic and travel activities on the road traffic movement and develop strategic guidelines for optimal traffic movement in the urban areas of the Eastern Cape Province by considering a case study of Mthatha. The use of questionnaires, non-structured interviews and field

surveys were done and for the sake of this paper only 50 out of 150 questionnaires conducted was analysed to find results, the study and analysis is still ongoing.

4. LITERATURE REVIEW

Sustainable development is about finding better ways of doing things, both for the future and the present. Sustainable road transportation is an integral part of sustainable development because large scale transportation and vehicular activities are increasingly contributing to the economic, mobility, living conditions and environmental challenges of regions or cities (EC, 2005; Haghshenas, Vaziri and Gholamialam 2015; Schipper, Deakin and McAndrews, 2009). It reduces short and long term negative impacts on the local and macro environments while providing safe and secure access and mobility for both people and goods. Scholars have advocated that it should be based on economically viable infrastructure and efficient operations (Banister, 2008; Beaudoin, Farzin, Lawell, 2015; Bongardt, et al., 2011; Broaddus, 2014; Dalkmann and Huizenga, 2010; Litman, and Burwell, 2006). Thus, and in other words, sustainable transportation influences spatial configuration, economic vitality and environmental quality of a region or city (Cervero et al., 2009; Deakin, 2001; Li, et al., 2009; Litman, 2007) and offers efficient accessibility and mobility. As, urban areas/ regions require safe, fast, energy-efficient and low carbon emission transportation system in order to contribute to the sustainability of cities or regions (Rockwood and Garmire, 2015), it is imperative to prioritise sustainable road transportation (Dobranskyte-Niskota, Perujo and Pregl, 2007; Emberger, et al., 2008; Haghshenas, Vaziri, and Gholamialam, 2015; Litman, 2009; Rodrigue et al., 2007).

Since, urban activities, land use and road transportation system are complementary to each other in a city/town and the efficiency of road transportation is measured by indicators such as accessibility to- and quality of public transportation, level of congestion, level of carbon emissions and polluting matters, road utilization, facilities for pedestrian movement, traffic accidents, etc., (Haghshenas, Vaziri, Gholamialam, 2015; Litman, 2003, 2007; Schipper, Deakin, and McAndrews, 2010; Zhao, 2010). Some scholars have advocated that sustainable road transport policy should tackle rising levels of congestion, optimal traffic flow, and reduction of traffic crashes among other factors such as higher use of public transportation, reduction of noise and pollution, and use of more environmentally-friendly modes of transport, (Dobranskyte-Niskota, Perujo and Pregl, 2007; Emberger, et al., 2008; Haghshenas, Vaziri, and Gholamialam, 2015; Litman, 2007; Zhao, 2010).

In the context of the African continent and specifically in the cities/towns of South Africa, initiatives have been taken to adopt a sustainable transport framework for a transition to sustainable road transportation. The strategies include boosting of the use of sustainable fuels, reduction of greenhouse gas emissions through the use of low-emission fuels and curb air pollution, improvement of road safety, encouragement of non-motorised transport, and fostering of quality of public transport. Moreover, one of foremost and very important strategy considered is to invest in clean technologies including the use of ICT (UNEP, 2014).

In this regard, advances in ICT, and its linking power through mobile devices are creating fresh opportunities for modernizing road transportation and traffic infrastructure (Loukopoulos, 2005; Vijayakumar and Mehendiratta, 2011). ICT applications in the transport system differ in complexity, ranging from simple electronic communication (signals) to interactive and highly intelligent applications in traffic management and control, and in car fuel management (Van Geenhuizen, 2009). Types of ICT that can assist in sustainable road transportation system include Video Surveillance and Response, Informational Signing (variable messages), Advanced Traveller Information Systems,

Adaptive Cruise Control, Intelligent Speed Adaptation, and Dedicated Short Range Communications (Van Geenhuizen, 2009). Thus, arguments have emerged that effective use of ICT in socio-economic activities and travel needs of people, and Intelligent Transportation systems (ITS) in road and vehicular traffic management can bring change in travel pattern and travel behaviour. Consequently, it can enable reduction in the need for travel; reduce congestion, travel time, delay, and travel cost; enhance traffic management system and improve movement manoeuvrability, which ultimately enable attainment of innovative and sustainable transportation in the regions/cities (Belella et al., 2009; Emuze and Das, 2015; Fugate et al, 2009; Monni and Raes, 2008; Schipper, Deakin, and McAndrews, 2009; Sietchiping et al., 2012). However, studies relating to sustainable road transportation at a city/town scale considering the urban activity, travel pattern and use of ICT in day to day urban activities of people and in road transportation to meet the sustainable transportation challenges, particularly in South Africa are scarce. Thus, by using a case study of Mthatha town this study envisages exploring the concept of sustainable road transportation from different perspectives, and to assess how sustainable road transportation can be achieved, particularly by integrating ICT in the socio-economic and travel activities of people and in the transportation system in South African cities/towns.

5. STUDY METHODOLOGY

A number of surveys were conducted to collect relevant data. Physical road parameters survey and traffic survey counts were conducted at selected roads of the town to collect data relating to geometric parameters of roads and traffic parameters such as traffic volume, speed, speed changes, waiting time, traffic flow pattern, queue length, congestion condition, and parking situation. These surveys were conducted by direct measurements at road sections utilizing relevant measuring techniques and the information was recorded by using standard templates.

Road users and stakeholders' surveys were conducted by using pretested questionnaires and non-structured interviews. A systematic and stratified random sampling process was used for this purpose. The parameters in the survey questionnaire included demography of road users, purpose of travel, modes of travel, travel patterns, origin and destinations, travel itineraries, travel times, various challenges with regards to the influence of road design elements on road users, and human factors that hamper road safety. Questions were also framed with regards to the use of ICT in socio-economic activities of people, impacts of ICT on travel behavior, and trip decision making. Similarly, the questionnaire also addressed the perception of road users and stakeholders on various sustainable indicators as well as undesirable aspects of the transportation system. Furthermore, stakeholders such as urban planners, transportation planners, transportation engineers, consultants, ICT experts, policy makers and decision makers were also engaged by using semi-formal and unstructured interviews. The discussions focused on various strategies and polices that are being taken and considered for improving road transportation system in cities of South Africa.

Specifically, the Project Manager of King Sabata Dalindyebo Local Municipality under Technical Services was engaged through a non-structured interview and also answered one of the questionnaires.

For this papers sake, a sample of 50 Questionnaires and certain data of the major roads and intersection was used to compile the results, the study is ongoing.

6. RESULTS AND DISCUSSIONS

The results of the speed changes in major roads, traffic count data, responses and percentages of the sample of 50 people interviewed and the physical and geometric parameters is in Table 1, Table 2 and Table 3, Table 4 respectively. While analyzing the data, the inconsistent and vague responses were eliminated through scrutiny of the data set and only credible and complete responses were used for analysis.

Table 1: Average and peak hour speed on major roads of the study area

Roads	Average Speed during normal hours (in km/ h)	Average Speed at peak hours (in km/ h)	Percentage (%) difference in speed between normal hours and peak hours
R61 (Sutherland)	40	15	62.5
Sprigg Street	40	25	37.5
Madeira Street	40	20	50
Nelson Mandela Drive	50	30	40

Table 2: Traffic count data on major intersections in study Area

Road Intersections	Traffic during Peak Hour (06H30–08H30)	Traffic during Peak Hour (12H00–13H30	Traffic during Peak Hour (16H00–17H30	Date of Traffic Surveys
Mthatha Bypass & Nelson Mandela Drive	1300	1237	1201	06/06/2018
R61 and Sisson Road	2700	2000	2245	07/06/2018
Madeira & Sutherland	3926	2450	3000	08/06/2018
Nelson Mandela & Madeira	3101	3255	2950	09/06/2018
Sprigg Street & Sutherland	2020	1875	2360	10/06/2018
Nqandu & N2 (Durban Road)	2010	1600	1831	11/06/2018

Note: These values include All Vehicle Types going in All Directions

Table 3: Analysed questionnaire data of a sample of 50 people interviewed in the study area

Most used Travel Route	Nelson Mandela (National Road2)	R61 (Sutherland)	York Road	Khwezi Road	Sprigg Street	Tutor Ndamase						
	34	7	1	4	3	1						
%	68	14	2	8	6	2						
Highest rated Traffic Congestion Causes (1 less important – 5 most important)	Commercial Function	Civic/Administrative Functions	On Road Informal Activities	Bus Stops, Taxi Stops	On Road Parking	Road Condition	Lack of Pedestrian Crossing	Accidents	Weather Conditions	Lack of Respect for Traffic Rules and Regulations	Types of Traffic Signaling	Type of Vehicles
	30	20	18	23	15	26	25	14	12	30	17	12
%	60	40	36	46	30	52	50	28	24	60	34	24
Ownership of ICT Devices	Computer	Laptop	Smart Phone	Tablet								
	28		46	10								
%	56		92	20								
Internet Access	Yes	No										
	50											
%	100											
Quality of Internet Connection	Good	Bad										
	42	8										
%	84	16										
Will ICT Information system assist with Traffic Movement	Yes	No	No Response									
	46	3	1									
%	92	6	2									
Willing to pay for ICT System	Yes	No										
	40	10										
%	80	20										
Will Economy Improve if ICT Integrated	Yes	No										
	45	5										
%	90	10										

Table 4: Physical and Geometric Parameters of Major Roads in the study area

Name of the roads	Road type (N/R/ Arterial/ local streets, etc.)	Road width (m)	Number of lanes	Lane width(m)	Availability of bicycle pedestrian/ lane	Pavements/ footpaths /shoulders width	Kerbs	Median width	Radius of Curvature	Gradient (%)	Type of Road surface	Condition of road surface	Availability of Traffic control system	On street parking type Right angle/ inclined/ parallel
Nelson Mandela Dr (N)	U3	6	2	3	Y(PD/P)	P-2.1	Y	Y(Line) 1.6	Gentle	1.0 - 2.0	Sealed	Good	Automated signalling	Y(Parallel)
Nelson Mandela Dr (S)	U3	6	2	3	Y(PD/P)	P-2.1	Y	Y(Line) 1.6	Gentle	1.0 - 2.0	Sealed	Good	Automated signalling	Y(Parallel)
Sprigg (N)	U3	7	2	3.5	Y(PD/P)	P-3.5	Y	N(One way road)	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Sprigg (N)	U3	9	3	3	Y(PD/P)	P-3.5	Y	N(One way road)	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Sutherland (S) Towards Ngcobo	U3	3	1	3	Y(PD/P)	SW-1.7	N	N(Line)	Gentle	1.0 - 2.0	Sealed	Acceptable	Automated signaling & Speed Humps	N
Sutherland (N) Towards Ngcobo	U3	3	1	3	Y(PD/P)	SW-1.7	N	N(Line)	Gentle	1.0 - 2.0	Sealed	Acceptable	Automated Signaling,Speed Hump	N
Sutherland (S) In Town	U3	8	2	4	Y(PD/P)	F-7.5 P-1.3	Y	1.6	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Sutherland (N) In Town	U3	8	2	4	Y(PD/P)	F-7.5 P-2.2	Y	1.6	Gentle		Sealed	Good	Automated signaling	Y(Parallel)
Sutherland (S) Towards PSJ	U3	6	2	3	Y(PD/P)	F-2.2	Y	4.5	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Sutherland (N) Towards PSJ	U3	6	2	3	Y(PD/P)	F-2.2	Y	4.5	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Madiera (S)	U3	9	3	3	Y(PD/P)	P-7.5	Y	N(One way road)	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Main/Durban Road (N)	U3	6	2	3	Y(PD/P)	P-2.2	Y	4.3	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)
Main/Durban Road (S)	U3	6	2	3	Y(PD/P)	P-2.2	Y	4.3	Gentle	1.0 - 2.0	Sealed	Good	Automated signaling	Y(Parallel)

N= North (Towards inside of the city)
S = South (Towards outside of the city)
PD- Pedestrian facilities, B- Bicycle, P- Paved, UN- Unpaved, Y- Yes, N- N
PV-Pavement, F- Footpath, SW- Shoulder Width

6.1 Average speed changes in major roads

The results shown in Table 1, show speed changes in the major roads highlighted in the table, the speed changes were taken while driving in the road during normal hours and during peak hours in order to find the difference and changes in speed. As the table shows, speed changes occur, they drop drastically, thereby causing a challenge for traffic movement in the city.

6.2 Traffic count data on major roads

The results in Table 2 shows traffic count data that was collected between the 06 – 11th of June 2018, each intersection was done on its particular day in different peak times for an hour, the values shown there include all vehicle types (light to heavy) going in all directions of that intersection. This data shows how much volume of traffic that Mthatha experiences in those peak times and looking at the correlation between Table 1 and 2, it is visible that traffic congestion is experienced as speed drops as the amount of vehicles increase in these intersections.

6.3 Analyzed questionnaire data

Table 3 shows results from 50 respondents who were interviewed. However the study is ongoing, but for this paper 50 questionnaires were used, and only important questions were tabulated that help in establishing whether ICT can be a solution to the traffic challenges if integrated.

According to the table 100% of the respondents which is the 50 respondents in Mthatha own ICT enabled devices, 84% have good internet connection or access. These results alone show that if an ICT transport solution is well managed, understood and introduced, people would have access.

80% out of the 50 respondents are willing to pay for this service if it will improve addressing their transport challenges. One of the most important and basic reasons for improved transportation is to achieve economic stability, and 90% of the people agree that ICT integration can in fact assist in improved economic situations in Mthatha.

Table 3 also shows the response of people on what they think is the most contributor to traffic congestion and it is found that the highest, 60% is Commercial functions which can be explained as shopping malls, and also 60% being lack of respect to traffic rules and regulations. There are other contributors like road conditions and parking challenges which can be improved but if ICT is integrated and people are aware of using online shopping through their ICT enabled devices to procure their goods, a certain percentage of traffic can drop within the Mthatha area.

Table 3 also shows that the Nelson Mandela Road which is also the National Road is the mostly used route and it runs through the CBD area of Mthatha from both ends of the town of Mthatha, carrying traffic from both Durban and East London. Through the integration of ICT, alternative routes can be established within existing ones and information on the amount of congestion can help driver plan their trip effectively.

6.4 Physical and geometric parameters of major roads

Table 4 shows the physical and geometric parameters of the major roads in Mthatha, these parameters were taken physically through measuring and some data was established according to the recommended physical and geometric design standards of the roads (SANRAL, G2 manual, 1-304; 2015, Guidelines for Human Settlement Planning and Design, Roads: Geometric design and layout planning,7,1-41).

7. CONCLUSION

The study is being undertaken to find out whether integration of Information communication technology for sustainable road traffic movement can be achieved in Eastern Cape in the town of Mthatha.

Based on the current results, Mthatha stands as a town that can accept developments with regards to ICT and any transport related solution, and since the new cameras were installed in 2018, driving behaviors have since changed. Integration of ICT in Mthatha will also not be as challenging because people own ICT devices and have connection to the internet. But any implementation poses a challenge of resistance from people toward a new idea and further studies and analyses of available data still needs to be performed to get the final recommendation with regards to the study topic.

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