Transport Realities and Challenges for Low Income Peripheral Located Settlements in Gauteng Province: Are We Witnessing the Genesis of a New Transport Order or Consolidation of the Old Transport Order?

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Abstract. Optimised transport systems plays multi-purpose growth and development functions and roles in any area or region. When transport systems are optimised, integrated and efficient, such transport systems have the innate capacity and capability to support the flow of goods, labour and increased mobilities. In Gauteng, the apartheid manufactured "spaces and mobility lines" have been credited with various scales of transport, growth and development inequalities. Well over 25 years, since the dawn of the 1994 new democracy in South Africa, shifts in transport, spatial planning and development have made significant but arguably "microscopic gains" in seeking to reverse and advance new spatial scales and forms of transformative development. This paper, based on Gauteng province showcases the transport realities and challenges in Johannesburg, making use of case studies from low income peripheral located settlements. The recommendations resonate with the need for decisive systems and the "planting" of an adaptive, robust and flexible steering mechanism in order to transform the transport geography of Gauteng province. The central question discussed revolves on whether new transport geography or the old transport geography is being (re)created and (re)imagined in Gauteng province.

Keywords: Transport · Realities · Challenges · Genesis · Gauteng province

1 Introduction

Transport geography transitions, pathways and futures are an important hallmark in seeking to address spatial fragmentation, social exclusion and promoting integration in previously divided and gentrified cities [1, 2]. Tackling transport fragmentation and distortion manifestations in Gauteng province is an essential plan in seeking to spatially transform and reform the spatial transport and land use order in any place. This paper therefore unpacks the spatial and transport geographical disorder and mismatches in Gauteng province with a view to unravelling and better understanding the emerging transport realities and challenges for low income peripheral located settlements in the

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province. The central question that is answered is whether we are witnessing the genesis of a new transport order or consolidation of the old transport order.

Historically, "transport studies in South Africa" have tackled "urban public transport issues from a generalist and apologetic position" [3–5]. Apologetic transport studies conceive urban public transport problems from an *"exterior transport theory approach"* [4–7]. Invariably, Urban public transport is perceived as a sad outcome of the apartheid machinery [8]. On the other hand, the post-apologetic studies cohort adopts the *"interior transport theory approach"* to exploring "urban transport issues in contemporary South Africa" [9–16]. Likewise, urban public transport challenges are linked to the complex interplay of social, political, economic, physical and environmental factors shaping an urban community [17, 18]. The limitations of the above mentioned urban transportation theoretical approaches are manifold. Firstly; urban transportation problems in urban areas such as Gauteng province are reduced to being the negative outcome of apartheid. This in itself is an incomplete approach to tackling and seeking to advance solutions to resolve the situation. Secondly, urban transportation problems are inadequately viewed from a narrow contextual and inward looking approach. The result of such conceptualization is that transportation planners, policy makers and development practitioners inadvertently miss opportunities for implanting an inclusive, transformative and integrated land use and transport agenda. As a result, despite the successful application of such transportation approaches in Gauteng province, challenges of commuting still persist with interventions remaining insufficient to resolve the public transport commuting matters [19, 20]. Overall, this underscores that existing initiatives are not enough.

1.1 Aim of Study

The aim of this study was to investigate transport realities and challenges for low income peripheral located settlements in Gauteng province. This aim was located within a wider discourse of seeking to answer the question as to whether we are witnessing the genesis of a new transport order or consolidation of the old transport order.

1.2 Research Objectives

Three objectives guided the study, namely:

1. To describe the existing transport commuting realities in Gauteng province;
2. To assess the nature of transport commuting challenges in Gauteng province and
3. To discuss the implications of the emerging transport order and shifts within Gauteng for policy and planning.

2 Research Methods

Overall the analysis was conducted within the purview of a transport governance and systems innovation theoretical framework [21–25]. The empirical research approach employed involved both primary and secondary data collection methods. The research

work employed "a case study approach" through making use of "Gauteng province" to unpack the "transport realities and challenges for low income peripheral located settlements" [10, 15]. "Case studies have been argued to be an appropriate methodology for gaining in-depth insights of a phenomena and process through the application of the attitudes, knowledge, awareness and practices (AKAP) tool or methodology as exercised in this instance" [2, 26–36]. Additionally, case studies are important in critically exploring complex socio-economic transport realities and challenges impacting on low income peripheral located settlements in Gauteng province. A total of 1550 randomized household surveys were conducted to elicit the attitudes, knowledge, awareness and public transport practices in Gauteng province. Figure 1 presents a map presentation of the research study area sampled households in which surveys were conducted.

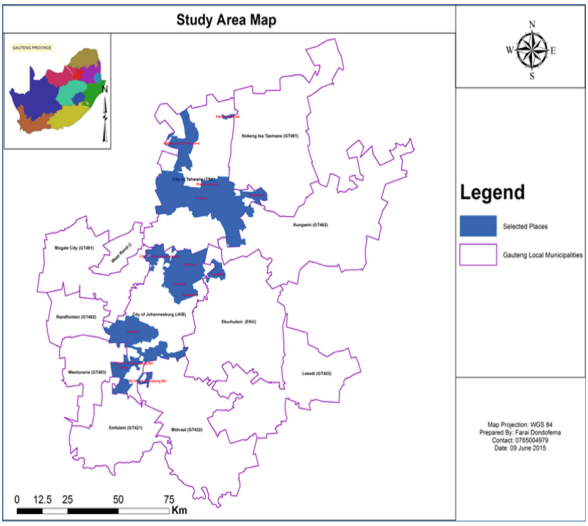

Fig. 1. Study area map (City of Johannesburg, Soweto, Alexandra, Sandton, Thembisa, Midrand, Mamelodi, Pretoria Central, Pretoria North, Hammanskraal, Soshanguve, Mapobane) Source: [17, 18]

From Fig. 1, we can deduce that the randomly selected suburbs in the research sample are as follows: Johannesburg (Alexandra, Midrand, Sandton, Soweto and Johannesburg Central), Pretoria (Hammanskraal, Mabopane, Mamelodi, Pretoria Central, Pretoria East, Pretoria North) and Ekurhuleni (Thembisa). The samples drew participants from low, middle and high income areas in addition to settlements that are both centrally and peripherally located from socio-economic hubs of Gauteng province. In any case, the research sample represented a cross-section of different public and non-public transport users in Gauteng province. The household commuting surveys were further complemented by key informant interviews (KII) with key transportation and related stakeholders. Critical content analysis of existing secondary documents through a thematic analysis technique assisted in further identifying the main public transport realities and challenges in Gauteng province.

3 Theoretical Overview of Spatial and Transportation Theories

Transport geography realities and challenges are dynamic and contextual [16, 37–39]. The manifestations of differentiated transport realities and challenges are linked to a set of complex social, economic, political, physical and environmental drivers of change. Table 1. Presents an overview of instructive spatial and transportation theories that shape and reshape urban mobilities and settlements transitions in any area.

Table 1. Overview of reviewed spatial and transportation theories.

Philosophy	Spatial fragmentation and social exclusion	Spatial integration
Theoretical/model culture	Primate Cities	Transit orientated development cities
	Automobile cities	Integrated cities
	Divided Cities	Connected & networked cities
	Fragmented cities	Compact cities
	Gentrified cities	New Urbanism
	Polarised cities	Smart Cities
	Divergent cities	Car Free Cities
	Mono-functional cities	Pedestrian Friendly Cities
	Poly-centric cities	Convergent Cities
	Edge cities	Spatial Clustering Cities
	General System Theory	Multi-centric cities
	Apartheid Cities	Green Cities
	Sprawling Cities	Adaptive and complex systems theory
	Polluted cities	Connected cities
		Densified Cities
Impact possibilities	Congested cities	Decongested cities
	Exclusive cities	Inclusive cities
	Motorised cities	Public transport friendly cities
	Carbon inefficient cities	Walkable Cities
		Cyclable Cities
		Low carbon cities

From Table 1, we can deduce that the shift and transition from spatial fragmentation and social exclusion towards spatial integration requires a paradigm shift. These paradigm shifts should occur at different scales of government, different sectors of the economy as well as filter through academic, research and professional bodies in order to have a total environment which is compliant to new ways of doing business in the spatial and transportation sector.

4 Discussion of Findings and Results

4.1 Describing the Existing Transport Commuting Realities in Gauteng Province

The existing transport commuting reality is a reflection of sub-optimal performance. This is because a constrained urban transport commuting model subsists on the backdrop of an inefficient transport system [8, 19, 40]. These spatial and transport inefficiencies are exacerbated by the preponderance for new suburban housing development to be "located at the periphery or edges of the cities be it for low income or high income" suburbs [8, 41, 42]. As a result, the existence of urban sprawl leads to a number of challenges including over extended peak hours. High motorization and car ownership especially among the middle class South Africans who are largely dependent on private vehicles for travelling continues to grow unabated with dire consequences for congestion, accidents and emissions. Additionally, over and above the spatial and transport inefficiencies and distortions which is imprinted on the spatial structure of towns and cities in Gauteng province, the province struggles with resolving and reducing the impact of direct and indirect costs on individuals, households and businesses. These challenges are more compelling given the reality that densities in South Africa's urban areas are very low compared with international standards. At the same time, the spatial fragmentation of the labour market disperses available work. Consequently, on average low income residents in Gauteng live in townships far away and located in the periphery of Gauteng's metros. The low income peripherally located residents are therefore faced with multiple forms of spatially induced transport and social exclusion constraints. Figure 2 presents a graphical illustration of best practice with respect to the public/private transport modal share compared to other city regions.

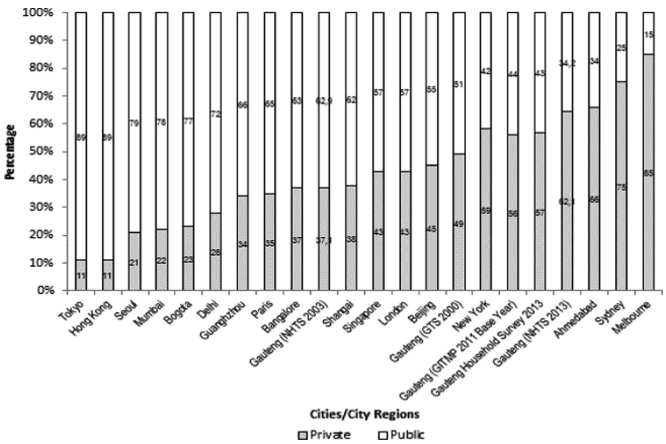

Fig. 2. Best practice: public/private transport modal share compared to other city regions Sources: [8, 17, 18, 42]

From Fig. 2, we can deduce that public transport in Gauteng province is still underdeveloped and is predominantly used by captive travelers who have on average little choice to leverage to any other mode of travel. This is partly because of the size of the Gauteng province, "low development densities and urban sprawl" [8, 17]. In any case, "low levels of public transport service coverage of the large areas and poor access to quality public transport services also contribute to limited private/public transport mode split and switch choice in the province" [8, 10]. Residents therefore "prefer the private car" although lately the "market for public transport has been growing" [8, 43].

4.2 Assessing the Nature of Transport Commuting Challenges in Gauteng Province

In South Africa, "at a local level, apartheid segregation created settlements that are separated from the main areas of employment and opportunities" [16, 37, 38, 44]. This model of "dispersed urban development (sprawl) not only consumes spaces and non-renewable energy, but is also the reason for high external costs in terms of traffic congestion, pollution, road accidents and social segregation" [8, 26, 45]. Prior to 1994, "transport design and planning was used as one of the instruments to segregate people, spaces, places and cultures" [3]. Yet, after 1994 "transport design, planning and policies were at the heartbeat of efforts aimed at reversing the impact of the legacy of apartheid in terms of spatial mismatches and the resultant transport distortions" [8, 16, 44]. The spatial impact of the development and location of gold mining towns that resulted in an East/West fragmented urban form is critical to understanding existing public transport commuting issues in Gauteng [43, 46, 47].

The North/South "steel" spatial development axis and the presence of dolomites in the study area is fundamental in explaining the spatial geological reality and spatial geographical development reality of present day need for improved commuting in all parts of Gauteng [48, 49]. From a spatial, integrated land use and transportation planning perspective, these processes which emerged first serving the apartheid political system founded the beginning of contemporary traffic congestion, air quality problems, noise pollution, energy consumption, urban sprawl and traffic accidents [48, 50]. Figure 3 presents fragmentation of space in Gauteng Province. "A complex array of factors and issues interact in multiple networked spatial and non-spatial interactions, relations and linkages to produce a package of spatial constraints to public transport commuting challenges in Gauteng province" [8, 18, 46].

From Fig. 3 we can deduce that spatial fragmentation is a big issue in Gauteng province and short, medium and long term efforts to reverse the effects require careful crafting. The implications of spatial fragmentation has multiple implications which are linked to transport, energy, social justice, environment, governance, economy, education and social facilities. "Unemployment is highest in low income settlements (i.e. Alexandra 32%, Soweto (51%), Johannesburg Central (38%), Hammanskraal (55%), Mobopane (51, 4%), Mamelodi (48%) and Tembisa (47, 4%) [8]. Survey respondents in the study area spent 21. 3% of total monthly income on transport" [8]. "Transport is a major cost to poor South Africans (who often have to travel the furthest for work), and this cost is frequently identified as a primary source of dissatisfaction with public transport" [41, 42].

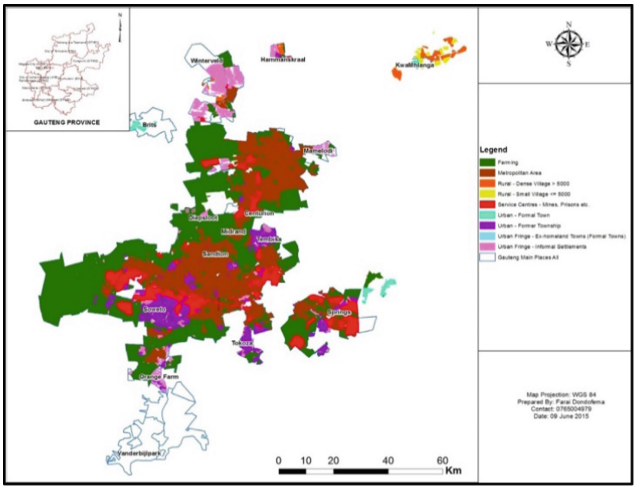

Fig. 3. Fragmentation of space in Gauteng Province *Source:* [8]

Although, the minibus "taxis are not subsidized", respondents indicated that "minibus taxis are a cheap alternative" for the "public who cannot afford to wait long hours to catch" the "subsidized" buses that operate "predominantly during peak hours" [8].

"Commuters from high density areas (i.e. low income areas) had respondents recording the highest frequency in citing that travelling times to socio-economic opportunity areas were long (i.e. Mamelodi 62 (4.38%), Mabopane 71 (4.58%), Hammanskraal 62 (4%), Tembisa 77 (4.96%) and Soweto 69(4.45%)" [8, 18].

The "highest number of people not travelling more than 10 min to work were 80 (Mamelodi), 89 (Mabopane) and 62 (Soweto) – all low income settlements" [8]. This represented "people employed in local economies" [41]. It was also because the majority of the respondents and residents in low income areas were self-employed in the "informal sector" as well as artisans who are motor mechanics that repair cars, hairdressers, barbers etc. [8, 42].

Gauteng province spatial and transportation structure exhibits "lack or absence of a loop transport" and or has insufficient scales of "hierarchies of transport loops" which is partly responsible for the "long commuting distances leaving the urban commuting network fragmented" [8]. In Gauteng, while public transport is provided, the downturn is that it is inefficiently provided.

4.3 Implications of the Emerging Transport Order and Shifts Within Gauteng for Policy and Planning

The study findings and results suggest the need to develop an integrated spatial transport model that is able to resolve the spatial and transportation distortions in Gauteng province [8]. This model should promote advanced forms of integrated land use and transport planning to enhance public transport urban commuting positive experience in Gauteng province. This would be achieved through the development of

an integrated spatial transport model for Gauteng province which has in-built capabilities and potential to reverse high commuting costs, long travel distances, spatial distortions as well as reduce public transport commuting constraints in the province. Given that "fragmentation of space occurs in the urban layout of Gauteng province" (i.e. provincial, municipal and local levels) and this creates commuting challenges in terms of long travelling times, there is need to explore and upscale the implementation and implanting of green public transport technologies and commuting options in order to transition towards a low carbon economy [8, 39, 51, 52]. "Fragmentation is a phenomenon that is driven by both physical and ideological factors" [8, 42]. Overcoming the phenomena as both a process and end result requires concerted paradigmatic shifts and changes at all scales of spatial and transport governance in Gauteng province in particular but South Africa in general. Indeed, the study findings and results corroborated that low income and peripheral settlement public transport commuters face challenges in terms of accessing socio-economic facilities – these challenges are manifesting themselves as various public transport level of service (LOS) performance indicators, namely; travel time, travel distance, congestion, delays and impact on the social, community and family fabric. However, not all hope is lost. There is need to explore how crowdsourcing, big data, internet of things, autonomous cars, electric cars and buses as well as uber's impact can translate into new forms of urban mobility emphasing a shift towards the consumption of mobility as a service (MaaS) rather than consumption of mobility as a product (MaaP) [53–56]. Furthermore, policy and planning gaps in the transport and spatial systems and frameworks require closing if sustainable transportation is to be delivered with a clear incorporation of a sustainable business model [56]. Figure 4 presents a graphical illustration of the public transport users realities and challenges for low income peripheral located settlements in Gauteng province: Are we witnessing the genesis of a new transport order or consolidation of the old transport order?

From Fig. 4. we can deduce that indeed a new wave of transport transformation is occurring in Gauteng province. These series of waves impact on the social, economic, political, governance, physical and environmental aspects requiring advanced forms of integrated spatial and sustainable transportation planning and management intelligence and responses. The generation, adoption and sustainable implementation of the correct mix of policy and planning options will lead to a smooth transition towards a new transport order in Gauteng province. This new transport order will be able to overcome spatial fragmentation and transport distortions in the area. However, a failure to implement the correct mix of policy and planning options will result in the continued consolidation and extension of the old transport order punctuated with spatial fragmentation and transportation distortions at all scales. In the new order, innovation and advancement in transport technologies such as electric buses and trains, the consumption of mobility as a service as well as the use of big data in the transport sector to offer more intelligent will feature strongly in a reconfigured single transportation authority for the Gauteng province.

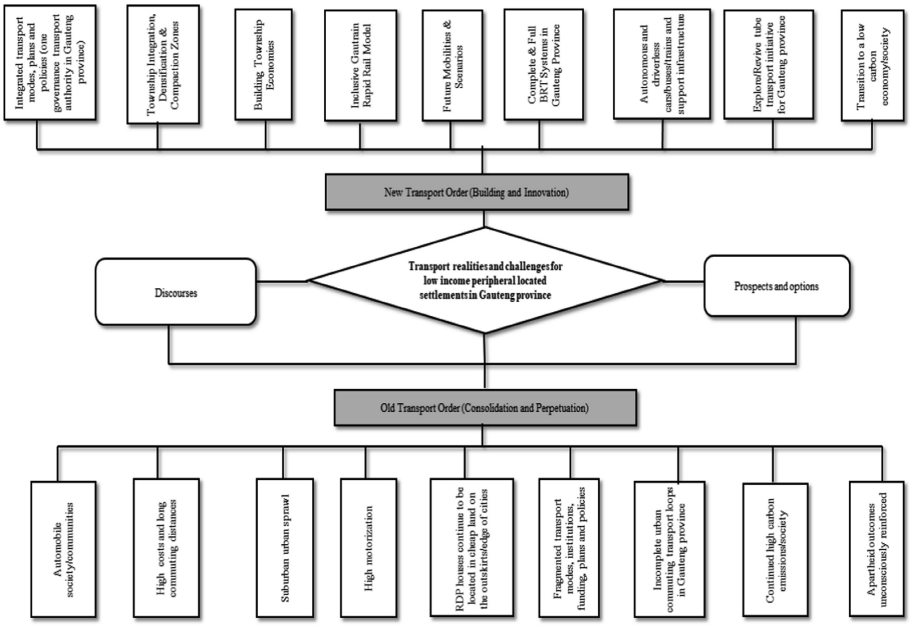

Fig. 4. Transport realities and challenges for low income peripheral located settlements in Gauteng province: Are we witnessing the genesis of a new transport order or consolidation of the old transport order?

5 Conclusion

This review has presented the nature of transport realities and challenges for low income peripheral located settlements in Gauteng province [57–59]. In the process a discourse with respect to whether we are witnessing the genesis of a new transport order or consolidation of the old transport order has emerged. The transition to a new transport order requires investment in new transport technologies (e.g. movement towards green cars, green buses and green trains (powered by electricity/solar etc.), transportation infrastructure and services science developments and advancements (e.g. solar or electricity charging stations, sensor, telematics and satellite communication devices and technologies for car/bus/train to communicate with each other through satellite communication systems and infrastructure expansion and coverage), change in policy and legislative (e.g. implications of driverless or autonomous trains/buses/cars in the built environment) as well as capacity building and re-curriculation of technical and University programmes in support and preparation of the new transport order direction (i.e. training of technicians to fix electric motors, green transport value chains as well as policy reform to incorporate new shifts in the transportation sector) [39, 70, 74, 75]. While these scale changes will not happen over time, the eventuality of the change in the transportation sector requires that planning and policy shifts should start now so that the switch to the new transport order from the old transport will be as painless as possible. Indeed, developing a sustainable and integrated advanced transport system in

Johannesburg requires the implementation of an integrated transport and spatial commuting network system model. In this set-up, "a sustainable and greener urban public transport system, coupled with more integrated planning with other sectors such as housing, energy and environment is integral to moving the South African society onto a more equitable long-term development path" [8, 39, 41, 60].

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