



The Influence of Non-Motorised Transport Systems Around the World

A Case Study of Singapore, Shanghai, Lagos, Jakarta, Johannesburg, and Cape Town


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Abstract

For the past few decades, cities around the world have sprawled, and citizens have become increasingly reliant on motorised transport to access services. This has led to severe traffic congestion and increased greenhouse gas emissions. In recent years, there has been a drive to create cities that are less dependent on motorised transport. Consequently,



non-motorised transport (NMT), such as walking, running, and cycling, is considered one of the more desirable forms of transport due to its various environmental, social, and health benefits. Since the majority of trips begin and end with NMT, improving NMT will also enhance motorised transport.

This research study adopted a case study research design and analysed literature on the integration of NMT and public transport in six cities: Singapore, Shanghai, Lagos, Jakarta, Johannesburg, and Cape Town. Data were collected through Google Scholar and the Web of Science and presented in the form of a literature review and a table summarising the lessons learned from each city. The study found that NMT provision boosts the use of public transport and vice versa. Government policies, plans, and regulations need to be established to control the use of dockless bikes. Safety measures, good infrastructure, and maintenance of NMT lanes are imperative for increased usage by users. Integration tools, such as smart payments, can seamlessly link NMT and public transport use to further encourage the utilisation of both. By analysing the six cases, the lessons learned can be applied to future planning and development regarding NMT and public transport integration.

Keywords: Non-motorised transport, public transport, policy, walking, cycling.

Introduction

For the past few decades, cities around the world have undergone swift and imbalanced development of transport systems that are extremely reliant on motorised transport (Gumbo & Moyo, 2022). This has led to severe traffic congestion and increased emissions of greenhouse gases (Moody, 2012, p. 1). Studies have shown that the transport sector emits more greenhouse gases than any other sector. In response, the transport sector has been realigned with new policies and guidelines aimed at remedying this situation. Most of these “solutions” have focused on mass transit systems, which commonly involve trains, buses, and minibus taxis, as well as rail-based Mass Rapid Transit (MRT) and Bus Rapid Transit

(BRT) that fall under public transport (Gumbo et al. 2022). However, a “historical” yet environmentally sustainable and cost-effective method of transport exists in the form of non-motorised transport (NMT). NMT is regarded as one of the more desirable forms of transport due to its various environmental and health benefits. Traditionally, NMT was viewed and used independently of motorised transport (Rahman, 2013, pp. 1-2).

Faster, newer modes of transport usually replace older, slower ones. This has led to reduced investment in walking and cycling, as they are considered relatively slow modes of transport. However, despite their slower pace, walking and cycling are still equally important. NMT improves the overall health of users, as it is a simple form of exercise (United Nations Centre for Regional Development, 2018, pp. 23-24). Walking is the most affordable form of NMT, as it is free; cycling, while requiring an initial investment, pays off in the long run as it is faster and requires less effort than walking (Götschi et al., 2016, pp. 1-2). Physically, socially, and economically disadvantaged people often rely on NMT to travel between Point A and Point B, typically to and from work. Improving NMT will therefore help to achieve social equity (Risimati et al., 2021). A significant amount of time, money, and planning goes into enhancing motorised transport; the fact that the majority of trips start and end with NMT means that improving NMT will also enhance motorised transport. Walking and cycling serve as recreational activities for users; promoting NMT therefore fosters a better lifestyle for all (Litman, 2017, p. 2).

This paper begins by reviewing literature on NMT, walkability, public transport, and transport as a whole. It then analyses six different case studies regarding their relationship with NMT and the application and integration of public transport. The paper concludes by summarising the various shortcomings and successes of each case study in a table that highlights the lessons learned.

Objectives

This study sought to:

- investigate the concept of NMT through walkability and transport through a literature review, and
- analyse different forms of NMT and public transport in six different case studies, namely Singapore, Shanghai, Lagos, Jakarta, Johannesburg, and Cape Town, in terms of their integration of NMT and public transport, as well as the lessons learned from each case.

The concept of walkability is significant when assessing the feasibility of travelling on foot. Walkability encompasses three components, namely density, mix, and access (Dovey & Pafka, 2019, pp. 96–101). Density is integral to walkability; a higher concentration of people in a certain area means that more facilities and services will be available within walking distance, which makes walking more feasible. Mixed land uses improve access by providing a variety of functions in an area, thereby shortening the distance between destinations. Urban planning studies have shown that mono-functional land zones hinder these close connections, which makes walkability challenging. Access networks refer to pedestrian flow, whether accelerated or slowed down. The concepts of “small blocks” and “pools of use”, now referred to as pedestrian permeability and catchments, describe zones within walking distance based on both distance and time (Dovey & Pafka, 2019, pp. 96–101).

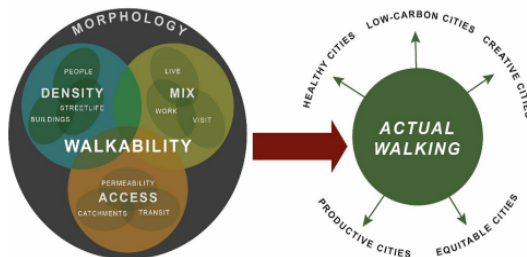


Figure 1: The Urban DMA (Density, Mix, and Walkability) and Actual Walking. Source: Dovey and Pafka (2019)

Transport is and has been a challenge in urban development, and poses many issues for planning. Urban development in most developing cities depends on motorised transport, which is given priority, while very little to no space on road reserves is allocated for the provision of NMT and its users. Motorised transport comes with many consequences, such as high resource consumption (fuel and materials to mass-produce these vehicles) and pollution in the form of greenhouse gases. Solutions to lessen the burden of heavy traffic on roads include reducing the total number of trips, which can be achieved through the provision of a more mixed land use neighbourhood. The other two methods are making public transport safer and more affordable, and promoting NMT (Selala & Musakwa, 2016, p. 587).

Almost all urban motorised trips (both private and public) are multi-modal, which means that some walking is involved to and from the “main” mode of transport, which is usually public transport or private vehicles. The distinction is that the walking involved in trips to and from private vehicles is often negligible, as it costs nothing and is very short due to the ample parking available close to users’ desired destinations. This is why the majority of private motorised vehicle users continue to rely on private motorised transport (Ortegon-Sanchez & Hernandez, 2016, pp. 3-4).

NMT can be particularly useful for short trips, as it has a considerably lower environmental impact (Ortegon-Sanchez & Hernandez, 2016, pp. 3-4). NMT includes any form of transport that is not motorised, such as walking, cycling, skating, and animal-drawn transport (Selala & Musakwa, 2016, pp. 587-588). NMT also allows users to choose workable times and routes that suit their needs.

Methodology

The study adopted a case study analysis research design and investigated several cases based on the desired criteria. This study falls within a qualitative research approach. Secondary data were utilised in the form of books, journal articles, and

conference papers. The data were analysed and presented as a literature review. The sources were identified using the keywords “non-motorised transport” / “non-motorized transport” and “public transport”. The data for the different case studies – Singapore, Shanghai, Lagos, Jakarta, Cape Town, and Johannesburg – were also sourced from various journal articles, conference papers, and other publications. All keywords for both the literature review and the case studies were sourced through Google Scholar and the Web of Science. The data were analysed in terms of the relationship to NMT and subsequently to public transport. The findings are presented in the form of a literature review and a table that summarises the lessons learned from each case study.

Results and Discussion

This section examines six case studies that focus on the relationship between NMT and public transport. Two case studies (Singapore and Shanghai) analyse developed countries, while two others (Lagos and Jakarta) explore developing countries. Additionally, two case studies (Johannesburg and Cape Town) investigate NMT and BRT systems in South Africa. Each case study presents distinct experiences and challenges associated with integrating NMT and public transport to enhance user experience in terms of affordability, safety, infrastructure, accessibility, and the legislative frameworks that regulate both NMT and public transport.

Singapore

Singapore’s Land Transport Authority is going to implement a widespread network of cycle paths to promote a healthier and more sustainable mode of transport. This will be rolled out in selected Housing and Development Board areas to encourage cycling and walking. These pathways will connect MRT stations, bus stations, schools, shops, and other key locations (Zhou et al., 2020, p. 2).

Dockless bike-sharing (see Figure 2) in Singapore features stations that facilitate an integrated smartphone app that allows

users to scan a QR code for payment. Global Positioning System (GPS) sensors are implanted in the bikes to track and manage them, which provides scholars and researchers with access to ridership data. A study conducted with over 10 000 bikes and 1.5 million observations during a nine-day period found that an increase in the introduction of new bikes lowered the number of trips. Higher density and mixed land use in the built environment increased the use of dockless bikes. Improved infrastructure and support systems also encourage bike usage; however, rainfall and hot weather conditions negatively affect the amount of bike users (Shen et al., 2018, p. 695).



Figure 2: Dockless Bike-Sharing in Singapore. Source: Abdullah (2018)

The study found high bike usage around MRT stations and bus stops, which implies that dockless bikes are frequently used for last-mile trips. Singapore aims to integrate dockless bikes with public transport through smart payment systems. This has great potential to increase not only dockless bike trips but also to decrease public transport usage (Shen et al., 2018, p. 695).

Shanghai

Shanghai is known for having the largest port and longest subway system in the world. The city of Shanghai, China, has an ever-growing population, recorded at 26 million in 2019,

which is predicted to rise to 31 million by 2030. The city is characterised by tall buildings, which accommodate a high population density of 5 800 inhabitants per square kilometre, similar to that of London or Rio de Janeiro (Sudmant et al., 2020, p. 11). The two main social and environmental challenges faced in the city are traffic congestion and air pollution, which are both exacerbated by rapid population growth. Bike-sharing in Shanghai began in 2009, with stations installed in five of the central business districts. The number of public bikes rose to more than 80 000 in 2017, which makes it the city with the largest number of public bikes in the world.

However, in 2015, dockless bikes were introduced, and the number of bikes on the streets of Shanghai grew exponentially due to their low costs (see Figure 3); reaching 260 000 by the end of 2016, 630 000 by April 2017, and 1.5 million by August 2017 (Sudmant et al., 2020, p. 11).

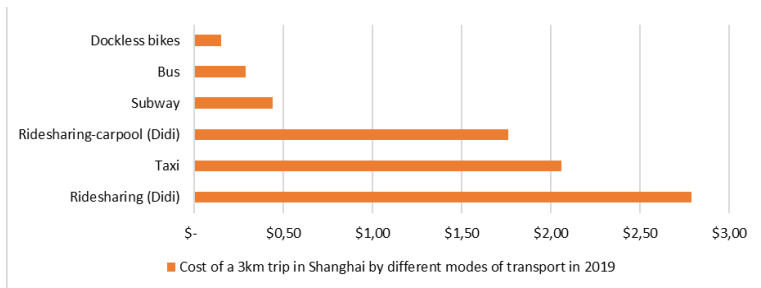


Figure 3: Cost of a 3-km Trip in Shanghai by Different Modes of Transport in 2019. Source: Sudmant et al. (2020, p. 11)

Problems arose in Shanghai when an oversupply of bikes became evident, with some areas reporting around 16 bikes per resident. This led to the shutdown of 10 bike companies. Sidewalks became overcrowded with bikes, and in some areas, there was a lack of biking infrastructure, which forced cyclists to compete with vehicles. This made it difficult for users to rely on cycling for their commute. Policy directives were the main turning point for Shanghai (Sudmant et al., 2020, pp. 12–13).

In 2017, the city introduced national urban bike-sharing regulations (Sudmant et al., 2020, pp. 12–13). The benefits of these regulations became evident in 2018 when real-time mapping and “georeferencing” were implemented. A mobile map was sent to all users, which indicated where they could and could not park, including a parking ban in seven locations. This initiative reduced illegal parking by 30%. The police had registered over 890 000 dockless bikes, and regulations regarding e-payments and insurance provided users with a sense of security. The regulations surrounding dockless biking policies aim to promote NMT. Planning in Shanghai is guided by the Shanghai Master Plan (2017–2035), with the main objective of creating “one networked, multi-modal, fully covered and highly intensive” public transport network. By 2035, the plan aims for 85% of all trips to be green, which means either public transport, walking, or cycling. Another strategy introduced to promote NMT is to bring “homes and workplaces closer together” by creating compact, connected, and coordinated urban development. Mixed-use development, coupled with improved public transport, bicycle lanes, widening of sidewalks, and speed bumps, will increase the use of NMT (Sudmant et al., 2020, pp. 12–13).

Lagos

Lagos has a growing population, estimated between 15 and 18 million in 2012, and is expected to rise to around 25 million by 2025 (Olawole, 2012, p. 2). Approximately six million trips are taken in Lagos every day, with 70% to 77% of these trips made using bus-based public transport, while the remainder relies on private vehicles (Alade et al., 2018, p. 3). Lagos introduced its first BRT system (see Figure 4) in 2008, which garnered significant attention (Olawole, 2012, p. 2). The BRT scheme transports approximately 10 000 passengers per hour.

Unfortunately, BRT stops are poorly maintained, inadequately designed, and poorly located (Alade et al., 2018, p. 3). The lack of law enforcement regarding BRT lanes in Lagos makes it difficult to demarcate these lanes. As a result, private vehicles frequently encroach on BRT lanes, which makes it

challenging for buses and passengers to access the service easily (Haas, 2019, p. 12).



Figure 4: Lagos Bus Rapid Transit (BRT) Buses. Source: Adekola and Ogundipe (2017, p. 10)

NMT, particularly walking, is the most common form of mobility in low-income households in Lagos (Alade et al., 2018, p. 4). Approximately 30% of mobility in Lagos is achieved through walking and cycling. The relationship with pedestrians in Lagos is hazardous, as there are very few walkways, footbridges, or underpasses, and no cycle lanes for bicycles. Pedestrians are forced to share the carriageway with motor vehicles. The inefficiency in NMT planning also leads to inadequate public transport provision, which results in many pedestrian accidents occurring at unsafe bus stops. The lack of proper NMT infrastructure to cross primary roads and highways restricts the easy movement of people and goods and creates poor pedestrian mobility. The issue stems from transport policy that neglects the promotion of NMT (Alade et al., 2018, p. 4).

Jakarta

In 2019, it was reported that less than 10% of residents travelled by private car. During the COVID-19 pandemic, there

was significant growth in cycling worldwide (Institute for Transportation & Development Policy [ITDP], 2021, pp. 6-8). Fortunately for Jakarta, the city had already been planning a 500-km network of cycle lanes, and the foundations were already laid. A study conducted in the city centre when lockdown restrictions were eased showed that cycling (see Figure 5) had increased by an impressive 1 000% from the previous year; other parts of the city experienced increases of 500% and more. This smooth transition is attributed to the efforts of the ITDP, which had worked for years to promote cycling prior to the pandemic (ITDP, 2021, pp. 6-8).



Figure 5: Cyclists in Jakarta. Source: ITDP (2021)

Through its involvement with the ITDP, the Transjakarta BRT system was able to reach one million riders per day in 2019 (ITDP, 2021, pp. 6-8). This achievement was due to the integration of multi-modal transport, service improvements, and enforcement. Other measures taken to enhance user utilisation of Transjakarta included ensuring that buses were on time and reliable by paying bus drivers based on the distance travelled instead of per passenger. The BRT also has 200 km of dedicated lanes across 13 corridors, which the police ensure remain clear of any vehicles other than the BRT. By promoting an increase in cycling (NMT), there was a corresponding rise in

dependency on public transport (BRT), which led to a reduction in the use of private motorised vehicles (ITDP, 2021, pp. 6–8).

Cape Town

The National Department of Transport released the Public Transport Strategy and Action Plan in 2007. This led to the City of Cape Town implementing the Integrated Rapid Public Transport System (Barendse, 2016, p. 35). The City of Cape Town Integrated Rapid Transit System Operational Plan Phase 1 Report identified the need to integrate different modes of transport to maximise customer utilisation, particularly the integration of NMT (Barendse, 2016, pp. 42–45). The NMT was provided to assist with the integration of the MyCiTi BRT service (see Figure 6). A 3-m-wide shared bicycle and pedestrian facility was implemented along the entire 16 km of the R27 corridor. Along the trunk route, 500 m of secondary network paths were provided for pedestrians and cyclists. However, the classification of NMT was based on the existing road reserve, where there was no demarcation of cycle lanes or a painted cycle lane on the existing road. No road widening provisions were made for cyclists, which creates the impression that cycling was not given much importance (Barendse, 2016, pp. 42–45).



Figure 6: MyCiTi BRT in Cape Town. Source: eNCA (2016)

To calm traffic, speed limits were implemented. Other traffic-calming measures, such as speed humps and roundabouts, were not introduced, as they would negatively impact bus speeds and user comfort when buses had to go over or around them. At intersections where stations are located, pedestrian priority was established, which resulted in blocked crossings. Tactile paving has also been installed to alert cyclists that priority should be given to pedestrians, which further suggests that cyclists are being neglected (Barendse, 2016, pp. 42–45).

Johannesburg

The NMT provided along the Soweto–Johannesburg central business district and Line 1B aims to facilitate access to Rea Vaya stations in both Soweto and the Johannesburg central business district, as well as the routes to the University of Johannesburg and the University of the Witwatersrand. A feasibility study on NMT infrastructure was conducted between 2012 and 2013, which analysed using seven indicators (Okoro & Lawani, 2022, pp. 71–74):

- **Level of usage:** The demand for the provided NMT is high as many pedestrians utilise it; however, cyclists barely use the NMT. The BRT (Rea Vaya) is in low demand as users have issues of accessibility, with their homes being too far away from stops and them rather using taxis or Uber.
- **Traffic congestion:** Traffic is very much evident during peak hours as Rea Vaya buses have to stop alongside the road because there is no dedicated parking for the buses. Other forms of private transport usually take up the space that should be reserved for the Rea Vaya buses.
- **Quality and condition of infrastructure:** The overall infrastructure of the roads, walkways, and cycle lanes were good. However, some users reported that maintenance was required in terms of vegetation, trash, and the paving being loose on walkways, as well as the road markings not being clear enough.
- **Maintenance:** Streets and NMT facilities are well maintained. The community contributes to the upkeep of the street and NMT.

- **Safety and security:** There are no security measures in place and users who walk or cycle do not feel safe in terms of crime and road congestion. Users also reported that the police are unhelpful and the public transport should be more directly linked to the NMT.
- **User satisfaction:** Users of the NMT are satisfied but expressed that many of them have to take one or more taxis just to reach the Rea Vaya. Costs were lessened through using the NMT.
- **New business ventures:** There have been new business ventures along the NMT such as secure parking of bicycles, lockers, places selling refreshments, Wi-Fi, bicycle repairs/maintenance, and so forth (Okoro & Lawani, 2022, pp. 71-74).



Figure 7: Rea Vaya Buses. Source: Business Insider SA (2014)

Lessons Learned

All the case studies have both shortfalls and successes. Table 1 lists the lessons learned from each case study, which other cities looking to implement NMT within a public transport realm can take into account.

Table 1: Lessons Learned

City	Lessons learned
Singapore	<ul style="list-style-type: none"> • Smartphone apps with a scanning QR code assists with faster payment. • GPS sensors installed on dockless bikes not only assist with bike management but also provide valuable data. • The introduction of new bikes lowers the amount of trips. • Better infrastructure and support services increase the amount of trips; however, when there is a lack of shelter, weather conditions such as rainfall and hot weather decrease the number of trips. • An integrated payment system is required to increase both NMT and public transport trips.
Shanghai	<ul style="list-style-type: none"> • Private companies not controlled by government regulations led to an oversupply of bikes, which created overcrowding and the shutdown of bike companies. • Government policy and regulation of bike use: The registration of bikes with the police, e-payments and insurance, and the creation of the Shanghai Master Plan (2017–2035) to connect NMT and public transport all improved the problem of an oversupply of dockless bikes. • Real-time mapping and a georeferencing mobile app of where and where not to park bikes reduced illegal parking by 30%.
Lagos	<ul style="list-style-type: none"> • Poor demarcation planning of BRT lanes created accessibility issues for buses and users. • Poor to no NMT planning for users is not only unsafe but also hinders efficient public transport planning and use.
Jakarta	<ul style="list-style-type: none"> • A large cycle network throughout the city combined with the COVID-19 pandemic boosted cycling dramatically. • The increase in NMT use increased the dependency of public transport use. • Increased usage of public transport due to multi-modal transport integration, service improvements, and enforcement.

City	Lessons learned
Cape Town	<ul style="list-style-type: none"> • An integrated rapid transit system that plans for both public transport and NMT increases the usage of both. • Using the existing road reserve to demarcate cycle lanes, or not creating cycle lanes at all, indicates that cycling is not given priority. Cyclists are also warned to give pedestrians priority on NMT lanes. • No traffic-calming tools are used around the BRT to ensure that buses remain on time and users are comfortable. • Intersections near BRT stations have block crossings for pedestrian safety and accessibility.
Johannesburg	<ul style="list-style-type: none"> • BRT is not very accessible to users, which creates low demand of NMT by cyclists but the demand, surprisingly, remains high for pedestrians. • NMT creates an opportunity for new businesses along the route such as bicycle repairs/ maintenance and the sale of refreshments.

It is evident that each case study has distinct lessons that cities around the world can learn from. One main point that clearly stands out is that improvements in NMT increase the usage of public transport and vice versa.

Conclusions and Recommendations

The evidence suggests that NMT has a positive impact on all cities. However, when left to private companies, there can be an oversupply of equipment required for NMT. For example, Shanghai experienced an oversupply of bikes that not only overcrowded sidewalks but also led to the closure of many bike companies. When governments intervene and implement policies, they assist in regulating and ensuring the smooth operation of bike use.

Singapore focuses on trip integration; NMT leads to public transport and other important nodes. The city aims to strengthen the integration of NMT and public transport through the use of smart payments to make the process seamless. Lagos has implemented various plans concerning the BRT, but when it comes to NMT planning, it falls short, with pedestrians and

cyclists having to share road space with motor vehicles, which is not only unsafe but inefficient as well.

Jakarta successfully transitioned to cycle transport as infrastructure and plans supporting NMT were implemented just as the COVID-19 pandemic struck, which made it easier and safer for people to travel via NMT. The NMT in Jakarta also increased the use of the BRT system.

Cape Town introduced NMT along BRT routes to improve transport integration for users; however, no traffic-calming measures were implemented to reduce speed and enhance user comfort on the BRT.

In Johannesburg, while NMT is helpful for accessing the BRT, users require additional modes of transport from their homes to the NMT. Many users do not feel safe using the NMT, but the community is involved in its maintenance and upkeep, and users believe that they save money by using it. More projects integrating NMT and public transport systems need to be carried out in cities worldwide; however, future initiatives must take into account the lessons learned from various case studies.

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