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The Perceived Effectiveness of Planned Measures of Modal Shift in Tshwane, South Africa

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ABSTRACT: The City of Tshwane has been undergoing rapid urbanisation, resulting in increased daily mobility enabled by motorised individual transport, potentially causing adverse environmental and public health effects. In light of this, promoting a modal shift towards sustainable transport modes has become a key priority for reducing the negative externalities associated with using motorised individual transport in the City. This study aimed to examine the perceived effectiveness of planned measures of modal shift to encourage the adoption of sustainable transportation modes, including public transport, cycling and walking, in the City of Tshwane. The study sought to determine the extent to which such interventions can reduce dependence on cars and mitigate the environmental impact of transportation. A questionnaire was used to collect data from 418 residents, revealing that the most effective interventions perceived to promote public transport usage were "more reliable public transport, more bus routes, and cheaper fares". Personal safety and security were the main concerns for cycling, while improved walking infrastructure increases the likelihood of walking for short distance journeys. The study concludes that substantial investment is necessary to improve transport infrastructure and increase usage of alternative transport modes to motorised individual transport and suggests future research examining the feasibility of bicycle rental facilities around the city centre.

KEYWORDS: Modal shift; walking; cycling; public transport; sustainable transport

1. INTRODUCTION

Transportation is a critical driver of socioeconomic development in cities. However, it is also responsible for a significant share of greenhouse gas (GHG) emissions and air pollution, which can adversely impact the environment and human health (Sobrino & Monzon, 2013). As of 2021, the transport sector contributes approximately 37 % of global carbon dioxide (CO_2) emissions from end-use sectors (International Energy Agency, 2023). The GHG emissions contribute to global warming, a significant driver of climate change (Petro & Konečný, 2017; Ramani & Zietsman, 2016). Effective management of the adverse impacts of transport is vital, given its significant contribution to CO_2 emissions. Creating sustainable cities and promoting sustainable transport are crucial to mitigating these impacts.

Sustainable transport is a complex concept without a standard definition, but it generally involves three main dimensions: social, economic, and environmental (Cheba & Saniuk, 2016; Eriksson, 2017; Patlins, 2017). Numerous frameworks of sustainable transport have been proposed to address the negative externalities of transport, with the modal shift being one of them. Promoting a modal shift towards sustainable transport has become a priority and is recognised as a key strategy for managing negative externalities of transport (Biondi, Romanowska & Birr, 2022; Elvik, 2009; Kii, Hirota, & Minato, 2005; Soto, Cantillo & Arellana, 2021). The modal shift towards sustainable transport modes aims to reduce greenhouse gas emissions, improve air quality, and promote public health and active transportation. However, a limitation of this concept is that it requires good quality public transport services and cycling and pedestrian infrastructure. Providing high-quality public transport services and implementing separate, bidirectional bicycle lanes can improve the safety of cyclists on the road.

Additionally, safe and accessible pedestrian infrastructure is essential for walking to be a viable form of transportation in the City. In some developing cities, pedestrians are often ignored or marginalised, and promoting walking requires the improvement of pedestrian infrastructure. Furthermore, some cities across African countries need well-developed public transport systems, which makes the concept of modal shift challenging and impossible (Timpabi, Osei & Adams, 2021).

From a local perspective, South Africa has ample room for improvement in reducing carbon emissions from transport sectors, which necessitates further research into this subject. South Africa is among the countries that adopted the UN's SDGs. SDG 11 target 2 aspires to "2030 provide access to safe, affordable, accessible and sustainable transport for all" (United Nations, 2017). The City of Tshwane is implementing a modal shift as part of a broader initiative to decrease dependency on private vehicles and encourage using active modes and public transport. This initiative aligns with the Green Transport Strategy for South Africa 2018-2050. The plan includes several initiatives aimed at improving the quality of life in the City, such as the promotion of public transport, the development of cycling infrastructure and the improvement of pedestrian access. In South Africa, there is a lack of transport infrastructure which supports a sustainable transport system (Department of Transport, 2017).

Besides the Green Transport Strategy for South Africa 2018-2050, the National Transport Master Plan (NATMAP) 2050 is another important policy document. NATMAP 2050 is a long-term strategic plan developed by the government to guide transport development and policy decisions until the year 2050. It provides a comprehensive framework for transport planning and development for the country. Among other initiatives, NATMAP 2050 promotes the establishment of a sustainable transport system. The City of Tshwane has its own Comprehensive Integrated Transport Plan (CITP), which outlines the city's vision for sustainable and safe transport. The CITP of the City of Tshwane includes a wide range of strategies and interventions, concerning the improvement of

public transport, the promotion of non-motorised transport modes, and the improvement of infrastructure to support safe and sustainable transport (Matlawe, & Swanepoel, 2015). The City of Tshwane is also part of the Gauteng Transport Authority, a regional body tasked with coordinating transport planning and implementation across the Gauteng province. Moreover, the city works with other stakeholders such as local transport operators and communities to ensure that the needs and preferences of all residents are considered as the modal shift initiative moves forward.

1.1 Research Aim

This study aimed to examine the effectiveness of interventions to encourage the adoption of sustainable transportation modes, including public transport, cycling, and walking, in the City of Tshwane. The study sought to determine the extent to which such interventions can reduce dependence on cars and mitigate the environmental impact of transportation.

1.2 Research Objectives

To this end, three objectives were formulated: (1) to establish how the public perceives the effectiveness of factors that promote cycling and walking; (2) to investigate the perceptions of the public on the effectiveness of public transport interventions and (3) to determine if there are any significant differences in the adoption of interventions promoting modal shift among the various regions of the City.

2. MODAL SHIFT

Modal shift is a concept that emanates from both health and environmental concerns. A modal shift in passenger transport pushes users from motorised individual vehicles towards sustainable modes such as cycling, walking, public transport (rail and bus) and zero-emission vehicles. Modal shift is intentional and works well with an integrated transport system. Using motorised vehicles that use fossil energy is highly undesirable to the environment and public health. Policies related to modal shifts are considered best practices in managing negative transport externalities in the cities (Sobrino & Monzon, 2013). Modal shift aims to reduce GHG emissions, improve air quality, and promote public health and active transportation.

Public transport modes such as buses and rail have a high carrying capacity and low energy consumption; as such, they are considered crucial sustainable transport modes (Friman, Gärling & Ettema, 2019). Compared to motorised individual vehicles, buses and trains with full passenger loads have the potential to reduce carbon emissions per passenger kilometre. However, more than the mere provision of public transport is required to draw transport users from motorised individual vehicles; it requires good quality public transport services (Luke, 2018). Good quality of public transport network incites cycling and walking (Buehler, Pucher & Altshuler, 2017); hence, managing challenges concerning passenger transport's first and last mile. Through high quality of transport and measures to control vehicle ownership, Singapore made public transport a "choice mode" (Diao, 2019; Han, 2010). Many cities across African countries need well-developed public transport systems including South Africa, which can make the concept of modal shift challenging and impossible.

Another form of sustainable transport is cycling. Cycling is associated with many benefits concerning public health and the environment. Previous research shows that cycling improves physical health, decreases noise and air pollution, saves fuel consumption, and does not contribute to traffic congestion (Biondi et al., 2022; Olojede, Yoade & Olufemi, 2017). However, the main concerns around cycling are safety (Stipdonk & Reurings, 2012) and the absence of cycling infrastructure (Timpabi et al., 2021; Xia, Zhang, Braunack-Mayer & Crabb, 2017). Cities worldwide have been prioritising the provision of cycling infrastructures as part of a transition towards sustainable transport systems (Pánek & Benediktsson, 2017). Studies have shown that implementing separate, bidirectional bicycle lanes can improve the safety of cyclists on the road (Sun, Mobasheri, Hu & Wang, 2017; Fishman, 2016). This is demonstrated by the success of such infrastructure in cities like Copenhagen, where dedicated bicycle lanes separate cyclists and motor vehicles, and bicycle streets have speed limits to ensure the safety of all road users (Gössling, Schröder, Späth & Freytag, 2016).

Finally, it is essential to note that walking is a mode of transportation with many advantages, such as alleviating traffic congestion and air pollution, enhancing physical and mental well-being, and fostering a sense of community (Coxon, Napper & Richardson, 2019). However, for walking to be a viable form of transportation in the City, it is vital for there to be safe and accessible pedestrian infrastructure, such as sidewalks, crosswalks, and pedestrian bridges. Additionally, the cities should promote walkability by designing neighbourhoods and public spaces that are easy to navigate on foot.

3. RESEARCH METHOD

The City of Tshwane, situated in the Gauteng province of South Africa, served as the study area for this research. As one of the largest metropolitan municipalities in the country, it has a diverse population of over 3.2 million people (Stats SA, 2018) and is regarded as a significant economic and transport hub. Comprised of seven regions, the City of Tshwane is recognised as one of the most populous cities in South Africa. In the context of the City of Tshwane, a "region" refers to a specific administrative division or geographic area within the city. The regions of the City of Tshwane were typically created for administrative, planning, and governance purposes, enabling more effective management and service delivery within specific areas. Region 1 covers the Winterveld area while Region 2 includes the Hammanskraal area. Region 3 spans from Atteridgeville to Central Business District, including the N1 Eastern border by-pass. Region 4 covers Centurion to R21 area. Region 5 includes Roodeplaat dam and Cullinan area while Region 6 covers Pretoria east including Mamelodi to South-East border. Region 7 encompasses Bronkhorstspruit to the Eastern border. Figure 1 shows the seven regions that make up the City of Tshwane.

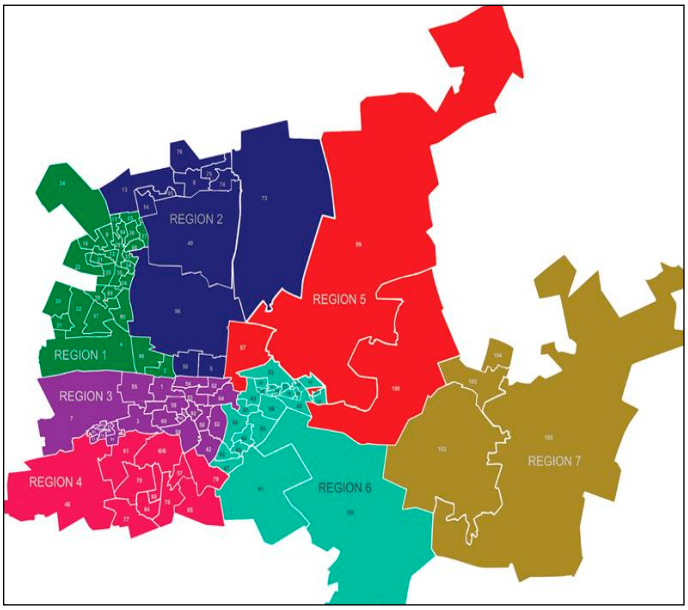

Figure 1. City of Tshwane regional map. Adapted from Pretoria REKORD (2023).

3.1 Study Design

This study followed a quantitative research method. The study utilised a survey research design to gather data from the City of Tshwane residents.

3.2 Study Sample

The study participants were individuals aged between 18 and 64 who were economically active. The rationale to exclude economically inactive individuals was made with careful consideration of ethical guidelines of the University of South Africa. Individuals below the age of 18 and seniors are classified as vulnerable population of which requires additional ethical scrutiny and safeguards to ensure their well-being and rights. Given the potential vulnerabilities associated with minors and senior citizens, ethical decision to exclude them from the study was made to prioritise their protection. However, we understand the importance of considering the needs of both minors and senior citizens, particularly in the context of pedestrian infrastructure.

To ensure the representativeness of the study population, multistage sampling was employed to select participants from the residents of the City of Tshwane. The initial stage was to stratify the City of Tshwane into seven regions based on their population share; hence stratification was by geographic location. The decision to stratify was made to ensure a representative sample that captures the diversity of the entire population. Each region was considered as a separate stratum and participants were then purposefully selected from each stratum to meet the required quota. Region 1 has a regional population of 28 %, Region 2 has 12 %, Region 3 has 20 %, Region 4 has 13 %, Region 5 has 3 %, Region 6 has 20 % and lastly, Region 7 has a regional population share of 4 %. The regions also align to the research objectives. The sample size was 418, with a 95% confidence level and a margin of error of 5 %. The confidence level and margin of error are reported for descriptive purposes, recognising the nature of the sampling strategy. A sample size ranging from 30 to 100 is often considered sufficient for basic statistical procedures (De Vos, Strydom, Fouché, & Delport, 2019). Zikmund and Babin (2010) suggest that a sample size of 300-500 is sufficient for obtaining accurate results; a sample size of 418 was deemed adequate for obtaining meaningful and reliable data. However, a methodologically soundness of sample selection is more important than the absolute sample size. "For all non-probability sampling techniques, other than for quota samples, the issue of sample size is ambiguous, and, unlike probability sampling, there are no rules" (Saunders, Lewis & Thornhill, 2009, pg. 233).

3.3 Data Collection

Data for this study was gathered from the residents of the City of Tshwane located in various areas of the City, including city parks, bus stops, venues of Athletics Gauteng North, and carwash facilities. These locations were selected as they were considered suitable for conducting the survey. To minimise the number of incomplete questionnaires, the researcher waited for each questionnaire to be fully completed before moving on to the next participant. Using a five-point Likert-type scale, the participants were asked to rate how they perceive the effectiveness of public transport initiatives, along with non-motorised transport alternatives that have the potential to incentivise their usage.

3.4 Data Analysis

To analyse data, descriptive and inferential statistics were used. This study used SPSS statistical software package version 29 to perform inferential statistics.

4. RESULTS

The study participants were individuals aged between 18 and 64 who were economically active as shown in Table 1. Of the participants, 56 % were female, and 44 % were male. The majority (67 %) of the respondents were employed, while 24% were unemployed and 9% were self-employed. The highest population share (26 %) was from Region 1, while Regions 5 and 7 had the lowest population share (7 %).

	Frequency	%
Age group		
18-24	100	24
25-45	248	59
46-64	69	17
Gender		
Male	182	44
Female	235	56
Work status		
Unemployed	98	24
Employed	279	67
Self-employed	38	9
Area		
Region 1	107	26
Region 2	46	11
Region 3	77	18
Region 4	50	12
Region 5	30	7
Region 6	77	18
Region 7	30	7

Table 1: Background information

The study utilised Exploratory Factor Analysis (EFA) to evaluate the constructs' validity. The correlation between items in the matrix was assessed by utilising the Kaiser-Meyer-Olkin (KMO) measure (Kaiser, 1974) and Bartlett's test of sphericity (Bartlett, 1950). The outcomes were a KMO value of 0.882 and a statistically significant Bartlett's test of sphericity ($p < 0.001$), suggesting that the factor analysis could be performed appropriately. Table 2 summarises the factor loadings and communalities that resulted from the analysis of transport interventions regarding public transport and non-motorised transport. Communalities assess how much an individual item is related to the overall factor structure (Pallant, 2007). When the communality value is close to 1, it indicates a high proportion of shared variance between the item and other items, implying that the item is related to the overall factor structure (Pallant, 2007). On the other hand, a communality value near 0 suggests that the item is unique and unrelated to other items in the factor structure (Pallant, 2007). Factor loadings can be described as numerical values that denote the strength of the relationship between an individual item and a particular factor in a factor analysis. Factor loadings range in value from -1 to 1, with higher values indicating a stronger relationship between the item and the factor. Factor loadings close to 0 suggest that the item is not well related to the underlying factor structure.

The principal axis factoring method was applied to 22 items related to transport interventions, and the EFA was used to extract the factors. The highest communality value observed in Table 2 was 0.721, and the remaining communality values of the items for transport interventions were all above 0.2. The items were assigned to the respective factors. Nine items

Items	Communalities	Factor loadings
Factor 1- Cycling		
2.7 Improved path network for bikes	0.721	0.844
2.3 Provision for bicycle parking	0.698	0.817
2.4 Exclusive lanes for bicycles	0.657	0.802
2.5 Security and safety measures for bicyclists	0.671	0.795
2.2 Rental services for bicycles	0.613	0.793
2.8 Availability of locker and bathroom facilities	0.614	0.768
2.6 low prices for bicycles	0.554	0.719
2.1 Allowing bicycles on public buses	0.555	0.707
3.2 Provision of workplace restrooms	0.357	0.433
Factor 2- Walking		
3.4 Walking companions	0.641	0.811
3.5 Walking challenges for health and fitness	0.541	0.747
3.3 Car-free days	0.534	0.661
3.1 Improved existing walking routes	0.340	0.392
Factor 3- Public transport		
1.3 More bus routes	0.685	0.856
1.2 More reliable public transport service	0.624	0.826
1.1 Cheaper fares for public transport	0.344	0.566
1.7 Monetary reward for using public transport	0.336	0.460
Factor 4- Parking management		
1.9 Higher parking fees	0.497	0.706
1.8 Less parking space	0.443	0.653

Table 2: Rotated factor pattern and final communality

were assigned to the first factor and labelled "Cycling". Four items were assigned to the second factor and labelled "Walking". The third factor included four items and was labelled as "Public transport", while the fourth comprised two items and was labelled as "Parking management". However, items 1.5 and 1.6 were not loaded and were subsequently excluded, and no other items were removed.

The reliability of constructs was tested through the Cronbach Alpha coefficient. The reliability estimates, which are presented as coefficients, indicate that the responses to the questions about "Cycling," "Walking," "Public transport," and "Parking management" were reliable, with coefficients ranging from 0.776 to 0.921. The items labelled 1.5 and 1.6, however, were found to have lower loadings and were not found to be part of the factor structure. Their commonality values were below 0.2, indicating that they are not reliable measures of the constructs being studied. Overall, the constructs being measured in the survey were reliable.

One-way analysis of variance test of transport interventions by Region

A one-way analysis of variance test (ANOVA) was performed to evaluate whether there were significant discrepancies in the transportation interventions required among the different regional areas within the City of Tshwane. In terms of "Cycling", Region 1 had the highest average score (M=4.14), while Region 5 had the lowest average score (M=3.49). Based on the Wilcoxon Rank Sum results, Region 1 showed a significant difference compared to Regions 6 and 5 at the 0.005 alpha level. In terms of "Walking",

Region 2 had the highest mean score, while Region 5 had the lowest in terms of "Walking" among the regional areas of the City of Tshwane. The F-test results revealed statistically significant differences among the regional areas regarding "Walking" at a 95% confidence level. The findings indicated that Regions 2, 3, and 4 significantly differed from Region 5.

Based on the ANOVA descriptives, Region 3 had the highest mean score (M=4.19), whereas Region 5 had the lowest mean score (M=3.58) regarding "Public transport" among all the regions. The F-test demonstrated a significant difference between the regional areas in terms of "Public transport" at a 95% confidence level. To further explore the specific variations among the different regions of the City of Tshwane concerning "Public transport," the Wilcoxon Rank Sum and SPSS: Games-Howell were utilised. The findings indicated that Region 5 differed significantly from the other regions.

The F-test results suggested no significant difference among the regional areas in terms of "Parking management" at a 95% confidence level. Hence, further tests were not deemed necessary.

5. DISCUSSION

The results are discussed according to the four factors – Cycling, Walking, Public transport and Parking management.

5.1 Cycling

Nine factors were found to load on Factor 1 'Cycling'. Cycling had a mean score of (M=3.9). The cycling intervention perceived as most effective was 'improved security and safety'. In South Africa, about 1.1% of the working population cycle to work, while 0.9% of learners cycle to school in South Africa (Stats SA, 2018). To a large extent, cycling infrastructure in many cities in South Africa is non-existent (Department of Transport, 2017). The lack of cycling infrastructure in numerous South African cities is a significant obstacle for urban residents who wish to cycle.

In many cities across the world, cycling is perceived as an unsafe mode of transport because of the lack of cycling infrastructure (Xia et al., 2017). Previous research has shown that improving security and safety for cyclists is an effective intervention for increasing bicycle usage (Fernandez-Heredia

et al., 2014; Verma, Rahul, Reddy, & Verma, 2016). Fernandez-Heredia et al. (2014) found that improving cycling infrastructure, such as dedicated cycling lanes and amenities like shower and locker facilities, can motivate more individuals to commute by bicycle. Furthermore, allocating more space for cycling, such as creating dedicated bike lanes, effectively entices non-cyclists to start biking (Fishman, Washington, Haworth, & Waston, 2015). The findings also indicate that if cycling interventions are implemented, residents in Regions 1 and 7 are the most likely to cycle. In contrast, bike awareness campaigns in Region 5 are the most likely to alter the mindset of commuters.

5.2 Walking

Most respondents perceived walking interventions as effective, except for 'car-free days'. Specifically, 'Improved existing walking routes' was considered the most effective among the various walking interventions. In South Africa, about 65 % of learners walk to school, while 19.9 % working population walk to work (Stats SA, 2021). Despite the poor state of pedestrian infrastructure in many cities throughout the country, a significant number of people walk for short-distance trips. This highlights the resilience and necessity of walking as a means of transport, even in the absence of adequate infrastructure. It is important to invest in pedestrian infrastructure and enhance safety and convenience for pedestrians across South African cities.

Previous research shows that pedestrian infrastructure in many developing countries needs to be addressed (Pojani & Stead, 2018). There is a high risk of fatalities and injuries of pedestrians in South Africa partly due to the lack of safe pedestrian infrastructure (Vanderschuren, Baufeldt & Phayane, 2015). Providing walking infrastructure is crucial in promoting walking (Song, 2018). To improve the perceived effectiveness of these interventions, it may be valuable to gather more specific feedback from residents in Region 5 on what aspects of the walking initiatives they find neutral and how they can be improved. Furthermore, it may be helpful to compare the results of these regions with other regions with similar characteristics to identify potential factors that contribute to the difference in perceived effectiveness.

5.3 Public transport

The effectiveness of public transport interventions is essential in promoting sustainable transportation systems (Litman, 2018). The high mean score for factor 3 in the EFA suggests that respondents view public transport interventions positively and could encourage more people to use public transport in the City of Tshwane. The finding that more reliable public transport and bus routes were rated as the most effective interventions aligns with research indicating that accessibility and reliability are critical factors in increasing public transport use (Park, 2018). The variation in mean scores across regions highlights the importance of tailoring interventions to different areas' specific needs and preferences. For example, the lower mean score in Region 5 suggests that public transport interventions may need to be targeted differently in this area to increase perceived effectiveness. This could include increasing the frequency and coverage of public transport in this Region and improving the reliability and accessibility of the system.

Overall, the results suggest that there is potential for public transport interventions to promote sustainable transport in the City of Tshwane. Further research and implementation of these interventions tailored to specific regions' requirements could yield significant benefits for residents and the environment. By enhancing the quality, accessibility, and reliability of public transport services, more individuals may be encouraged to shift away from private vehicles, leading to reduced congestion, improved air quality, and a more sustainable urban environment.

5.4 Parking management

The study found that residents of the City of Tshwane had a neutral opinion about the perceived effectiveness of parking initiatives, with the highest level of satisfaction in Region 1 and the lowest in Region 7. Parking management strategies can be used to reduce private car usage by making it less convenient and more expensive to park. Previous research suggests that measures such as high parking fees, time limits on on-street parking, and reducing the availability of parking spaces can all discourage car usage and encourage people to use other modes of transportation (Malasek, 2016). Reducing the availability of parking spaces in the City of Tshwane, by implementing parking restrictions or converting parking areas into pedestrian zones or green spaces, can further discourage individuals from relying on private vehicles. While the study in the City of Tshwane highlighted a neutral sentiment towards parking initiatives, the perceived effectiveness of these measures depends on many factors. Factors such as cultural norms, accessibility of alternative transport options, and the availability of viable parking alternatives need to be considered when implementing parking management strategies. Besides, understanding the preferences and needs of residents in different areas of the City of Tshwane can guide the implementation of parking management strategies that are effective and encourage the adoption of more sustainable modes of transport.

6. CONCLUSION

This study provides insights into the perceived effectiveness of planned measures of modal shift in the City of Tshwane, South Africa, based on the four factors of cycling, walking, public transport, and parking management. The results suggest that improving security and safety for cyclists and providing better cycling infrastructure can encourage more people to cycle to work. It is essential to acknowledge the unique challenges posed by South Africa's varied topography, which may not be conducive to widespread cycling. Many regions within the City of Tshwane present topographical constraints that can impact the feasibility of cycling as a primary mode of transport. This insight contributes to an understanding of the factors influencing modal shift preferences in the local context. For walking, providing safe pedestrian infrastructure is crucial for promoting walking. Most respondents found public transport interventions effective, with more reliable public transport and more bus routes being considered the most effective. Parking management was a neutral factor for most residents. However, research has shown that it can be an effective strategy to reduce car usage by making using a private car less convenient and more expensive.

The City of Tshwane is characterised by extensive urban sprawl, with a vast geographic area and dispersed residential and commercial developments. As such, it is challenging for the city to provide efficient and effective public transport services that can cater to the diverse needs of residents across different locations. Other key challenges in achieving a modal shift in the City of Tshwane and South African cities, in general, include lack of funding; limited public transport infrastructure; insufficient route coverage; fragmented passenger transport; cultural preference for private vehicles; lack of political will and crime in public transport. Despite well-documented transport policies and legislation, the infrastructure for non-motorised transport modes, such as walking and cycling, is often overlooked. Transport in South Africa and Africa in general, relatively gets low priority, resulting in

inadequate investment and limited development of transport infrastructure and services.

To overcome some difficulties associated with achieving a modal shift in the City of Tshwane and South Africa in general, require a multi-faceted approach. It is essential to advocate for increased funding for sustainable transport projects, promote public-private partnerships, and engage with decision-makers to build support for sustainable transport initiatives. Moreover, creating awareness among the public about the benefits of passenger modal shift can help create a better environment and public health. Furthermore, two crucial factors that significantly impact modal shift in South African cities are political will and financial investment in sustainable transport solutions. South African transport system needs a strong political will and commitment from government authorities to successfully implement policies and measures that encourage a modal shift. Political leaders need to prioritise sustainable transport, recognise its benefits for the environment, public health, and the economy, and actively support and promote initiatives that facilitate the transition.

The limitation of this study is that the study focused on the perceived effectiveness of interventions to promote sustainable transportation but needed to assess the actual impact of these interventions on transportation behaviour or other outcomes. This study implies that policymakers and urban planners in the City of Tshwane can use the findings of this study to design and implement interventions to promote sustainable transport. The study identifies regional differences in the perceived effectiveness of the interventions. Policymakers can use this information to tailor interventions to specific regions to maximise their impact. The study underscores the importance of pedestrian and cycling infrastructure in promoting sustainable transport. To promote walking and cycling, policymakers must prioritise enhancing pedestrian and cycling infrastructure quality and safety. The current study establishes a starting point for future research on sustainable transportation in the City of Tshwane. Policymakers can use the study findings as a benchmark to assess the perceived effectiveness of future interventions.

AUTHOR NOTE

This paper is based on a thesis submitted in partial fulfilment of the requirements for the Transport Economics Master's degree at the University of South Africa.

DISCLOSURE STATEMENT

The authors reported no potential conflict of interest.

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