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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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1 ABSTRACT

For the past few decades, cities around the world have sprawled and citizens have become extremely reliant on motorised transport, to access services. This has created problems around severe traffic congestion and the emission of greenhouse gases. In recent years there has been a drive to create cities that are less dependent on motorised transport. Subsequently, non-motorised transport (NMT) such as walking, running, cycling, are considered as one of the more desirable forms of transportation as it has various environmental, social and health benefits. Since, majority of trips start and end with NMT means that the improvement of NMT will also improve motorised transportation. The research study adopted a case study research design through the analysis of literature on the integration of NMT and public transport in six cities (Singapore, Shanghai, Lagos, Jakarta, Johannesburg and Cape Town). Data was collected through Google Scholar and the Web of Science and was displayed form of literature and a table with lessons learnt 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 put into place to control the use of dockless bikes. Safety measures, good infrastructure and maintenance of NMT lanes are imperative to the increased usage by users. Integration tools such as smart payments to seamlessly link NMT and public transport use can also increase the use of both NMT and public transport. By analysing all six cases, the table listing the lessons learnt can be applied to future planning and development around NMT and public transportation integration.

Keywords: Accessibility, Infrastructure, Safety, Non-motorized Transport, Public transport

2 INTRODUCTION

For the past few decades, cities around the world have been undergoing a swift and quite imbalanced development of transport systems which are extremely reliant on motorised transport (Gumbo and Moyo 2022). This has created problems around severe traffic congestion and the emission of greenhouse gases (Moody 2012: 1). Studies have shown that the transport sector emits greenhouse gases the fastest when compared to any other sector. The transportation sector was then re-aligned, with new policies and guidelines to try and remedy this situation. Most of these 'solutions' were and are focussed around mass transit systems which commonly involve trains, buses and minibus taxis, rail based Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT) which fall under public transportation (Gumbo et al. 2022). However, a 'historical' yet environmentally sustainable and cheaper method of transportation is available in the form of Non-motorised Transport (NMT). NMT is considered as one of the more desirable forms of transportation as it has various environmental and health benefits. Traditionally, NMT was seen and used independently of motorised transport (Rahman 2013: 1-2).

Faster, newer modes of transport usually replace older slower modes. This led to a reduced investment in walking and cycling as they are relatively slow modes of transport. Given that walking and cycling are considerably slower, they continue to be equally important. NMT's improve the overall health of users as it is a simple form of exercise (United Nations Centre for Regional Development 2018: 23-24). Walking is the most affordable NMT as it is free, cycling requires an initial investment that pays off in the long run as it is faster and requires less effort than walking (Götschi, Garrard and Giles-Corti 2016: 1-2). Physically, socially and economically disadvantaged people mostly rely on NMT to get from point A to B which is often to and from work, thereby improving NMT will help achieve social equity (Risimati, Gumbo and Chakwizira 2021). A lot of time, money and planning goes into improving motorised transport, the fact that majority of trips start and end with NMT means that the improvement of NMT will also improve motorised transportation. Walking and cycling act as recreational activities to users, by promoting NMT, a better lifestyle for all is promoted (Litman 2017: 2).

The paper starts by identifying literature around NMT, walkability, public transportation and transportation on the whole. It then goes on to analyse six different case studies on their relationship with NMT and public transportation application and integration. It ends by drawing on the various shortcomings and successes of each case study in the form of a table on the lessons learnt.

3 OBJECTIVES

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

4 CONCEPTUAL SYNOPSIS

The concept of walkability is quite significant when trying to find out whether it is feasible to travel on foot. Walkability can be seen to have three components which are density, mix and access (Dovey and Pafka 2019: 96-101). Density is integral to walkability as the higher density of people concentrated to a certain area, will mean that more facilities and services will be provided in that area within walking distance and will make walking more feasible. Mixed land usages improves access through many different land uses within an area; it shortens the distance from one place to the next. Urban planning studies have found that mono-functional land zones prevented these close connections, making walkability very challenging. Access networks refers to the pedestrian flow, either accelerated or slowed down. The concept of 'small blocks' and 'pools of use' which are now referred to as pedestrian permeability and catchments, are used to describe a zone within walking distance based on distance and time (Dovey and Pafka 2019: 96-101).

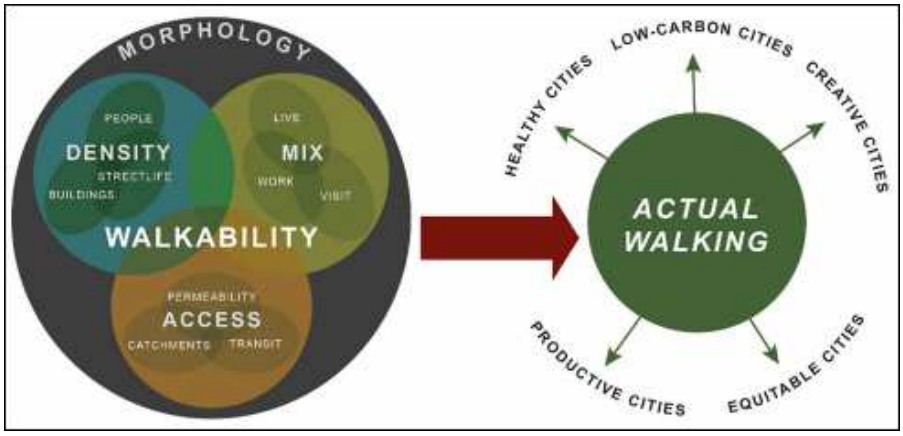

Fig. 1: The urban DMA (Density, Mix and Walkability) and actual walking (Dovey and Pafka 2019: 103)

Transportation is and has been a challenge in urban development and poses many issues for planning. Urban development in most developing cities are dependent on motorised transport as it is given priority whereas very little to no space on road reserves are given to the provision of NMT's and its users. Motorised transport comes with many consequences such as a high resource consumption (fuel and materials to mass produce these vehicles) and pollution in the form of greenhouse gases. Solutions to try and lessen the burden of heavy traffic on roads include reducing the total number of trips which would be possible through the provision of a more mixed land us neighbourhood. The other two methods are making public transport safer and more affordable and the promotion of NMT's (Selala and Musakwa 2016: 587).

Almost all urban motorised trips (private and public) are multi-modal, in the sense that there is some sort of walking involved to and from the 'main' mode of transport, which is usually public transportation and private vehicles. The difference is that this trip to and from private vehicles is almost negligible as it costs nothing and is very short due to the fact that there is ample parking fairly close to the desired destination of users. This is why majority of private motorised vehicle users continue to use private motorised transportation (Ortegon-Sanchez and Hernandez 2016: 3-4).

NMT can be very useful in short trips as they have a considerably lower environmental impact (Ortegon-Sanchez and Hernandez 2016: 3-4). NMT's include any form of transport that is not motorised such as

walking, cycling, skating, animal drawn and so forth (Selala and Musakwa 2016: 587-588). NMT's also allow for users to have workable times and routes that suit them.

5 METHODOLOGY

The study adopted a case study analysis research design where several cases were investigated based on the desired criteria. This study falls under a qualitative research approach. Secondary data was used in the form of books, journal articles and conference papers. This data was then analysed and displayed in the form of a literature review. The sources were identified using 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 out 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 was analysed in terms of each relationship to NMT and thereafter public transportation. The data was then presented in the form of literature and a table of the lessons learnt in each case study.

6 RESULTS AND DISCUSSION

The results below look at six case studies which focus on the relationship between NMT and public transportation. Two case studies (Singapore and Shanghai) look at developed countries, two case studies (Lagos and Jakarta) look at developing countries and two case studies (Johannesburg and Cape Town) look at NMT and BRT systems in South Africa. Each case study provides a very different experience and challenges that come along with trying to integrate NMT and public transportation for an overall better user experience in terms of affordability, safety, infrastructure, accessibility and legislative frameworks which regulate both NMT and public transport.

6.1 Singapore

Singapore's Land Transport Authority (LTA), is going to implement a widespread network of cycle paths in order promote a heathier and sustainable mode of transport. This will be implemented in selected Housing and Development Board Areas to encourage cycling and walking. These pathways will lead to and from mass rapid transit (MRT) stations, bus stations, schools, shops and other nodes (Zhou et al. 2020: 2).

Dockless bike-sharing (Figure 2) in Singapore have stations facilitate an integrated smartphone app with a scanning QR code for payment and there are GPS sensors are implanted in bikes to track and manage them. This allows scholars and researchers access to ridership data. A study conducted with over 10000 bikes, 1,5 million observations during a nine-day period found that an increase in the introduction of new bikes lowers the amount of trips. The built environment higher density and mixed land use increase the use of dockless bikes. Better infrastructure and support systems also encourage the use of bikes. However, rainfall and hot weather conditions negatively affects the amount of bike users (Shen, Zhang and Zhao 2018: 695).

Fig. 2: Dockless bike-sharing in Singapore (Source: Abdullah 2018)

The study found that there was high bike usage around (MRT) stations and bus stops which implies that dockless bikes are used for many last mile trips. Singapore will look towards integrating dockless bikes with public transportation through the use of smart payments. This has a great potential of increasing not only dockless bike trips but public transport usage as well (Shen, Zhang and Zhao 2018: 695).

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6.2 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 and is predicted to rise to 31 million by 2030. The city is characterised by tall buildings feeding to its high population of 5800 inhabitants per , which is around the same density of London or Rio de Janeiro (Sudmant 2020: 11). The two main social and environmental challenges faced within the city are traffic congestion and air pollution due to rapid population growth. Shanghai docked bike sharing began in 2009 stations were installed in 5 of the central business districts. The number of public bikes rose to more than 80,000 in 2017, making 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 have grown exponentially due to the low costs (Figure 3) to 260,000 at the end of 2016, then 630,000 by April 2017 and 1.5 million by August 2017 (Sudmant 2020: 11).

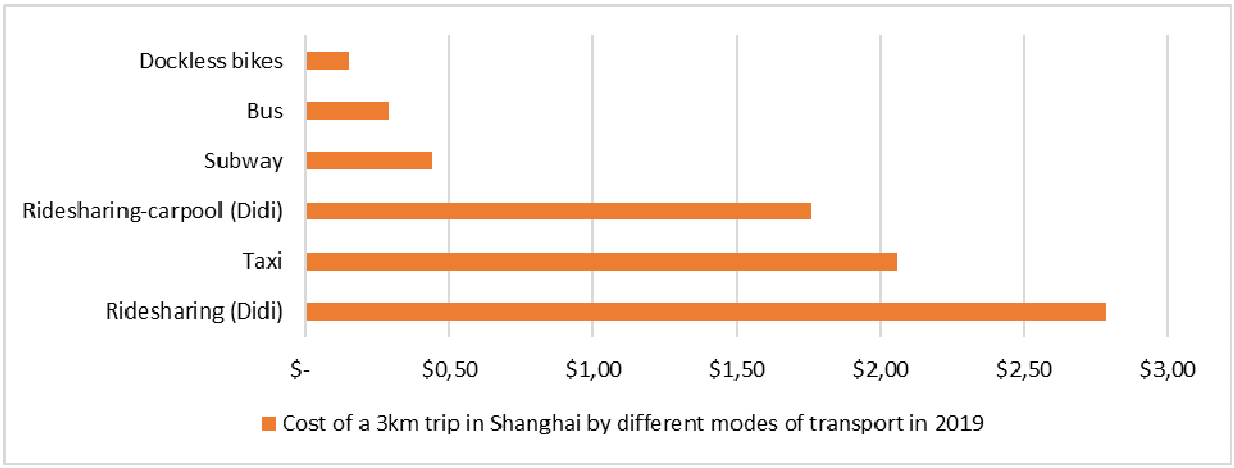

Fig. 3: Cost of a 3km trip in Shanghai by different modes of transport in 2019 (Source: Sudmant et al. 2020: 11)

The problems arose for Shanghai when there became an oversupply of bikes, some areas reporting around 16 bikes per residents, this led to the shutdown of 10 bike companies. Sidewalks were overcrowded with bikes and in some areas, there was lack of biking infrastructure which led bikers to compete with vehicles, making it difficult for users to depend on cycling as their commute. Policy directives were the main turning point for Shanghai (Sudmant 2020: 12-13).

In 2017, the city introduced national urban bike-sharing regulations (Sudmant 2020: 12-13). The benefits of these regulations could be seen in 2018 when real-time mapping and 'georeferencing' was introduced in the form of a mobile map was sent to all users on where they could and could not park, including a parking ban in 7 locations. This reduced illegal parking by 30%. Police had registered over 890,000 dockless bikes and regulations around e-payments and insurance made users feel a sense of security. The regulations around dockless biking policies are to promote non-motorised transport. Planning in Shanghai is guided by the Shanghai Master Plan (2017-2035) and the main aim is for "one networked, multimodal, fully covered and highly intensive" public transportation network. By 2035, the plan looks at making 85% of all trips green, meaning either public transport, walking or cycling. Another strategy introduced to promote NMT was 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 increases the use of NMT (Sudmant 2020: 12-13).

6.3 Lagos

Lagos has a growing population, from 15-18 million in 2012 and is expected to rise to an estimated 25 million in 2025 (Olawole 2012: 2). There are around 6 million trips taken in Lagos every day, with 70-77% of these trips being through bus based public transport and the rest relying on private vehicles (Alade, Adeniji and Alade 2018: 3). Lagos introduced their first BRT system (Figure 4) in 2008 which caught the attention of many (Olawole 2012: 2). The BRT scheme transports approximately 10000 passengers per hour. Unfortunately, BRT stops are poorly maintained and designed as well as located badly (Alade, Adeniji and Alade 2018: 3). The lack of law enforcement at BRTs in Lagos makes it difficult to demarcate BRT lanes.

This gives way for private vehicles to come in and use BRT lanes, making it hard for buses and passengers to have ease of access (Haas 2019: 12).

Fig. 4: Lagos BRT buses (Source: Adekola and Ogundipe 2017: 10)

NMT, more especially walking is the most common form of mobility in low-income households in Lagos (Alade, Adeniji and Alade 2018: 4). Around 30% of mobility in Lagos is through walking and cycling. The relationship between pedestrians in Lagos is dangerous as there are very few walkways, footbridges, under passing and so forth for pedestrians and no cycle lanes for bicycles. Pedestrians are forced to share the carriageway with motor vehicles. The inefficiency in NMT planning also leads to poor public transport provision with many pedestrian accidents occurring at unsafe bus stops. The lack of proper NMT infrastructure to cross over primary roads and highways restricts the easy movement of people and goods creating poor pedestrian mobility. The problem lies with transport policy neglecting the promotion of NMT (Alade, Adeniji and Alade 2018: 4).

6.4 Jakarta

In 2019, it was reported that less than 10% of Jakartans travelled by private cars. During the COVID-19 pandemic, there was a huge growth in the amount of cycling around the world (Institute for Transportation & Development Policy 2021: 6-8). Fortunately for Jakarta, the city had already been planning a 500-kilometre network of cycle lanes around the city and the foundations were already laid out. A study done in the city centre of when lockdown restrictions were eased showed that the amount of cycling (Figure 5) had increased by an impressive 1000% from the previous year, other parts of the city showed an increase of 500% and more. This smooth transition is owed to the work done to increase the number of cyclists by the Institute for Transportation and Development Policy (ITDP) for years prior to the pandemic (Institute for Transportation & Development Policy 2021: 6-8).

Fig. 5: Cyclists in Jakarta (Source: Institute for Transportation & Development Policy 2021)

Through the ITDP involvements, in 2019, the Transjakarta BRT system was able to reach 1 million riders per day (Institute for Transportation & Development Policy 2021: 6-8). This is due to the integration of multimodal transport, service improvements and enforcement. Other measures taken to improve the user

ISBN 978-3-9504945-1-8. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER

utilisation of Transjakarta was to make sure that busses were on time and reliable through bus drivers being paid based on distance travelled instead of per passenger. The BRT also has 200 kilometres of dedicated lanes in 13 corridors which the police make sure are clear of any other vehicle that is not the BRT. By ensuring the increase in cycling (NMT), there was an increased dependency on public transportation (BRT), lowering private motorised vehicle use (Institute for Transportation & Development Policy 2021: 6-8).

6.5 Cape Town

The National Department of Transport released a Public Transport Strategy and Action Plan in 2007. This led to the city of Cape Town to implement Integrated Rapid Public Transport System (Barendse 2016: 35). The City of Cape Town Integrated Rapid Transit System Operational Plan Phase 1 Report found the need to integrate different modes of transportation to maximise customer utilisation, particularly the integration of NMT (Barendse 2016: 42-45). The NMT were provided to assist with the integration of the MyCiti BRT services (Figure 6). A 3-metre-wide shared bicycle and pedestrian facility was implemented along the entire 16km of the R27 Corridor. Along the Trunk Route, 500 metres of secondary network paths were provided for pedestrians and cyclists. However, the class of NMT was decided using the existing road reserve, whereby, there were no demarcation of cycle lanes, or a cycle lane was painted on the existing road. No road widening provisions were made for cyclists, leading one to realise that cycling was not given much importance (Barendse 2016: 42-45).

Fig. 6: MyCiti BRT in Cape Town (Source: eNCA 2016)

In order to calm traffic, speed limits were implemented. Other traffic calming options such as speed humps and roundabouts were not implemented as it would have negative impacts on bus speeds and user comfort when busses would have to go over or around these. Pedestrian priority at intersections where stations are located have block crossing. Tactile paving was also applied to warn cyclists that priority should be given to pedestrians which again suggests that cyclists are being neglected (Barendse 2016: 42-45).

6.6 Johannesburg

The NMT provided along Soweto–Johannesburg CBD and Line 1B to aid in ease of access to Rea Vaya (Figure 7) stations in both Soweto and the Johannesburg CBD and Line 1B which is the University of Johannesburg and the University of Witwatersrand routes. The feasibility study of NMT infrastructure was conducted between 2012-2013 and was analysed using seven indicators (Okoro and Lawani 2022: 71-74).

Fig. 7: Rea Vaya buses (Source: Business Insider SA 2014)

- 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 would rather use taxis or an Uber.
- Traffic congestion: traffic is very much evident during peak hours of the day as Rea Vaya buses must 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 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 do not feel safe in terms of crime and road congestion not being safe for those who walk or cycle. 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 the users must take one or more taxis just to get to the Rea Vaya. Costs were lessoned 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 and Lawani 2022: 71-74).

7 LESSONS LEARNT

All case studies have had both shortfalls and successes. Below (Table 1) provides a list of lessons learnt from each case study which other cities looking to implement NMT within a public transport realm can take into account.

City	Lessons learnt
Singapore	• Smartphone apps with a scanning QR code for payment assists with faster payment. • GPS sensors installed on dockless bikes not only assists with bike management but also provides valuable data. • The introduction of new bikes lowers the amount of trips. • Better infrastructure and support services increases the amount of trips, however when there is a lack of shelter, weather conditions such as rainfall and hot weather conditions decrease the amount of trips. • To increase both NMT and public transport trips, an integrated payment system is required.
Shanghai	• Private companies not controlled by government regulation leads to an oversupply of bikes – creates overcrowding and the shutdown of bike companies. • Government policy and regulation of bike use – the registration of bikes with police, e-payments and insurance and the creation of the Shanghai Master Plan (2017-2035) to connect NMT and public transport all improved the dockless bike problem of an oversupply of bikes. • Real-time mapping and 'geo-referencing' mobile app of where and where not to park bikes reduced illegal parking by 30%.
Lagos	• Poor demarcation planning of BRT lanes creates 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	• A large cycle network throughout the city combined with the COVID-19 pandemic boosts cycling dramatically. • The increase in NMT use increases the dependency of public transport use. • Increased usage of public transport due to multi-modal transport integration, service improvements and enforcement.
Cape Town	• An integrated rapid transit systems which plans for both public transportation and NMT increases usage of both.

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	• Using the existing road reserve to demarcate cycle lanes or not even creating cycle lanes 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 buses remain on time and users are comfortable. • Intersections near BRT stations have block crossing for pedestrian safety and accessibility.
Johannesburg	• BRT is not very accessible to users – creating a low demand of the NMT for 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 refreshments. • Poor demarcation planning of BRT lanes creates accessibility issues for buses and users. • Community engagement and maintenance of NMT contributes to the upkeep of the street and NMT.

Table 1: Lessons learnt (Source: Authors)

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

8 CONCLUSIONS AND RECOMMENDATIONS

Evidence suggests that NMT has a positive impact on all cities. However, when left to private companies there could be an oversupply of equipment required for NMT, for example, the case of Shanghai where there was an oversupply of bikes which not only overcrowded sidewalks but also led to many bike companies closing down. When government intervenes and implements policy it assists the regulation and smooth process of bike use. Singapore focuses on the integration of trips, NMT leads to public transportation and other important nodes. Singapore looks to strengthen the integration of NMT and public transport through the use of smart payments making the process seamless. Lagos has put many plans into place with regards to the BRT but when it comes to NMT planning, Lagos fall short with pedestrians and cyclists having to share road space with motor vehicles, which is not only unsafe but inefficient. Jakarta was able to seamlessly transition into cycle transport as infrastructure and plans supporting NMT were implemented just as the COVID-19 pandemic had struck which left people finding it easier and safer to travel via NMT. The NMT in Jakarta also gave way to the increased use of the BRT system. Cape Town implemented NMT along BRT routes to improve the integration of transport for users, however, no traffic calming methods were implemented to reduce speeds and user comfort on the BRT. Johannesburg's NMT, though helpful to get to the BRT, other modes are required from users' homes to the NMT. Users do not feel safe using the NMT but the community is involved in the maintenance and upkeep of NMT and users believe that they save money from using it. More projects integrating NMT and public transport systems need to be carried out in all cities around the world, however, future projects need to take into account the lessons learnt from the different case studies.

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ISBN 978-3-9504945-1-8. Editors: M. SCHRENK, V. V: POPOVICH, P. ZEILE, P. ELISEI, C.BEYER, J. RYSER