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Unpacking the impact of public transport infrastructure investments on transformations in the City of Johannesburg

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Abstract

In the age of smart cities and globalisation, smart mobility is not only a vital component in the physical functionality of cities but also an economic and social performance of the modern urban centres. Urban transformations that are taking place in South African cities exhibit a strong shift towards the adoption of smart cities concepts that entail smart governance, mobility, economy, living, environment and people; hence prioritizing the economy and the society's needs. There have been massive innovative public transport systems developments in the City of Johannesburg since 2010, which are the rapid Gautrain, Gaubus and Rea Vaya bus as a way of complimenting the already existing Putco bus, Metro bus and Metro rail services. Paradoxically, the impact of such innovations particularly on socio-economic development of the City of Johannesburg has not been highlighted conclusively in existing literature. Consequently, this paper seeks to explore and highlight socio-economic benefits of innovative public transportation systems in communities focusing on the City of Johannesburg. To comprehend this, the study used a mixed approach of qualitative, quantitative and spatial investigation. Questionnaires, key informant interviews, maps from ArcGIS software as well as crowd sourced data from Echo-Echo software were applied. This helped to reveal the socio-economic impact, developmental trends as well as perceptions of commuters using the innovative public transit systems. Research results revealed that innovative public transit systems contribute to socio-economic benefits however, a lot still needs to be done to improve their impacts on ordinary citizens and residents in the City of Johannesburg. Pursuant to that, the paper ends by recommending that there is need for strong linkages between innovative and sustainable public transportation development and socio-economic imperatives within communities and societies.

1. Introduction

The world is moving towards a paradigm shift of the smart cities concept in both developing and developed countries, consequently promoting sustainable development that conserves the environment and caters for socio-economic sustenance. At the heart of this concept is smart mobility which is not only a vital component in the physical functionality of cities but also economic and social performance of the modern urban centres (Peal and Goetz, 2015; Zheng and Peeta, 2015). Recently there has been

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an increasing demand for innovative public transportation in developing countries across the world, South Africa being one of which is committed to developing these integrated and innovative public transportation in its cities (Cardinale et al., 2014; Ryser, 2014; Schwaberger, 2014). Urban transformations that are taking place in South African cities reveal a strong shift towards the adoption of smart cities concepts that entail smart governance, mobility, economy, living, environment and people hence it should cater for the economy and the society's needs (Giffinger et al., 2007; Chen et al., 2014; Wendt et al., 2014).

Gauteng Province in South Africa took the path towards developing smart mobility in three of its metropolitan cities, that is, the City of Johannesburg Metropolitan Municipality, Tshwane Metropolitan Municipality and Ekurhuleni Metropolitan Municipality respectively. There have been massive innovative public transport systems developments in the City of Johannesburg since 2010, that among others include the Gautrain, Gaubus and Rea Vaya bus services as a way of improving the already existing Putco bus, Metro bus and Metro rail services (COJ, 2015; SITPF, 2013; Kolluru and Jain, 2015). However, the impact of such innovations particularly on socio-economic development of Johannesburg communities has not been highlighted conclusively in existing literature hence there is need to further explore and highlight socio-economic benefits of innovative public transportation systems in the City.

This paper explores the impact of innovative public transport systems on socio-economic transformations in the City of Johannesburg, this is to search for the relationship between public transport provision and its impact on socio-economic development as well as other issues surrounding urban public transport which are central to the establishment of strategies aimed at improving underprivileged sectors of the City. As a final point, the paper provides evidence of a problem that is vastly affecting social groups in the City of Johannesburg as a result of social exclusion exaggerated by inefficient public transport services. Section 2 of this article discusses a theoretical synopsis on literature about public transport and their impacts on socio economic development as well as unpacking the relationship between accessibility, socio-economic exclusion and public transport in the City of Johannesburg. Section 3 discusses the case study focused on investigating the impact of public transport on socio-economic development in the City of Johannesburg. Section 4 covers the methodology that was used in this study. Section 5 discusses results of the public transport impact of socio-economic development in the City of Johannesburg and lastly Section 6 offer the conclusion and discussions.

2. Conceptual framework

The world is a global village that is continuously evolving into a Smart village where countries facilitate development in a sustainable and smart way were socio-economic development is highly prioritized (Ferris et al, 2010; Kamga et al, 2013; Tang and Thakuriah, 2012). At the centre of the smart cities concept is the smart mobility in relationship with smart people and smart governance (see figure 1). Over the years through industrial revolution transportation remains one of the most important innovation and service rendering people's needs economically and socially (Transportation Research Board, 2009), moreover increase in demand perpetuate the need for transport provision hence the need to increase and improve public transportation is important. Moreover, the increase in transportation is a result of the ever increasing population in many countries worldwide and studies show that this will be the case in years to come if a solution is not found to solve this problem, therefore the continuing increase in demand encourages the need for development of innovative public transport in support of

existing ones (Transportation Research Board, 2009, Tillner, 2014; Zhukova and Smirnova, 2014). Innovative public transport service providers have been successful in implementing rapid bus and rail transit as well as improving existing modes of public rail and road transport hence attracting users to use public transport to enhance its full functionality for the betterment of the economic, social and environmental benefits of the country and its citizens (Hadasa et al., 2014; Hino et al., 2011; Ibarra-Rojas et al., 2015).
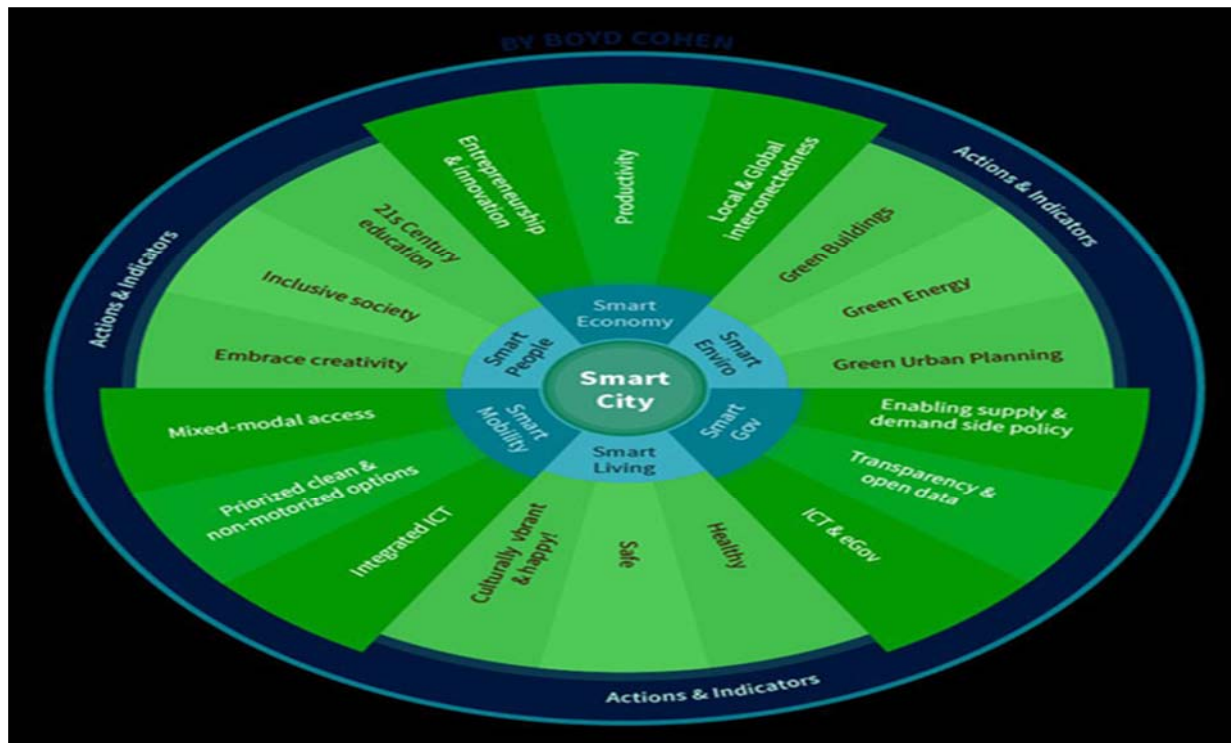

Figure 1: Smart city concept. (Source: Cohen, 2015)

Central to these efforts is a focus on reorienting current public policies that promote costly and destructive transportation and land use development patterns towards more economically efficient, equitable, and environmentally sound outcomes that strengthen communities and enhance the quality of life (Agostino et al., 2014). Sustainable transportation and smart growth are linked, as a result smarter growth patterns will be difficult to achieve without more sustainable transportation approaches; significant transportation improvements will be difficult to achieve without more sensible development practices (Tuominen and Ahlqvist, 2010). The City of Johannesburg had since adopted and implemented Transit Oriented Development (TOD) to bring its communities together and sustainably develop corridors (NDP, 2012). TOD is a well-known worldwide urban phenomenon linking transport infrastructure to property development in a sustainable way. It is evident that TOD principles, developed carefully within a South African context could help urbanize South Africa in a rapid, sustainable way.

Sustainable transportation systems are meant to transport individuals and groups of people whilst ensuring to stimulate social inclusion hand-in-hand with development (Gudmundsson, 2004; Miranda and Rodrigues da Silva, 2012; Cobbinah, Black and Thwaites, 2011; Cobbinah, Erdiaw-Kwasie and Amoateng, 2015). Furthermore, many cities in many countries around the world have implemented this

concept to legislature, strategic plans, policies and other frameworks that will help facilitate smart development and TOD.

3. Case Study: City of Johannesburg

The Gautrain, Rea Vaya, Putco, Metrorail and Metrobus are located in the Johannesburg Metropolitan City of Gauteng province, South Africa (Figure 2). Johannesburg Metropolitan City is the most competitive economic hub of the country and the fastest growing city in terms of the economy, development and population. It is home to both the wealthy and poor, residents and refugees, global corporations and emerging enterprises with diverse ethnic groups (COJ, 2013). Johannesburg has the largest population in South Africa with an estimated population of 4.4 million (Stats SA, 2016). The Gautrain, Putco and Metrorail operates in three metropolitan cities in Gauteng province namely City of Johannesburg, City of Pretoria and Ekurhuleni metropolitan municipality, however Metrorail alone operates 4 provinces (Gauteng, Western Cape, KwaZulu-Natal, Eastern Cape) in South Africa. These three areas form a city region which is the economic heartland of South Africa and are the only cities in South Africa having a rapid transit train. The Rea Vaya and Metrobus only operate under the jurisdiction of the Johannesburg Metropolitan City across many communities and city centres.
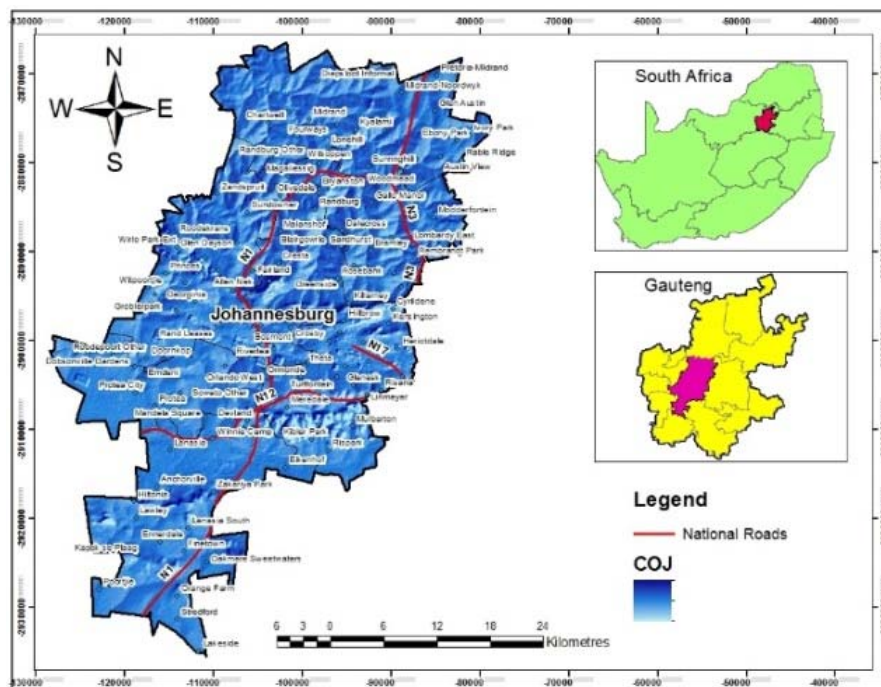

Figure 2: City of Johannesburg. (Source: Own source)

4. Methodology

Echo-Echo software was used to mine crowd sourced data from social media platforms such as Twitter and Facebook. The data revealed commuters locations that is used to show the infiltration of these public transport platforms within the City of Johannesburg. The results assisted in showing spatial integration, socio-economic transformations and presence of public transport within the City. Travel behaviours helped to reveal the socio-economic effects of public transport in the City of Johannesburg. Echo-Echo software was used to conduct the analysis of data collected from social media. It also

assisted with qualitative and quantitative understanding of language usage, the psychological drivers behind conversations, language and linguistic insight, advanced word clouds, topics, category analysis and crucial data in determining socio-economic transformations in the City (Oliveira & Welch 2013).
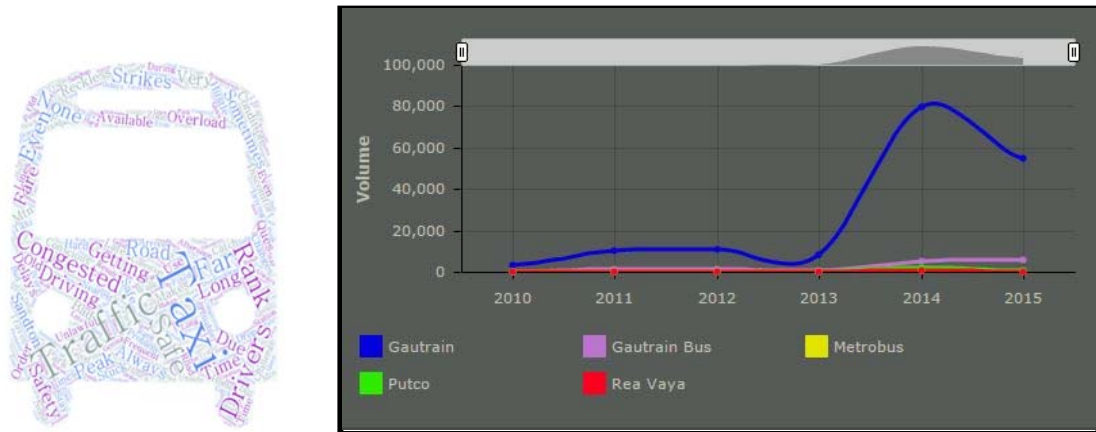
5. Results and discussions

Figure 3: Mention Count (Source: Echo-Echo, 2015)

This analysis counts the number of times the different rail and bus services have been mentioned. The graph indicates that social media feeds have been dominated by the mention counts of the more than other public transportation. The mention count of the Gautrain reached its peak in the year 2014 with 80 000 feeds made within that year. Second to this is the Gautrain bus with a volume of 5 000 social media feeds followed by Putco bus (1000 social media feeds in 2014), Metrobus (1000 social media feeds in 2014) and Rea Vaya bus (0 social media feeds from 2010 to 2015) (see Figure 3). The reason for this trend could be that the use of social media has reached its peak in the last two years in South Africa, especially with the Gautrain using social media platform to acquire feedback from their commuters and to convey any crucial matters to their commuters.
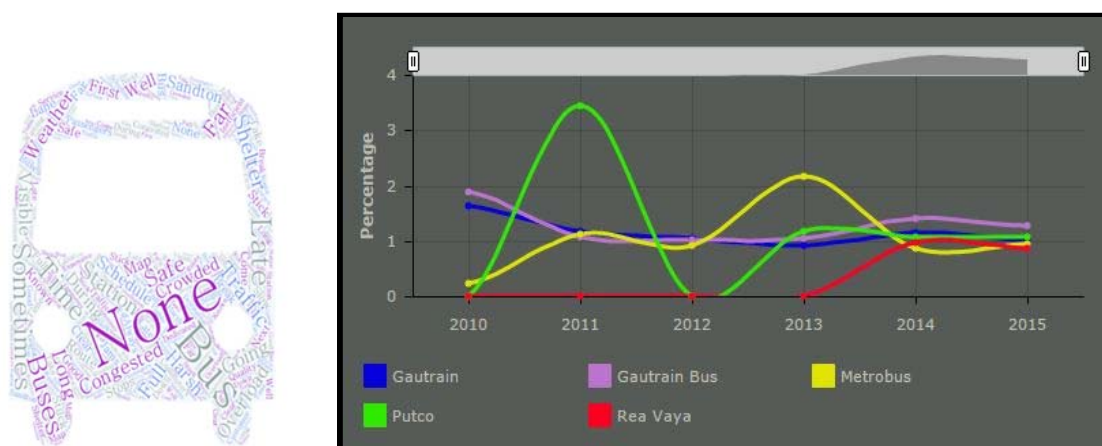

Figure 4: Leisure (Source: Echo-Echo, 2015)

Figure 4 above shows the percentages of commuters who have used the train and different bus services to travel to areas of leisure such as malls, zoo's, stadiums etc. The graph indicates that in the year 2011, there was 3.5% of Putco commuters using the bus services either to travel to areas of leisure or

promotions of leisure areas which were in proximity to the Putco stations. In the very same year, the Gaubus, Gautrain, Metrobus were trailing behind with only 1% of the commuters using these services for leisure (see Figure 4). However, Rea Vaya did not have any mentions until 2013 when there was a gradual increase in the percentage of commuters who have mentioned areas of leisure and the Rea Vaya bus. Both the Gautrain and Gaubus mention counts reduced from the year 2010 to 2015. This could have been due to the price hikes of the rapid rail and bus services. The gradual use of urban public transport for leisure proves that urban public transport investments have transformed the Gauteng Province through improvement in social cohesion by participating in social media, supporting social events and spatially invested in integrating areas of leisure with micro level communities in the province. These investments have also contributed to the development of Transit Oriented Development (TOD) such as mixed land uses along urban public transport routes that connect economic nodes. The development of mixed land uses have contributed to urban regeneration in cities across the province.
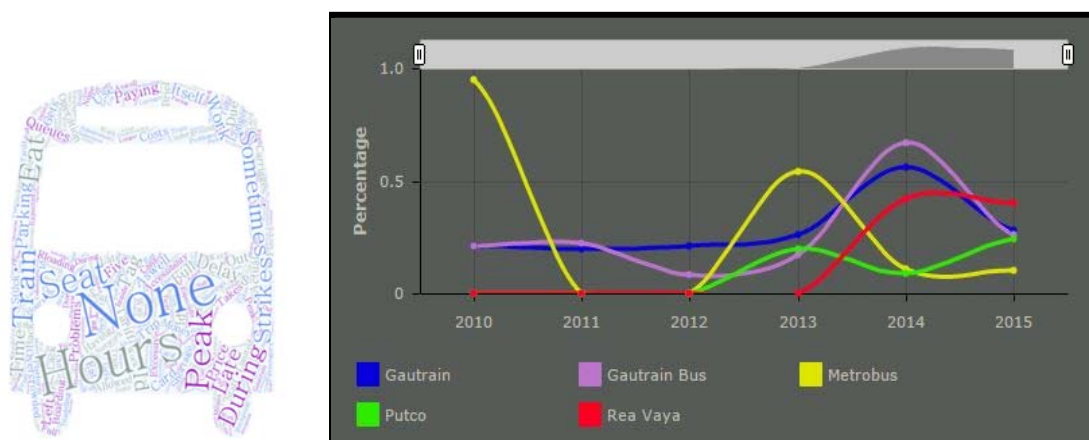

Figure 5: Home (Source: Echo-Echo, 2015)

Figure 5 shows the percentage of commuters who have mentioned the word 'home' in their Facebook posts or tweets, making reference to the rail and different bus services. From the graph, one can tell that in 2010 there was a very large percentage of Metrobus commuters who made social media comments using the word 'home'. This was either through advertising accommodations which were close to the Metrobus stations or people simply talking about their experiences using the Metrobus when they travel from their homes to different locations. The graphs show that other public transport services such as Gaubus, Gautrain and Rea Vaya had reached the peak in 2014 suggesting that many people used these public transport to travel home either interchanging from one of these modes to another hence showing integration of public transport systems in the Johannesburg Metropolitan city. As a result, urban public transport investments in the Gauteng Province contribute to spatial integration between micro level communities, the metropolitan cities and other economic nodes. TOD and the expansion of urban public transport infrastructure to small communities have promoted economic opportunities such as malls to open in micro level communities hence increasing employment and improving socio-economic state of many small communities.
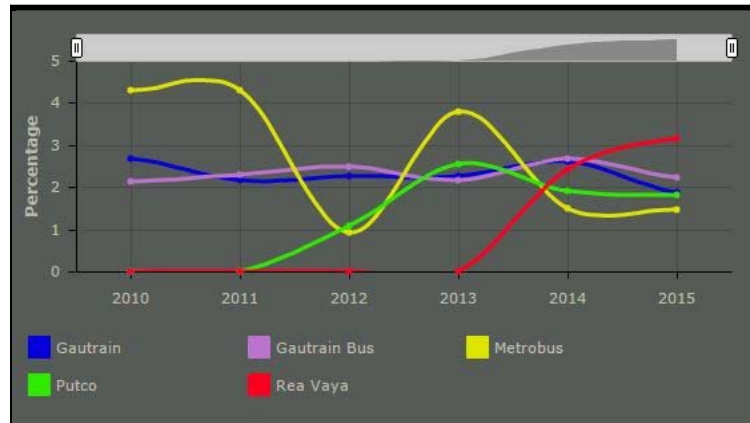
Figure 6: Work (Source: Echo-Echo, 2015)

The graph (see figure 6) above shows percentage of people who use the different bus services to commute to work. The graph indicates that the Rea Vaya bus services had a stagnant percentage of commuters using the bus services. However, the percentage of commuters who use the bus service to get to work increased drastically from 2013 onwards. The low percentages of the Rea Vaya commuters between the years 2010 to late 2012, could be a result of having the bus service being relatively new and people not being familiar with it. The Metrobus during the 2010 to 2011 had a high percentage (4.4%) of people using the bus service to commute to work. This percentage however, had a sharp drop between the years 2011 to 2012. Thereafter, the percentages increased and then decreased from the year 2012 to 2014. From 2014 to 2015, there was a constant number of commuters using this bus services. This fluctuation is a result of the bus fare hikes because according to the graph, the years 2013 and 2014 reveal a decrease in the number of commuters who use the Metrobus to commute to work. Simultaneously, there was an increase in the number of commuters who used the Rea Vaya bus services to get travel to work. Both the Gaubus and Gautrain have fluctuation between 3% and 4% as compared to other modes meaning their commuters have managed to use the Gautrain services for work purposes constantly. Consequently, this shows that urban public transport in Gauteng province is invested towards achieving employee trip reduction from micro-level communities into metropolitan cities and other micro city centres by improving spatial integration and allowing easy access in Gauteng Province.

Figure 7 below is a snapshot of City of Johannesburg map with an indication of the number of tweets and Facebook posts which have been made by commuters using the train and the different bus services. The different coloured circles represent different number of tweets and Facebook posts and they are as follows:

- Blue icon = 1 tweet
- Blue = less than 10 tweets
- Yellow = less than 100 tweets
- Red = less than 1000 tweets
- Pink = less than 10 000 tweets
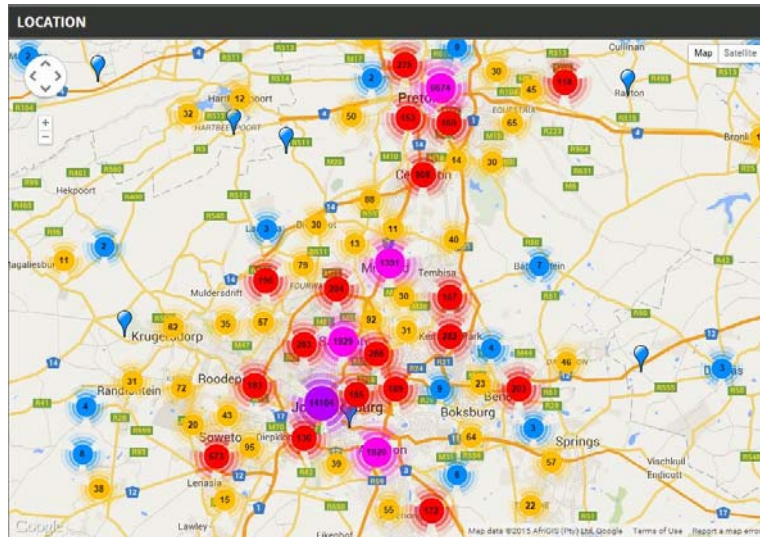- Purple = less than 100 000 tweets

Figure 7: Location analyses (Source: Echo-Echo, 2015)

From figure 7 above, it can be deduced that there is a lot of social media activity taking place in the Gauteng province, specifically between the Johannesburg and Pretoria region. The map indicates that in Johannesburg there is an accumulated 14 104 tweets and Facebook posts which have been made on the basis of trending topics centred on the Gautrain, Gaubus, Metrobus, Rea Vaya and Putco. This could be a result of the integration of public transport in the Central Business District (CBD). Therefore, more of the tweets regarding the topics on the Gautrain, Gaubus, Metrobus, Rea Vaya and Putco are from their commuters and some from residents.
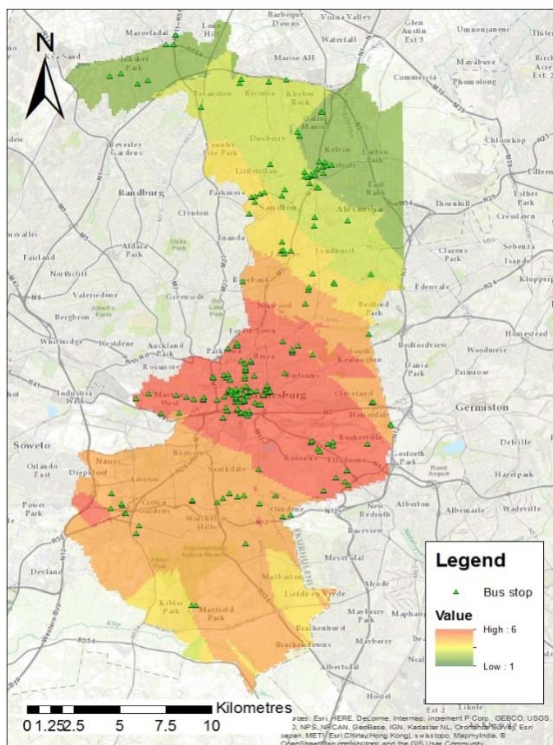

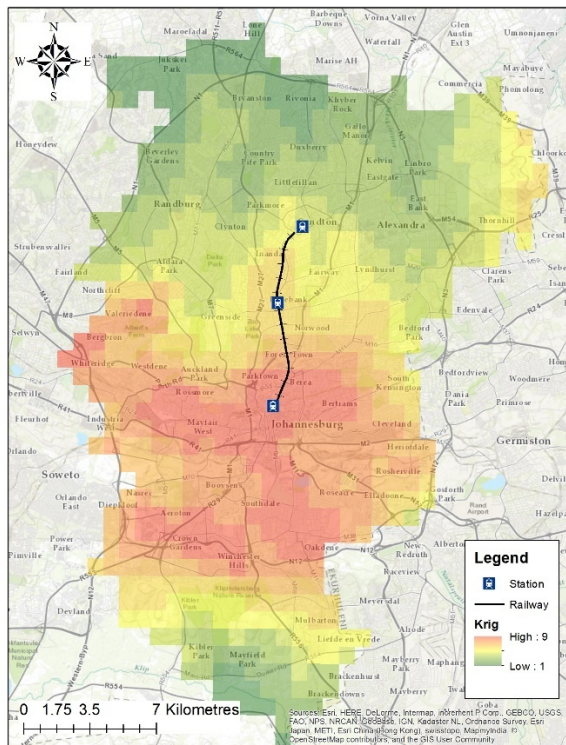Figure 8: Rea Vaya Sensitivity analysis (Source: Own source)

Figure 9: Gautrain Sensitivity analysis

Figure 7, 8 and 9 further indicates that there aren't a lot of social media activities taking place on the East and West of Johannesburg, as there are less tweets and Facebook posts being made in those locations. However, the map also indicates areas which have the second highest number of tweets and Facebook posts. These areas are the neighbouring cities such Pretoria and Kempton Park. The Gautrain, Gaubus, and Rea Vaya does not operate in some of Gauteng's cities such as Springs and Krugersdorp. However this high number indicates that the train and bus service was trending on the social media even in the area where it is not operating. This could be due to consumers complaining and bringing forth their desires of having the Gautrain, Gaubus, and Rea Vaya operating in their respective cities.

6. Conclusion

This study contributes toward unpacking the impact of innovative public transport systems on socio-economic transformations in Gauteng province, in conclusion that innovative public transport investments in Gauteng does contribute to socio-economic transformations. However, to a moderate extent the lack of accessibility to multiple urban public transport systems and rapid transit in disadvantaged areas away from city centers has proven that innovative public transport still needs to expand further from city centres, hence socio-economic needs of people far from urban centres will ultimately be met. The solution to addressing these gaps are to include the currently marginalized areas that do not have full access to these modes of urban public transport in policies to ensure they are included in priority expansions and for future mobility development. Social media has improved perceptions of the public about urban public transport and has created a platform for commuters to communicate directly with service providers. However there still remains an economic gap as not everyone who uses urban public transport use social media at all or as a result of restricted access because of unaffordability of data for the social media services. Traffic demand management has been improved through rapid rail and bus transit as they have their own dedicated lanes that do not suffer the consequences of traffic congestion. Socio-economic challenges such as safety, convenience, reliability, affordability and accessibility of urban public transport systems have improved over the years, the multiplicity of modes and investments in multi modal integration has improved urban public transport standards.

6.1.   Limitation and further research

This research has explored the impact of innovative public transport systems on socio-economic transformations in the City of Johannesburg. Future studies could expand the scope of the study through increasing data collection tools to collect more data in the study area and beyond, as well as to allow for more factors to be identified and analysed. The recommendations herein are approaches primarily aimed at stimulating public transportation usage by commuters in Johannesburg. Future studies can also factor in the viewpoints of other key stakeholders, such as city planners and public transportation agencies.

References
Agostino, D., Steenhuisen, B., Arnaboldi, M., & Bruijn, H. (2014). PMS development in local public transport: Comparing Milan and Amsterdam. Journal of Transport Policy Vol. 33, pp. 26–32.

City of Johannesburg. (2013). Strategic Integrated Transport Plan Framework. Available at www.joburg.org.za. Accessed 01 September 2015.

Cobbinah, P.B., Erdiaw-Kwasie, M.O. & Amoateng, P. (2015). Africa's urbanization: implications for sustainable development. Cities, Vol 47, pp 62-72.

Ferris, B., Watkins, K., Borning, A. (2010). Location-Aware Tools for Improving Public Transit Usability. Journal of IEES CS.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). Smart cities-Ranking of European medium-sized cities. Vienna University of Technology.

Hadasa, Y., Rossib, R., Gastaldib, M., and Geccheleb, G. (2014). Public Transport Systems' Connectivity: Spatiotemporal Analysis and Failure Detection. Journal of Transportation Research Procedia, Vol. 3, pp. 309 – 318.

Hino, A.A.F., Reis, R.S., Sarmiento, O.L., Parra, D.C., and Brownson, R.C. (2011). The built environment and recreational physical activity among adults in Curitiba, Brazil. Journal of Preventive Medicine, Vol. 52, pp. 419–422.

Ibarra-Rojas, O.J., Delgado, F., Giesen, R., and Muñoz, J.C. (2015). Planning, operation, and control of bus transport systems: A literature review. Journal of Transportation Research Part B, Vol. 77 pp. 38–75.

Kamga, C., Yazici, M.A., Singhai, A. (2013). Implementation of interactive transit information kiosks at New York City facilities: Analysis of user utilization and lessons learned. Journal of Transportation Research Part C, Volume 218-231.

Legara, E.F., Monterola, C., Lee, K.K., and Hung, G.G. (2014). Critical capacity, travel time delays and travel time distribution of rapid mass transit systems. Journal of Physical A, Vol. 406, pp. 100–106.

Małeckia, K., Iwanb, S., and Kijewskab, K. (2014). Influence of Intelligent Transportation Systems on reduction of the environmental negative impact of urban freight transport based on Szczecin example. Journal of Social and Behavioral Sciences, Vol. 151, pp. 215 – 229.

Miranda, H.F., and Rodrigues da Silva, A.N. (2012). Benchmarking sustainable urban mobility: The case of Curitiba, Brazil. Journal of Transport Policy, Vol. 21, pp. 141–151.

Munoz-Raskin, R. (2010). Walking accessibility to bus rapid transit: Does it affect property values? The case of Bogota´, Colombia. Journal of Transport Policy, Vol. 17, pp. 72–84.

NDP 2030. (2012). Available at www.gov.za [Accessed 20 April 2014].

Perl, A.D. & Goetz, A.R. (2015). Corridors, hybrids and networks: Three global development strategies for High speed rail. *Journal of Transport Geography*, 42, 134-144.

Statistics SA. (2016). National household travel survey. Available at www.statssa.gov.za

Tang, L., & Thakuriah, P. (2012). Ridership effects of real-time bus information system: A case study in the City of Chicago. Journal of Transportation Research Part C, Volume 146-161.

Tao, S., Corcoran, J., Mateo-Babiano, I., and Rohde, D. (2014). Exploring Bus Rapid Transit passenger travel behaviour using big data. Journal of Applied Geography, Vol. 53, pp. 90-104.
Tillner, S. (2014). More green open space in a densified city. Journal of Real Corp, pp 407-415.

Tuominen, A., and Ahlqvist, T. (2010). Is the transport system becoming ubiquitous? Socio-technical road mapping as a tool for integrating the development of transport policies and intelligent transport systems and services in Finland. Journal of Technological Forecasting & Social Change, Vol. 77, pp.120–134.

Weber, K.M., Heller-Schuh, B., Godoe, H., and Roeste, R. (2014). ICT-enabled system innovations in public services: Experiences from intelligent transport systems. Journal of Telecommunications Policy, Vol. 38, pp. 539–557.

Zheng, H., and Peeta, S. (2015).Network design for personal rapid transit under transit-oriented development. Journal of Transportation Research Part C, Vol. 55, pp. 351–362.

Zhukova, N. & Smirnova, O. (2014). Smart Navigation for Modern Cities. Journal of Real Corp, pp 593-602.

Zhukova, N. (2014). Technological Solutions for Knowledge Management in Smart Cities. Journal of Real Corp, pp 653-664.