

SUSTAINABLE TRANSPORT IN DAR-ES-SALAAM:  
THE POTENTIAL FOR BRT AND CYCLING FROM A USER  
PERSPECTIVE

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FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

SUSTAINABLE TRANSPORT IN DAR-ES-SALAAM:  
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PERSPECTIVE

DISSERTATION

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on the authority of the rector magnificus,  
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on account of the decision of the graduation committee,  
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by

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born on 15 September 1978

in Kiboga, Uganda

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## **Chapter 1**

### **Setting the stage**

## **1.1 Introduction**

Urbanisation is occurring all over the world but in the developing world in particular it is taking place at an alarming rate. Cities like Dar-es-Salaam have been growing at an average annual growth rate of 4.67% over the period 1990-2010 (UN-Habitat, 2012), and are expected to grow by a staggering 80% up to 2025 (The Economist/UN-HABITAT, 2010). The role of transport in urban areas is crucial to accommodate the increasing levels of travel demand. Solving transportation problems has become a chief task confronting governments in developing countries. For all sectors of transportation, decisions hinge on the interpretation and understanding of the behaviour of trip makers, their perceptions, preferences, and choices.

All through the twentieth century, transportation planning and the implementation of transportation facilities in the developing world have been heavily weighted towards private motorised transportation (MT), despite the facts that non-motorised transportation (NMT) and public transportation (PT) constitute a significant proportion of all trips in urban areas (Khisty, 2003), and that they can provide viable alternatives to most motorised trips. Not until the last two decades, many researchers and practitioners worldwide have recognised the importance and advantages of NMT and PT. Their investigations and findings have contributed much towards identifying, if not mitigating, some of the more glaring problems of urban transport. However, most of these investigatory studies have been performed in a piece-meal and in disjointed fashion, and have focused mostly on a developed world context.

This research discusses individual attitudes, perceptions and preferences that play a key role in understanding people's choices for NMT and/or PT. For cycling, knowing and understanding these factors may help in identifying and overcoming key social and spatial barriers to its use, whereas for public transport understanding these factors can serve to make public transport a more viable alternative to private motorised modes, crucial for achieving a sustainable urban transport development.

In the remainder of this introductory chapter, key characteristics of NMT and PT are discussed, followed by a reflection on their potential in Sub Sahara African cities, leading to the problem statement and research objectives, followed by a short discussion of the study area and the further organisation of the thesis.

## **1.2 Non-Motorised Transport**

"The paradox of transportation in the late 20<sup>th</sup> century is that while it became possible to travel to the moon, it also became impossible, in many cases, to walk across the street"(Tolley, 1997, Vanderwagen, 1995, Khisty, 2003).

The natural form of locomotion for human beings is walking. Humans on foot are thermodynamically more efficient than any motorized vehicle and most animals, yet humans on bicycles surpass them, able as they are to go three to four times faster and yet use five times less energy in the process. Equipped with a bicycle, man is more efficient than all machines and all animals too (Tolley, 1997). What is more, walking and cycling have a negligible environmental impact. When one adds to the fact that humans using their feet for transport are inherently equal, it can be seen that walking and cycling are ideal ways of travelling from the point of view of energy conservation, environmental impact and social equality (Tolley, 1997).

It is ironical that although NMT holds many outstanding advantages over Motorized Transportation (MT) for the individual, for the community, and for the city, from the standpoint of such factors as energy conservation, environmental impact, social equity, and economy, these attributes have seldom been exploited to their fullest extent by developing countries (Khisty, 2003). What is most alarming is that the majority of transportation policy-makers in developing countries believe that a higher proportion of MT, often at the expense of NMT and PT, which is highly present in these cities (Figure 1.1), is vital for economic development. The actions stemming from this belief have led to such problems as severe traffic congestion, wide spread air and noise pollution, increased fuel consumption, steeper infrastructure costs and higher accident rates (Khisty, 2003, Khisty and Ayvalik, 2003, Khisty and Zeitler, 2001).



Figure 1.1: Cycling (l), Daladala and push cart (m), BRT construction [2012] (r) in Dar-es-Salaam

In most developed countries, cycling has been growing in popularity as many cities work to create a more balanced system and have reclaimed streets from auto dominance. Cycling has surpassed recreational niches to become an extraordinary viable mode of transportation in northern European cities (World Health Organisation, 2000). Currently the highest bicycle mode share in the world is 27% in the Netherlands, 18% in Denmark, 10% in Germany and 10% in Sweden (Pucher and Buehler, 2007). All these countries have a very high standard of living, a growing auto ownership and rising income. Yet cycling has been thriving, primarily due to long term commitment of enhancing safety, speed and convenience of the green mode while making auto use difficult (Pucher and Buehler, 2007). The greater awareness of growing environmental and social problems has also added momentum to the popularity of cycling in many cities. (Maddox, 2001, Ascroft, 1997, Osberg and Stiles, 1998).

On the other hand, the potential contribution of cycling as an inexpensive, affordable and sustainable mode of transport is immense in the developing world and particularly in African countries. Essentially, its benefits are twofold: Firstly, it provides better access to activities and facilities that

society considers vital for survival, such as medical services, education, employment, basic commercial and social activities. The presence of these facilities at proximity locations, provides benefits both to users and to the entire society, and by improving people's opportunities to participate in socio-economic activities (Litman, 2003). Secondly, cycling creates an employment opportunity and generates significant amounts of non-skilled employment and is vital in maintaining incomes of some of the most vulnerable urban population (DFID, 2002). Despite all its well-known advantages and significance for facilitating mobility, cycling has remained largely unrecognized and an inferior mode characterized by a very low modal share in most of the less developed countries and in African cities in particular (World Bank, 2005). For example, the current level of cycling in the city of Dar-es-Salaam is only about 5% which contributes a marginal amount compared to the potential demand (JICA, 2008). The factors involved in such low profile of cycling in most of the African cities are many and different factors carry different meaning in a particular context. For example in the city of Dar-es-Salaam the most cited deterrent factors are: safety, security, culture, history, weather, topography, lack of cycling infrastructure like cycling lanes and cycle parking facilities among many others. Of course, some of these factors such as safety and security cannot be underestimated. While history, culture, topography and weather are important variables, they do not necessarily determine the fate of cycling (Pucher and Buehler, 2008). Thus creating a need for further investigation on how people (decision makers) can be influenced to change their travel behaviour towards use of greener modes like the bicycle. This suggests that a more detailed examination of the attitudes and perceptions of the potential users may provide more useful information on which to base the development of designing travel behaviour change strategies.

### **1.3 Public Transport**

An efficient and cost-effective public transport system essentially connects people to daily life (Wright, 2011). For the vast majority of developing city residents however, public transport is the only practical means to essential services, especially when such services are beyond viable walking and cycling distances (Wright, 2011), and is often preceded with an NMT trip.

To counter the current fleet of uncontrolled and uncoordinated PT services that are creating a host of serious problems related to accidents, contamination, economic efficiency and social inequity, many cities in developing nations are investing in Bus Rapid Transit (BRT) systems that provide high-quality metro-like transit service at a fraction of the cost of other options.

Bus Rapid Transit refers to high quality customer-oriented transit that delivers fast, comfortable and cost-effective urban mobility. BRT can provide high-quality, metro-like transit service at a fraction of the cost of other options, a cost that most cities, even developing cities can afford (Wright, 2002). A BRT is a new mass rapid transit system. Its origin can be traced to Latin America, where it was introduced in the 1970s to accommodate the large amount of commuters in growing cities with limited financial resources (Wright, 2002). Mass Rapid Transit (MRT) refers to those modes of urban public transport that have their own specific fixed track, or have exclusive use of the urban street network over most of their alignment such as rail based metros, bus rapid transits (Menckhoff, 2002). Latin America's BRT system developers astutely observed that the ultimate objective was to swiftly, efficiently and cost-effectively move people rather than cars (Wright, 2002). Today, the BRT concept is becoming increasingly utilized by cities looking for cost-effective transit solutions. A BRT has a couple of main characteristics that distinguishes it from a 'normal' bus line and include: segregated bus ways, rapid boarding and alighting, clean, secure and comfortable stations and terminals, efficient pre-board fare collection, effective licensing and regulatory regimes for bus operators, clear and prominent signage and real-time information displays, transit prioritization at intersections, and modal integration at stations and terminals (Wright, 2002).

BRT systems in cities such as Bogotá and Curitiba in Latin America have provided a world class mass transit service accessible for all groups of people especially the poor. Accessibility of the BRT to the urban poor has shown a great achievement of the main objective of public transport which is to facilitate participation of less mobile people (disadvantaged groups) in economic activities and improve mobility of all groups (Fjellstrom, 2002).

Bus Rapid Transit (BRT) has emerged as an economically advantaged mass rapid transit system with significant potential in developing cities. Many cities recently announced plans for introducing BRT corridors, including Dar-es-Salaam, Tanzania (ITDP, 2005). Although the development of a BRT system is viewed by many as the preferred solution for urban mobility problems, its success cannot be taken for granted. There are many different aspects that need to be taken care of, before a BRT can operate. One of the most important aspects are its accessibility by the urban community, its actual performance and potential impacts, all of which have hardly been studied especially in developing countries like Tanzania.

Zooming in to Dar-es-Salaam, the case study city in this dissertation, one can see that public transport is generally poor and unsafe, lacking professionalism, efficiency, quality and safety for the commuters. The main factors leading to the above situation include: rapid expansion of the city

which has far outpaced the capacity to provide basic infrastructure (such as good roads) and services, poor state of majority of the buses, untrained bus drivers and conductors driven by the pursuit of daily revenue targets payable to the bus owners, non-adherence to traffic rules and regulations and lack of an organized public transport system. Public transport service is mainly dominated by small buses called daladala. The actual fare level of the daladala is 250-350 TSH, independent of the travel distance. Although the daladalas are by far the major public transport mode, the service offered is mainly poor and characterised by the following main problems as stated by Kanyama et al. (2004) and Sohail et al.(2006):

1. Overloading of buses: Overloading and overcrowded buses particularly during peak hours, also characterised by reckless driving, route shortening. This overloading often results in pick-pocketing, impaired air circulation, bad smells, harassment of women and school children, sexual abuse and commuter worries about the spread of diseases.
2. Travel time: The majority of the commuters consider the travel time as long. The problem of long travel time is indicated by this interesting quote *"in order to minimize travel time during the morning rush hour, some commuters who live in the middle of bus routes, especially those in a hurry to work, board buses going in the opposite direction so as to return with them to the desired destination. In this way, commuters are prepared to pay the fare two-fold in order to save waiting time"* (Kanyama et al., 2004)
3. Poor comfort level: Many commuters consider daladalas noisy and unhygienic. Also commuters remarked the poor treatment by conductors and the dangerous driving style of the daladala drivers.
4. Air pollution: the current transportation system is characterized by polluting vehicles particularly during peak hours dominated by traffic jams on most major roads which have a significant negative impact on the health of the city residents.

Realizing this, the city authorities have proposed the BRT (Dar Rapid Transit), which is planned to be a high quality mass transport system operating on specialized infrastructure and offering affordable mobility, environmental improvements, and a better quality of life to the residents of Dar-es-Salaam. Its long-term plan is to cover the whole city by the year 2035. The BRT system will be implemented in six phases and will be complemented by a network of bicycle lanes. Although the first phase was planned for implementation in 2009, there have been severe setbacks to the extent that no lines have been commissioned yet and phase 1 is still under construction. It is planned that once all phases are implemented, the total corridor length will be more than 130 kilometres. The BRT mission is to provide quality and an affordable mass transport system for the residents of Dar-es-Salaam, to

reduce emissions and to have spinoffs in terms of poverty reduction and a more sustainable economic growth.

#### **1.4 PT and NMT potential in African Cities**

Anybody familiar with cities in the developing world will notice that an increasing number of them are becoming unliveable. These urban areas have horrendous problems of traffic congestion, safety, and environmental damage. Governments in these countries are facing serious challenges to keep people and goods moving with no relief in sight. Realizing the multidimensional and sinister nature of transportation problems in developing countries, researchers and professionals in a variety of fields have investigated strategies to tackle these dilemmas, while dealing with issues of economic growth, environmental concerns, sustainability and energy consumption.

In addition, most cities of the developing world and in particular those of African countries are experiencing rapid urbanisation characterised by uncontrolled urban sprawl and high population growth rates. For example in the city of Dar-es-Salaam, the population in 2002 was approximately 2.5 million (Tanzania Population and Housing Census, 2002), but presently the population size of the city is estimated to be more than 3 million with an estimated population growth rate of more than 4 % per annum (Dar es Salaam City Council, 2004, JICA, 2008). This rapid growth in most African cities has resulted into many multifaceted and intertwined problems among which transport is intense. The rapidly growing motorised transport combined with population growth, triggered by both migration and natural growth has led to severe congestion in most cities in recent years and thus threatening their economic growth prospects (World Bank, 2005).

Mobility in the developing world cities is characterised by travel demand that far exceeds travel supply (World Bank, 2002, Gakenheimer, 1999). African cities are not exceptional to this reality. Indeed the demand for public transport has grown steadily for the past decades due to urban population increase whereas the supply has been declining thus creating severe transportation problems (Amer, 2007, Khisty, 2003). Moreover, a large portion of the city population still depends on either the poor public transport or walking because they do not have an alternative to make another choice (Amer, 2007, Gakenheimer, 1999). This has compelled urban residents in particular those in informal unplanned settlements to walk long distances to their work places to and from every day (World Business Council for Sustainable Development, 2007) and pay higher cost on transport.

Studies have revealed that a household expenditure on public transport is disproportionately high and has grown from 9.1% in 1993 to 17% in 2002

(World Bank, 2002, Olvera et al., 2007). This is undoubtedly substantial in cities of Sub-Saharan Africa like Dar-es-Salaam where 36 % of the residents live below the basic need poverty line and rely on a meagre income (JICA, 2008). Thus regular use of motorised transport is unaffordable to the urban poor population (Olvera et al., 2008, World Business Council for Sustainable Development, 2007). The situation, therefore, calls for an alternative and affordable mode of transport such as cycling to improve mobility of the disadvantaged groups.

NMT modes such as cycling have due recognition in some African cities, however, they have been neglected as an important mode of transport because of heedless urban transport planning and unplanned city developments. This has significantly affected accessibility of city residents in particular those that are living in urban rural fringes but make their livelihood by working in the city centres. In this process, initiatives of improving the urban mobility of the low income people in cities such as Dar-es-Salaam have been tried mainly to integrate the low cost modes (primarily cycling) into the urban transport system.

In the past few years, considerable achievements have been made in terms of increase of low cost mobility policy and commitment of municipal and local government bodies towards the use of non-motorised transport for urban mobility (Interface for Cycling Expertise [I-CE], 2007). In effect, the modal share of cycling has shown a modest increase from 3% in 2002 to 5% in 2007 in cities such as Dar-es-Salaam where cycling promotional initiatives have been implemented. Despite this marginal growth the modal share remains very low as compared to the enormous potential. Convincingly, Interface for Cycling Expertise [I-CE](2007) argued that if cycling is done below potential, then there are obviously other physical or psychological barriers, which need to be investigated and removed. Given the potential of cycling in addressing some of the transport problems and its contribution for utilitarian travel, the questions why more people do not cycle and how more people can cycle are justified. Such an investigation related to cycling potential is less or hardly investigated in African cities. Similarly, looking at commuters' travel attitudes and preferences in relation to the proposed Bus Rapid Transit (BRT) system, i.e. in terms of proximity, travel cost and service quality for access, can reveal very strategic information about the role of BRT in providing a viable, sustainable alternative to trip makers in Dar-es-Salaam.

While some research in various areas of sustainable urban transportation, NMT and PT in particular has matured and come of age, the identification and investigation of many gaps, particularly from a travel behavioural point of view, still need to be filled. Hence, it is time to take stock of what we know and that we do not know, with an intention of finding better sustainable

solutions drawn from the society point of view to meet the current alarming urban transportation problems.

Therefore, this thesis looks at what individual, social and spatial factors (with respect to attitudes, perceptions and motivations) determine how (potential) users of cycling and BRT in Dar-es-Salaam perceive these systems, and what are the appropriate measures and strategies to motivate people to use these sustainable transport modes.

### **1.5 Problem statement**

Sustainable transport policy can serve as a lever to alleviate poverty while stimulating economic growth and climate change mitigation, by providing socially-equitable and environmentally sound transport alternatives to the people. For such policy development to be effective, efficient and equitable, it is important to understand the key factors and motivators for people to choose their mode of transport. This understanding allows to better target policies to specific groups of users (equity), which allows for a more efficient and effective deployment of (scarce) transport resources. Behavioural factors are of particular importance when looking at modal choice given the multitude and complexity of factors that determine people's preferences for one mode over the other. These factors are for example known to depend strongly on aspects like location (spatial factors) and traveller characteristics (socio-demographic and travel pattern related factors, attitudinal factors and perceptions).

To deal with this problem, this research attempts to identify the key spatial factors, attitudinal factors and perceptions that can explain people's preferences for sustainable transport modes, such as cycling and Bus Rapid Transit (BRT). Furthermore, we investigate how such factors may vary over space and by identifiable group of individuals, and how changes in behaviour coincide with life events. Finally, we demonstrate empirically how these factors can be used to derive sustainable urban transport policy in the context of an African developing city such as Dar-es-Salaam.

### **1.6 Objectives of this study**

The overall objective of the study is to investigate and explain commuter's attitudes and preferences towards cycling and BRT in the context of the city of Dar-es-Salaam, and use the knowledge generated to suggest better targeted policies to market cycling and BRT.

Specific research objectives are:

**BRT focus**

- To identify how commuters perceive and value the proposed BRT service quality attributes
- To determine how the perception of the proposed BRT service quality vary over space.
- To examine the effectiveness of the proposed BRT system based on its characteristics and commuters' attitudes & preferences in comparison to the currently offered public transport services.

**Cycling focus**

- To examine the attitudes and perceptions, motivators and barriers of people towards cycling so as to derive and describe homogeneous groups in different stages of behaviour change.
- To use these groups to define and characterise potential cycling market segments
- To determine the socio-demographic and travel pattern-related factors that affect bicycle commuting for these groups
- To assess the willingness of people to change their travel behaviour towards cycling based on the individual preferences for different types and quality of cycling infrastructure and facilities
- To determine which policy interventions are likely to result in an increased use of the bicycle
- To investigate how and when changes in cycling behaviour coincide with changes in peoples life cycle or life events

## **1.7 Conceptual framework**

In conceptualising the ideas of this study, a general conceptual framework is presented (see figure 1.2). The conceptual framework relates individual commuter's decision making to the objective environment and individual features, which frequently are suggested to account for individual travel behaviour (Bamberg et al., 2011). From figure 1.2, perceptions of the built environment such as available travel modes and their level of service quality, and spatial distribution of activity locations provide the knowledge base from which individual commuters can derive their set of possible travel options. It is assumed that these travel options consist of trip chains (Gärling et al., 2002) defined as bundles of attributes (i.e. travel time, travel purpose, monetary costs, etc.). Besides the built environment, the individual (socio-demographic, attitudes, perceptions, preferences, and beliefs), the social and natural environment features as well as situational factors (e.g. family logistics, time of the day, unexpected events) are assumed to influence the individual commuter decision making on possible travel options. These factors are disturbances that can lead to changes in travel behaviour.

Hard transport policy measures modify the objective environment. This may lead to changes in travel behaviour if the commuters perceive how the environment is modified (e.g. car free zones, congestion charges, car parking charges), deliberately reflect on the consequences it may have for the possible set of travel options (e.g. resulting in increased travel time by car, increased monetary costs), and judge that consequences provide sufficient reasons to change current travel behaviour (e.g. public transport and cycling provide a faster and quality service). Moreover, soft transport policy measures are aimed to directly influence individual user's decision making process by changing their perceptions of the objective environment, by altering their judgements of the consequences associated with the use of different travel options, and by motivating and empowering them to switch to alternative sustainable travel options. The resulting changes in travel behaviour may lead to an improvement in one's well-being.

It can be noted that the conceptual frame work emphasises the interaction between individual features and the objective (built, social and natural) environment. It also stresses the interdependence of hard and soft transport policy measures. With the implementation of hard transport policy measures that change the relative attractiveness of sustainable travel options, the possibility increases that soft transport policy measures would be effective in motivating and empowering individual commuters to switch to these options.

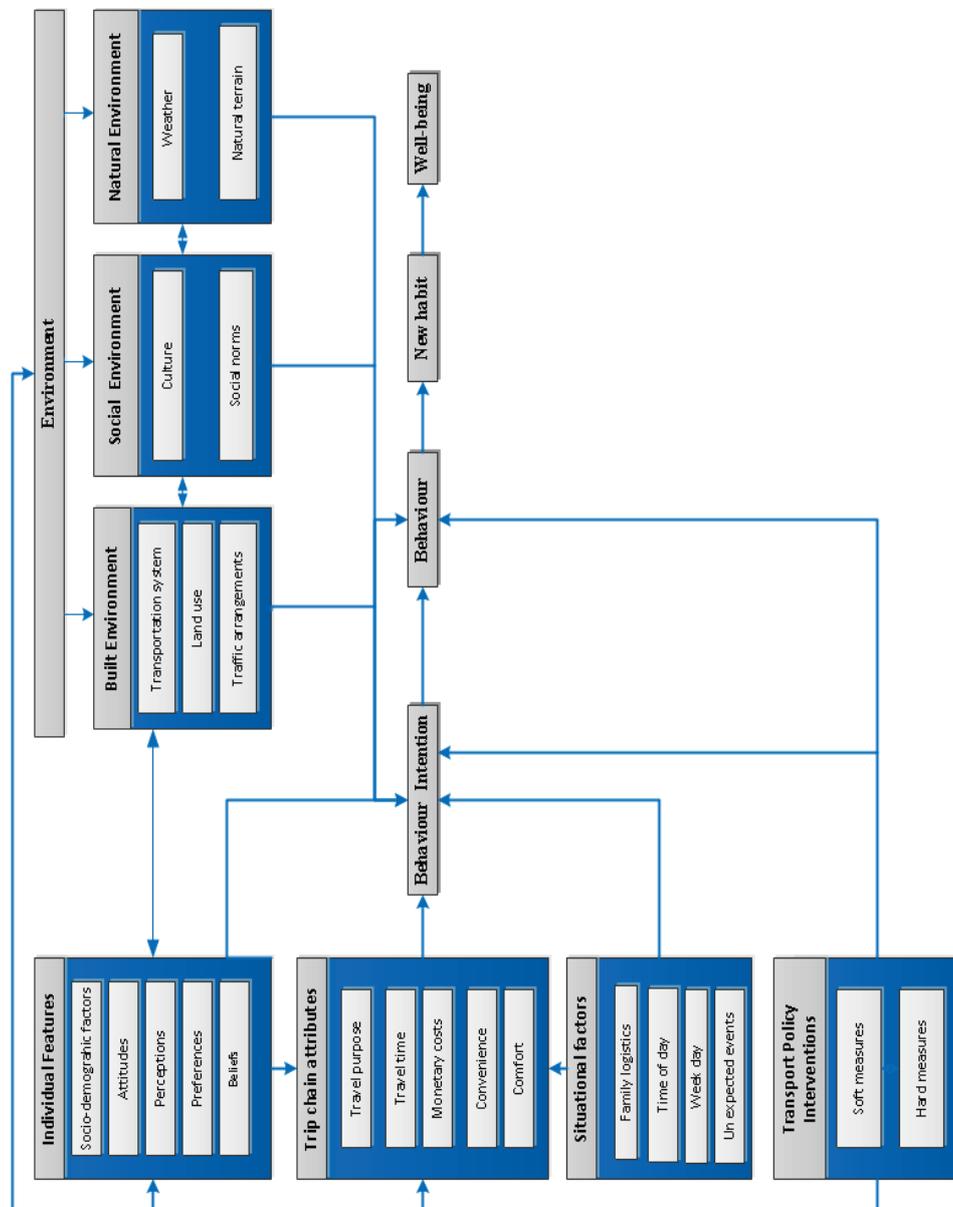


Figure 1.2: Conceptual framework

## 1.8 Study area

Dar-es-Salaam is the largest city in Tanzania. It is a coastal city located in the eastern part of the country. It is popularly believed that Dar-es-Salaam means the "Harbour of Peace" and it was established in the early 1860s, as a trading centre by Arab merchants. Later its roles and functions changed, and the city has since experienced significant growth. Dar-es-Salaam was

declared a township in 1920 and it was designated as a municipality in the British Colonial period in 1949. When Tanzania became independent in 1961, Dar-es-Salaam became a city and later it became the Capital of the United Republic of Tanzania. Although the Capital was moved to Dodoma in the 1970s, Dar-es-Salaam has remained and has continuously served as the largest and most important commercial and administrative city in the country. It is an important centre for transport, business, and cultural activities. Looking at the urban growth pattern of the city, urbanization has extended significantly along the coastline and the major arterial roads: Bagamoyo; Morogoro; Nyerere and Kilwa Road, resulting in a mono-centric radial development pattern (see figure 1.3).

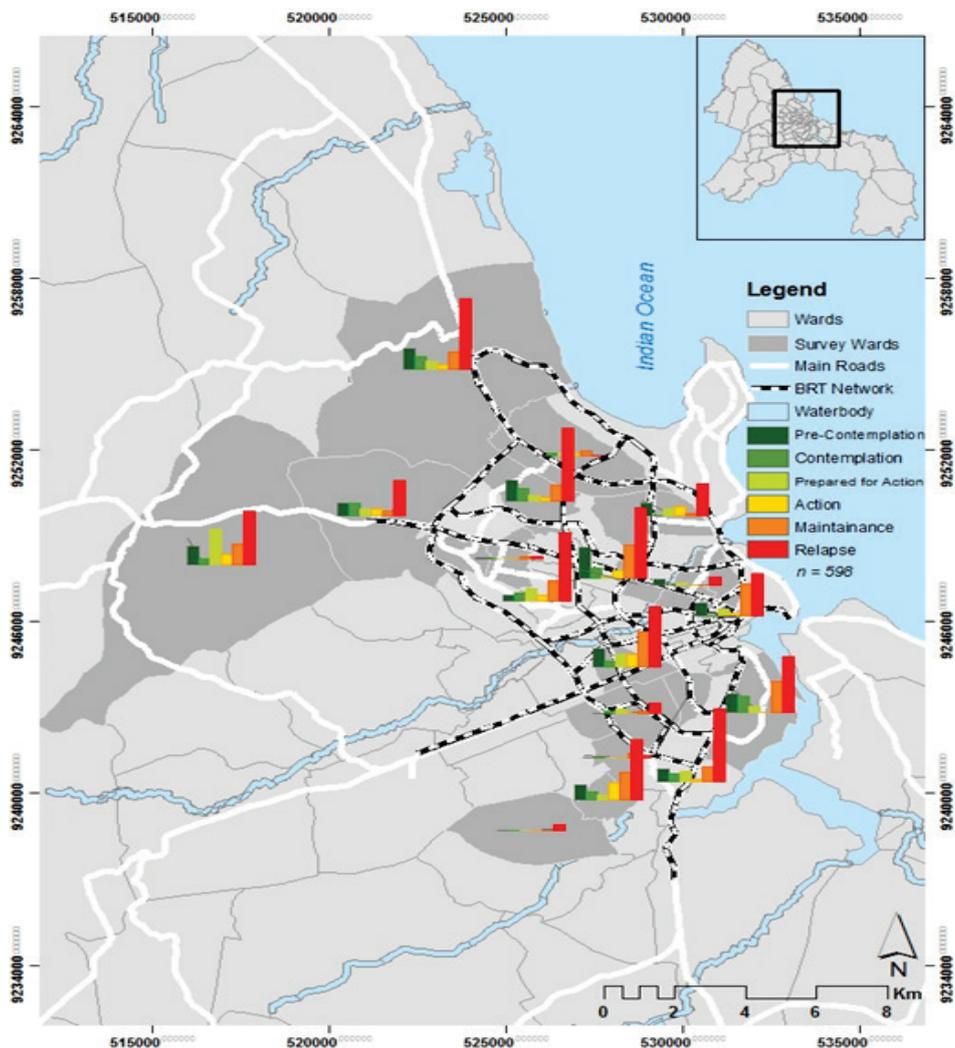


Figure 1.3: Geographic location of the survey zones in the city of Dar-es-Salaam and the sample distribution in the different zones

## **1.9 This thesis**

The rest of the thesis is organized as follows:

Chapters 2 and 3 report on the study of perceptions and valuing of service quality attributes for the proposed BRT system in Dar-es-Salaam. Chapter 2 specifically reports on the set up and results of the experiment, while chapter 3 discusses how preferences for BRT service quality attributes vary over space based on the analysis of the behavioural models in chapter 2 in a GIS.

Chapters 4 to 7 report on the study of perceptions and attitudes towards cycling in the city of Dar-es-Salaam. Chapter 4 sets out with the identification of focus groups based on their actual cycling behaviour and discusses cycling potential per group. In chapter 5 the groups are further analysed to see how they affected by socio-demographic and travel pattern -related factors. Chapter 6 analyses how willing people are to change their travel behaviour towards cycling based on the individual preferences for different types and quality of cycling infrastructure and facilities. This chapter also discusses in more detail the effectiveness of different policy (including marketing) strategies to support cycling promotion in an African city context. From the analysis in chapters 4-6 it appears that life events play a major role in understanding people's perception and attitudes towards cycling. Therefore, chapter 7 discusses some preliminary results on how changes in cycling behaviour coincide with changes in life courses or with life events.

Chapter 8, finally, provides a synthesis of the work that was performed within this study and places its results in the wider context of transport planning of African cities. It discusses how chapters 2 – 7 contribute to the better understanding of the role (potential) users play in achieving sustainable transport.



## Chapter 2

# Modelling Commuter Preferences for the Proposed Bus Rapid Transit in Dar-es-Salaam<sup>1</sup>

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<sup>1</sup> This chapter is based on: Nkurunziza, A., Zuidgeest, M.H.P., Brussel, M.J.G. and van Maarseveen, M.F.A.M. (2012) Modelling Commuter Preferences for the Proposed Bus Rapid Transit in Dar-es-Salaam. *In: Journal of Public Transportation: open access*, 15(2012)2, pp. 95-116

## **Abstract**

The paper analyses individual commuter preferences towards the proposed bus rapid transit (BRT) system in Dar-es-Salaam, Tanzania. The objective of the survey was to identify how commuters perceive and value the proposed BRT service quality attributes. A stated preference survey of potential users of the proposed BRT was administered to 684 commuters who travelled to the central business district (CBD) on a regular basis. To this end a special pictorial score card was developed that was suited for the local context and needed to capture the preferences of the commuter respondents. The BRT attributes considered for study are; travel time, travel fare and comfort. The stated choice data was analysed using a binary logit model. The findings reveal in order of importance that comfort is the most valued attribute compared to travel time and travel fare respectively.

## 2.1 Introduction

In the city of Dar-es-Salaam, Tanzania, as elsewhere in developing countries, concerns over urban growth and its transport implications are becoming more important in both the national and local political agendas. This is particularly true in the city where increasingly new peripheral developments have resulted to increased congestion and placed stress upon the local transport networks and the urban environment (World Bank and OECD., 2003). Dar-es-Salaam is one of the fastest growing cities in Sub-Saharan Africa with an estimated urban population of almost 4 million inhabitants in 2010 and annual population growth rate of over 4% per annum (JICA, 2008). The city is characterized by a high proportion of informal development and poverty where nearly 70% of its population live in informal settlements (World Bank, 2002). Most people cannot afford a private car and around 75% of trips in Dar-es-Salaam are made by public transport and walking (Olvera et al., 2003, Nkurunziza et al., 2012) .

Like many other rapidly growing cities in Sub-Saharan Africa, Dar-es-Salaam has not escaped from the impacts of poor public transport services which include: inefficiency, poor quality of service and lack of safety for commuters. The main factors leading to the above situation include; rapid expansion of the city which has far outpaced the capacity to provide basic infrastructure and services, the poor state of majority of the buses, untrained bus drivers and conductors driven by the pursuit of daily revenue targets payable to the bus owners, non-adherence to traffic rules and regulations, and lack of an organized public transport system (Kanyama et al., 2004, Nkurunziza et al., 2012). The city public transport service is mainly dominated by small buses 'Daladalas', with capacities ranging from 16 to 35 passengers. The actual fare level of a Daladala is between 250 and 350 Tanzanian shillings, independent of the travel distance. The current public transport system has great difficulty in coping with the demographic and spatial growth of the city and in meeting the basic needs of its inhabitants (Sohail et al., 2004). Access to affordable and good quality public transport services is critical for the urban population, as a lack thereof leads to economic, social and physical isolation (Department for International Development, 1999) especially low income communities located in the city outskirts with inadequate access to public transport and other basic urban facilities (Hine, 2003, Olvera et al., 2003).

In response to the public transport challenges in Dar-es Salaam, an urban development strategy was designed and proposed to introduce a *bus rapid transit system* for the entire city (ITDP, 2005). Bus rapid transit (BRT) has emerged as an economical transit alternative with significant potential for developing countries (Wright, 2002). Today, the bus rapid transit concept is becoming increasingly implemented by cities looking for cost-effective transit

solutions. The proposed bus rapid transit system branded the '*Dar-es-Salaam Rapid Transit (DART)*' will operate on specially designated infrastructure and is planned to replace the current inefficient and unpredictable Daladals on the main corridors. The DART will be implemented in six phases with the construction of the first phase set to start in 2010. Once the current plans are implemented, the total corridor length will be more than 130 kilometers with a long-term plan of covering the whole city by the year 2035. The DART Agency will be the public regulatory authority managing the DART System to ensure quality control and will be responsible for policy-setting, regulation, planning and controlling of operations and marketing of the system (JICA, 2008). The DART project seeks to provide a high quality, affordable mobility service that improves both the environment and the quality of life of the city's residents.

Although the BRT is aimed to enhance and improve the quality of service to regain passengers' confidence in public transport, the critical challenge remains regulating and controlling cost minimisation pressure of the profit-seeking private sector which currently dominates public transport service provision without sacrificing the quality of service offered (Sohail et al., 2004). The main objective of this paper is to analyse commuter preferences towards the proposed BRT system in Dar-es-Salaam and explore user perceptions of its service quality attributes.

## **2.2 Overview of earlier studies and approaches**

The need to improve the quality of public transit services to meet the ever-increasing needs and expectations of the passengers has been one of the main desires of urban transport planners world-wide (Mfinanga and Ochieng, 2006, Ji and Gao, 2010, Currie and Delbosc, 2011). For each individual journey, people have the choice between different travel modes, each with specific characteristics, advantages and disadvantages (Garling, 2005). In other words, public transport competes with other modes and will only be used if it can meet the expectations of the travelling public, that is, if it can deliver an attractive, accessible, reliable, affordable and safer service (Stradling et al., 2007, Currie, 2005). A thorough understanding of user's perception of the quality of service provided by the system is, therefore, a prerequisite to realisation of the above ambition.

A review of the international literature on public transit quality shows that quality of service in public transit reflects the passengers' perception of transit performance (Currie and Wallis, 2008, Hensher et al., 2003). The concept of service quality has been extensively applied to public transit systems and may be defined as customer perception of how well a service meets or exceeds their expectations (Geetika. and Nandan, 2010). Service

quality can be measured in terms of customer perception, customer expectation, customer satisfaction, and customer attitude. It covers many diverse topics such as comfort outside and inside the vehicle, journey times, convenience of the service and the existence of supporting infrastructure (Litman, 2008, Currie, 2005). The overall process to improve public transit service quality entails the identification of customer's priorities and needs, the measurement of customers' satisfaction using appropriate indices, the use of this feedback to evaluate the relevant service parameters and finally the definition and implementation of measures to improve the services provided to customers. Research has revealed that the quality of each of the public transit service attributes is related to the importance each individual commuter places on them (Dell'Olio et al., 2010, Foote et al., 2001).

Much effort has been made by various studies on urban public transit services, for example, a number of approaches and techniques such as customer loyalty and benchmarks have been used to define, assess and evaluate quality of service. These approaches have been addressed at different levels of significance in various countries primarily in the developed world (Foote et al., 2001, Morpace International Inc, 1999, Kittelson & Associates et al., 2003). Some studies have focused on the assessment of public transport level of service (Mfinanga and Ochieng, 2006, Too and Earl, 2010). While others evaluate public transit service quality from the perspective of user satisfaction, for example; Ji and Gao (2010) identified significant factors of satisfaction from the analysis of people's satisfaction with public transportation as well as accessibility factors and personal attributes with a multi-level logistic regression model. Dell'Olio et al.(2010) used ordered probit models to evaluate how bus users perceive the quality of their public transit service. Stradling, S. (2007) characterised the dimensions of bus service acceptability by examining what bus users disliked and liked about travelling by bus in Edinburgh using factor analysis. Tyrinopoulos and Antoniou (2008) combined factor analysis and ordered logit modelling to assess the quality implications of the variability of the user's perceived satisfaction across public transit systems. Too and Earl (2010) developed and used a SERVQUAL framework to measure public transport services. Their findings revealed a wide gap between community expectations of public transport services and the actual service quality provided. Eboli and Mazzulla (2008) conducted a stated preference experiment to identify the importance of service quality attributes on global customer satisfaction and calculated a service quality index which provides an operationally appealing measure of current or potential service effectiveness.

Although there is much work on public transit quality, based on the author's knowledge, the study of this topic in sub-Saharan African cities and Dar-es-Salaam in particular using a similar approach is very rare, indeed perhaps not

available at all. Knowledge of how people value the quality of a public transit service would benefit transport planners, policy makers and public transit operators to stipulate strategies of service quality improvement. This would help to design service quality interventions that meet customers' expectations while eliminating subjectivity in the decision-making of urban policies. This paper aims to address this gap in our knowledge and will report the results of a stated preference survey conducted in the city of Dar-es-Salaam.

## **2.3 Methods and materials**

### **2.3.1 Survey design and data collection procedure**

A stated preference (SP) survey was conducted in September, 2007 among individual regular commuters in the city of Dar-es-Salaam who travelled to central business district for main daily activities<sup>2</sup>. The objective of the survey was to collect stated choice data to analyse commuters' preferences towards the proposed BRT quality of service. Given that the BRT system was not yet in place at the time of the survey (not even at the time of submission of this article), the study was conducted to only daily commuters who were assumed to be a right target group with the potential of using and affording the BRT system service.

The survey samples were collected from pre-selected zones of the city based on three criteria: a) whether the residential zones are densely populated and located in areas around the proposed BRT corridors, b) whether the residential zones are planned or un planned in order to capture views from different categories of people, c) The residential zone location distance from the central business district. Based on these criteria, the selection of the survey zones was done with assistance from group discussions held with local experts from the Dar-es-Salaam Rapid Transit (DART) agency, Dar-es-Salaam city council, Ardhi University, the university of Dar-es-Salaam and the JICA team who were conducting the city transport master plan study. The individuals were approached in their homes (with in the pre-selected zones) in the evenings after they had returned from their daily activities. This was done purposely to allow for more time for the respondents to reason their answers in relaxation for the choice questions. The homes were visited at random with the help of local leaders in a given residential area. The study employed the concentric zonal survey approach, which is sampling respondents in reference to distance from central business district (Goudie, 2002). A central business district (CBD) is a major trip attraction zone of a city and for the case of Dar-es-Salaam; the CBD accommodates most of the

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<sup>2</sup> Main daily activities in this study are defined as government/private office work; personal commercial business; and school.

public and private activities and is a major destination of most of the commuting trips in the city. The city was divided into four ring buffers based on the radial distance from CBD where the CBD was taken as a reference point. The four ring buffers created were: zones within 5km from CBD, zones between 5-10 km, zones between 10-15 km and zones beyond 15km distance from the CBD. It was decided to work with categories of commuters (potential users) defined by radial distance from the CBD with an aim to reveal whether the residential location distance from the CBD has an influence on the commuters' choice of the proposed BRT service.

The survey questionnaire used was composed of three main parts. The first part collected information related to individual travel behaviour which was used to customise the second part and gives an overview of the sample travel characteristics. The second part was strictly stated choice questions (i.e. a series of binary bus choices). The third part was meant to collect some socio-economic and demographic information of the sample. A total of 740 commuter respondents were interviewed from different residential zones within the four different ring buffers resulting in 684 completed questionnaires, a response rate of 92%. The high response rate is attributed to the methods employed and the mini-pilot survey done prior the main survey data collection. As each respondent made nine choices from the nine scenarios, the potential total number of observations (pseudo-individuals) was 6156, a reasonable sample size for choice modelling. Earlier studies show that the ideal number of respondents required per design treatment is between 30 and 50 individuals (Ahern and Tapley, 2008, Hensher, 1994). Normally, samples of 500 to 1000 sample observations are more than adequate to give better estimations (Louviere et al., 2000). Because of the focus on commuters, the respondents interviewed were aged 15 years and above.

### **2.3.2 The stated choice design**

The stated preference (SP) approach has been widely used in transportation given its potential to measure how people choose not-yet-existing travel modes or how people take actions in case of introducing new policies for example in this case with the introduction of a new bus transit system (Hensher, 1994). As people in Dar-es-Salaam city have not experienced the proposed BRT system, it is not reliable to use only data about actual travel behaviour to represent people's future preferences. It is necessary to use stated preference approach which has the ability of measuring responses under not-yet-existing conditions (Louviere et al., 2000). Stated preference questions were designed to reveal the alternatives that individual commuters say they would choose in a given hypothetical situation. Each alternative is

assigned a certain combination of attributes, and the individual chooses the alternative they find has the most appealing combination of attributes.

### **2.3.3 Definition of the BRT attribute variables**

The attributes used in the choice experiment are based on the proposed BRT service quality features obtained from the BRT system design reports of Logit (2007) from the DART agency and Dar-es-Salaam city council. The three attributes taken were: Travel time, Travel fare and Comfort. Travel time (one way) in this study is defined as the sum of [access (walking) time to BRT stop, waiting time at BRT stop and in-bus travel time] taken to reach the CBD. Travel fare (one way) is defined as a fee charge of using the BRT to reach the CBD. The DART will operate according to a flat fare system and thus respondents were presented the same travel fare. According to the BRT Investors documents the travel fare for the BRT one way is Tshs<sup>3</sup> 500 and this was the fare considered in this study. Comfort in this study is defined as the in-bus comfort during the trip to CBD. Comfort attribute was measured at three levels: comfortable seating which means that a commuter can sit during the complete journey. Comfortable standing which means that the commuter can only stand during the trip. The standing conditions are comfortable, if the commuter can easily move his arms and legs, and can easily leave the bus without the need to ask other people to give space. Overcrowded standing means that the commuter has no seat available during the trip but in this case the standing conditions are worse than comfortable standing. Walking through the bus is almost impossible. Thus, the respondent can roughly make a comparison with the situation of an overcrowded Daladala.

The three attributes were selected among others based on inputs obtained through work sessions with local experts from the DART Agency, Dar-es-Salaam city council and Ardhi University, who also helped to individualise the most relevant attribute levels. Comfort was also considered into this study because other studies in Dar-es-Salaam had shown that people value comfort highly (Kanyama et al., 2004). The attributes and their levels were later validated based on inputs from a mini-pilot survey among daily commuters. Hensher et al., (2005) suggests that three attributes with three levels are enough to provide knowledge of a good approximation of the true underlying utility function. The attributes were varied over three levels (see, Table 2.1). Table 2.1 describes the BRT attribute variables used in the study.

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<sup>3</sup> Tshs = Tanzania Shillings, 1 US Dollar = approx. 1200 Tshs ( at the time of the survey)

Table 2.1: Description of BRT attribute variables

Attribute	Level values	Unit	Description
Travel time	0 -5km: 15,30,45 5-10km: 20,40,60 10-15km: 30,55,80 >15 km: 45,75,105	Minutes	Total BRT travel time to CBD (Walk time to BRT stop +Wait time at BRT stop + In vehicle travel time) (one way)
Travel fare	300,500,700	Tshs*	Total BRT Travel fare to CBD (One way)
Comfort	1 = Seat guaranteed; 0 = Comfortable Standing; -1 = Overcrowded Standing	Level of comfort	Comfort level when inside the bus

Tshs\* = Tanzania Shillings, 1 US Dollar = approx. 1200 Tshs as of september, 2007

In order for the attribute level values to be realistic for the study context and acceptable to respondents, the maximum and minimum attribute level values for the experiment were set close to the attribute level values of a Daladala and realistic for the BRT system. The attribute levels were tested through a pilot survey with 20 individual Daladala regular commuters. This enabled to increase the realism of the hypothetical choice context to a plausible maximum by bridging the gap between reality and stated intentions. The pilot survey also enabled us to validate the questionnaire and to verify the existence of trade-offs in the evaluation of attributes and the lack of dominant or lexicographic behaviour among respondents.

The stated preference scenarios for this survey were constructed using a fractional factorial design. To produce a fractional factorial, traditional orthogonal design<sup>4</sup> in statistical package, SPSS was used. The method of producing factorial design in SPSS is described in Hensher et al., (2005). The full factorial allowing estimating main effects requires defining 27 choice scenarios. However, submitting respondents to such burden runs the risk of losing their attention and obtaining inconsistent answers (Iragüen and de Dios Ortúzar, 2004). For these reasons, a fractional factorial was therefore used to reduce the number of scenarios from 27 to 9.

<sup>4</sup> It is important to note that more recent research concluded that D-efficient designs- the designs that minimise the D-error, that is, the elements included in the asymptotical matrix of expected variance-covariance- produce significantly improved results in terms of statistical or relative efficiency (Rose and Bliemer, 2009; Rose et al. 2008).

For the purpose of this study, respondents were asked to choose between two unlabeled<sup>5</sup> bus alternatives – Bus A or Bus B. Unlabeled choice scenarios were presented to respondents to avoid bias that could be brought by the attached label 'BRT' when making a choice. In Dar-es-Salaam where most people have a low literacy level, it was necessary to present choice scenarios in a way that could be interpreted easily and homogeneously to have an effect on better utility estimations. Carson et al.(1994) recommend the use of graphic representations as an aid for respondents and this was emphasized in recent SP studies (Iragüen and de Dios Ortúzar, 2004, Tilahun et al., 2007). To make sure that every individual respondent interprets homogeneously the same bus quality attributes in all choice scenarios, especially for the qualitative attributes like comfort where different interpretations from respondents were possible, a combined pictorial and verbal format was presented and elaborately tested at the SP exercise. Figure 2.1 gives an example of one of the nine stated preference scenarios presented in the survey. A copy of the nine SP survey choice sets can be available from the author upon request.

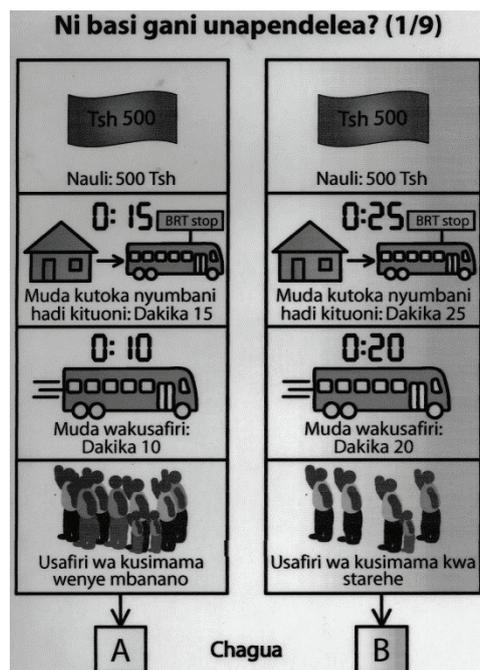


Figure 2.1: Sample stated preference scenario

<sup>5</sup> Unlabeled experiment is a choice experiment that uses generic titles for the alternatives where respondents make choice solely on the basis of the differences in attribute level values among the presented options (Louviere et al. 2000). This experiment does not attach a label to any of the alternatives.

### 2.3.4 Model structure and explanatory variable specification

The stated choice data from the SP survey was analysed using a random utility model. This is by far the most used model for processing data from choice experiments in transportation research (Ben-Akiva and Lerman, 1985, Louviere et al., 2000). The model assumes that travel decision makers face a utility maximisation problem based on the cost and quality of service stemming from using a given mode and the uncertainty to choosing the given mode (Ortúzar and Willumsen, 1994). This study uses a random utility model in form of binary logit. The maximum likelihood method was used to estimate the binary logit models. The stated choice data was modelled using Bierlaire's optimisation toolbox for general extreme value model estimation (BIOGEME) version 1.5 (Bierlaire, 2003). The specified random utility model estimated for this study is expressed as:

$$U_{bn} = V_{bn} + \varepsilon_{bn} \quad (1)$$

where  $n$  is an index for individuals ;  $b$  is an index for bus (BRT) - ( $b = A$  or  $B$ , because each scenario comprises two alternative buses);  $U_{bn}$  = the utility of the bus rapid transit (BRT/DART) by an individual  $n$ ;  $V_{bn}$  = the systematic utility component of the BRT; The random error term  $\varepsilon_{bn}$  = the non-observable utility component of the BRT which is assumed to be identically and independently standard Gumbel distributed across alternatives and observations. The systematic part of utility  $V_{bn}$  depends on the attributes considered in the study and in this case is given by the equation:

$V_{bn} = \sum \beta_{bk} X_{bkn}$  Where:  $V_{bn}$  = the systematic utility component of the BRT;  $\beta_{bk}$  = the utility coefficient associated with attribute  $X_{bkn}$  of the BRT;  $X_{bkn}$  = represents a vector of explanatory variables specific to BRT  $b$  and individual  $n$ ;  $k$  = the  $k^{\text{th}}$  attribute of the BRT. The systematic utility functions of the alternatives are linear combinations of the bus service quality attributes, as shown in the following expression:

$$V_{brt\_b_i} = \beta_{tt\_b_i} TT_{brt} + \beta_{fare\_b_i} FARE_{brt} + \beta_{cft\_b_i} CFT_{brt} \quad (2)$$

where:  $V_{brt\_b_i}$  = Systematic utility component of BRT per buffer ring;  $TT_{brt}$  = Total travel time of BRT (one way);  $FARE_{brt}$  = Total travel fare of BRT (One way);  $CFT_{brt}$  = Comfort of the BRT;  $\beta_{tt\_b_i}$  = coefficient associated with

attribute travel time, specific for each buffer ring;  $\beta_{fare\_b_i}$  = coefficient associated with attribute travel fare, specific for each buffer ring;  $\beta_{cfi\_b_i}$  = coefficient associated with attribute comfort, specific for each buffer ring;  $b_i$  = buffer ring  $i$  where  $i = 0-5\text{km}; 5-10\text{km}; 10-15\text{km}; >15\text{km}$ .

As this was an unlabelled design, the intercept has not been considered when designing the models and no socio-economic variables have been introduced (Hensher et al., 2005). For a more detailed discussion on stated preference surveys see (Polak and Jones, 1997, Rose and Bliemer, 2009, Rose et al., 2008, Hensher et al., 2005) and discrete choice modelling, see (Ben-Akiva and Lerman, 1985, Louviere et al., 2000, Ortúzar and Willumsen, 1994).

## **2.4 Results and discussion**

### **2.4.1 Descriptive statistical analysis**

The descriptive analysis results of the survey data (see Table 2.2) show relatively good representation of male and female respondents and the comparison between the sampled population and the Dar-es-Salaam population indicates a relatively good representative sample. The employment status of the sampled population shows that all groups were represented. However, the self-employed are over-represented because, unlike the city population at large, most commuters to downtown are self-employed businessmen and petty traders.

Table 2.2: Socio-demographic profile of the sample respondents

<b>Factor</b>	<b>% Sample respondents</b>	<b>% Dar-es-Salaam population</b>
<b>Gender*</b>		
Male	53.7	50.5
Female	46.3	49.6
<b>Age group*</b>		
15 - 25 years	30.3	36.5
26 - 64 years	68.1	60.4
>64 years	1.6	3.1
<b>Employment status**</b>		
Full time	21.2	22.1
Part Time	12.9	N/A
Self-employed	44.7	22.8
Student	11.8	11.5
Other	9.4	
<b>Education level**</b>		
No education	1.3	7.6
Primary	32.3	60.6
Secondary school	44.9	1.7
Higher	21.2	2.9
Missing data	0.3	

\*Source: Population & Housing Census 2002

\*\* Source: Household Budget Survey 2000/01

Most respondents were between 26 and 64 years of age as expected since this is the working age group which indicates good data in the point of view of this research. A higher percentage of the sampled respondents had completed their secondary level education compared to the city population. This difference is reasonable since one would expect the daily commuters to have a higher education level.

Table 2.3: Travel behaviour of the sample respondents

<b>Factor</b>	<b>% Sample respondents</b>	<b>% Dar-es-Salaam Population</b>
<b>Main trip purpose to CBD</b>		
Work	28.5	N/A
School	9.5	N/A
Business	49	N/A
Other	12.9	N/A
Missing data	0.1	N/A
<b>Main mode of travel</b>		
Daladala (public transport)	87.9	42.0*
Bicycle	0.3	3.0*
Walking	1.8	46.0*
Private Car	8.9	9.0*
Other	1.1	N/A

\*Source: Amer et al.2007; N/A = data not available

Table 2.3 shows that most commuters travel to CBD for business (large-scale business, petty trading, business shopping) activities. Those who travel to CBD for office work activities i.e., government and private institutions constitute about 29%, while school trips count for about 10%, the remaining others contribute 13%. The modal share of the sample shows that 88% of the commuters use public transport (Daladala); 8.9% private car; 1.8 % walking; 0.3% bicycle and 1.1% other modes.

## 2.4.2 Model results

Results from all models have shown that, the parameter on travel time variable is negative and highly significant, reflecting a preference for shorter travel times. The parameter on travel fare variable is negative and showing a significant aversion to expensive travel fares. The comfort parameter has a positive sign as expected and significantly indicates that commuters prefer travelling in comfortable environment.

To examine the relative importance of the attributes, the willingness to pay (WTP) values were estimated. The willingness to pay estimates examines the value attached to each of the attributes by respondents from different locations of the city. The willingness to pay (WTP) value for travel time attribute of the BRT is the marginal rate of substitution between travel time and travel fare and is given by the ratio of travel time utility parameter and the travel fare utility parameter. Likewise the WTP value for comfort is given by the ratio of comfort utility parameter and the fare utility parameter (Louviere et al., 2000). The results shown in (Table 2.4) suggests that a sampled individual is willing to pay, on average, 30.2 Tshs to save one minute of time spent travelling to CBD holding other factors constant. In the same way, a sampled individual is willing to pay 343 Tshs to gain a unit level

of in-bus comfort. The results again show that, on average, a sampled individual is willing to pay 11.4 times more to gain a unit level of in-bus comfort than to save a unit of travel time.

Tables 2.5 and 2.6 show results from models depending on distance from CBD. A sampled individual is willing to pay, on average, 18.3 Tshs, 4.2 Tshs, 5.5 Tshs, and 8.6 Tshs to save one minute of time spent travelling to CBD *ceteris paribus* when one is from within 5km, 10km, 15km and beyond 15 km distance from CBD respectively. Likewise, on average, holding other factors constant, a sampled individual is willing to pay 745 Tshs, 360 Tshs, 291Tshs and 282 Tshs to gain a unit level of comfort from within 5km, 10km, 15km and beyond 15 km distance from the CBD respectively. The results also reveal that a sampled individual is willing to pay, on average, 40.7, 86, 52.9 and 33 times more to gain a unit level of comfort than to save a unit of travel time when one is from within 5 km, 10 km, 15 km and beyond 15 km distance from the CBD respectively. The model results in all cases clearly indicate that the value attached to comfort (in bus during travel) is higher than that of travel time, simply suggesting that, an individual commuter would be willing to pay more to gain a unit level of comfort (in bus) than to save a unit of travel time holding other factors constant. For example, considering the overall model results (Table 2.4), an individual commuter from any zone in the study area is willing to pay on average, 11.4 times more to gain a unit level of comfort than to save a unit of travel time.

While the willingness to pay values of the attributes differed in the different models, results from all models show that comfort is more valued than travel time and travel fare revealing its importance to the proposed BRT service quality. Although comfort is more valued than travel time and travel fare from all model results, the value placed on comfort decreased as residential location distance from the CBD increased. People located in zones close to the CBD attach more value to comfort and this value decreases as one moves away from the CBD. The possible explanation for this may be that people who mainly live in the city peripherals are the poor and for these people comfort would be reasonably less valued compared to those who live closer to CBD. Similarly, comfort and travel time is valued higher by commuters from zones close to CBD (i.e. within 5 km to CBD) than those from city peripherals. It was, however, expected that commuters from zones located far from the CBD would highly value travel time and comfort since they have to travel longer. The suggested reason could be that people who live close to the CBD are mainly government workers highly educated and big business men with relatively high income who from their point of view, time is money and comfort is high class.

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Table 2.4: Overall model based on total sample

<b>City Level</b>				
<b>Attribute</b>	<b>Coef.</b>	<b>WTP</b>	<b>t - test</b>	<b>p - value</b>
Travel Time	-0.0487	30.2	-17.75	.000
Travel Fare	-0.00161		-5.16	.000
Comfort	0.552	343	10.38	.000
<i>No. of estimated parameters</i>	3			
<i>No. of observations</i>	6156			
<i>Init. log-likelihood</i>	-4266.321			
<i>Final log-likelihood</i>	-2652.603			
<i>Likelihood ratio test</i>	3227.436			
<i>Rho-square</i>	0.378			

Table 2.5: Models depending on radial distance from CBD

<b>Attribute</b>	<b>&lt; 5 km</b>				<b>5-10 km</b>			
	<b>Coef.</b>	<b>WTP</b>	<b>t - test</b>	<b>p value</b>	<b>Coef.</b>	<b>WTP</b>	<b>t test</b>	<b>p value</b>
Travel Time	-0.0272	18.3	3.23	.000	-0.0148	4.2	-2.81	.010
Travel Fare	-0.00149	-	-2.01	.040	-0.00353		-5.26	.000
Comfort	1.11	745	8.26	.000	1.27	360	10.96	.000
<i>No. of estimated Parameters</i>	3				3			
<i>No. of observations</i>	610				1341			
<i>Init. log-likelihood</i>	-422.127				-923.272			
<i>Final log-likelihood</i>	-352.817				-799.266			
<i>Likelihood ratio test</i>	138.618				248.012			
<i>Rho-square</i>	0.164				0.134			

Table 2.6: Models depending on radial distance from CBD

Attribute	10-15 km				>15 km			
	Coef.	WTP	t test	p value	Coef.	WTP	t test	p value
Travel Time	-0.0343	5.5	-3.06	.000	-0.0347	8.6	-6.66	.000
Travel Fare	-0.00623		-3.40	.000	-0.00405		-4.17	.000
Comfort	1.81	291	5.66	.000	1.14	282	5.60	.000
<i>No. of estimated Parameters</i>	3				3			
<i>No. of observations</i>	272				504			
<i>Init. log-likelihood</i>	-188.536				-349.346			
<i>Final log-likelihood</i>	-153.549				-302.459			
<i>Likelihood ratio test</i>	69.975				93.774			
<i>Rho-Square</i>	0.186				0.134			

On the other hand, although travel fare proved very significant, it was unexpectedly less valued than other attributes. It was though expected that people would value travel fare more than comfort and travel time given that the Dar-es-Salaam population is mainly low income. The two possible explanations are: first, since most commuters usually have to make one or more Daladala transfers currently from their residential locations to reach CBD and each time when a transfer is made one has to pay double the travel fare (the Daladala fare was ranging from Tshs 250 to Tshs 500 one way travel at time of survey), the BRT travel fare (expected to charge a flat fare of Tshs 500 one way) may be seen less expensive to commuters than the Daladala fare charge. Second, given the poor service and travelling environment of the Daladalas characterised by uncomfortable, unsafe and overcrowded conditions rendered to its customers, high preference for comfort than travel fare sounds reasonable and unsurprising.

### 2.4.3 Policy implications

The study results indicate that when asked to rank the importance of three variables related to future BRT, commuters in Dar-es-Salaam overall placed a premium on comfort followed by faster travel times and lower fares. There was some variation based on how far the respondents lived from the CBD. Respondents who lived closest to the CBD placed a premium on comfort (in-bus) while respondents who lived on the periphery of the CBD placed a premium on lower fares.

Moreover, it was possible to extract spatial variation in preferences for the proposed BRT service attributes among the potential users. Such an understanding can be incorporated into the planning process to help planners

to make better recommendations and operators to make appropriate investment decisions in order to provide a public transit service that is more appealing to the public.

The high significance of the in-bus comfort, travel time and travel fare attributes in modal choice decision making of a commuter suggests that the DART Agency would pay more attention and consider these attributes important when providing the BRT service. However, when implementing the BRT, priority and particular attention should be given to the order of importance of the attributes for effective delivery of high quality public transit service.

Although results have generally shown that travel fare attribute is less important compared to comfort and travel time, planners and decision makers should handle it carefully given its high significance and also given that Dar-es-Salaam population is dominated by low income earners. Only through providing transport services characterised by better comfort, lower travel times and lower travel fares will the proposed BRT be sustainable and attractive to its potential users.

#### **2.4.4 Conclusion**

This study attempted to evaluate the proposed BRT service quality through analysis of commuters' stated preferences. In most developing countries, population preferences are hardly taken into account by planners and policy makers, consequently not meeting the desires of the society under question. The stated preference approach and the logit model used in this study can be used to integrate the views of the society in planning especially in evaluating new public transit services or changing existing ones. This gives logit models a very strong policy role by assisting analysts, researchers and planners in evaluating the impact of many policies as defined by specific mixes of attributes modelled in utility expressions.

A stated preference survey instrument was developed where people had to make choices among two hypothetical bus alternatives. The results generally revealed in order of importance that commuters are willing to pay the highest price for travelling in a more comfortable environment, followed by lower travel times and paying lower travel fares respectively. However, the results further highlight the differences in valuation of the attributes based on spatial location of the sampled population in the city. A higher preference is indicated for in-bus comfort by commuters from zones close to the CBD while commuters from the city peripheral zones seemed to have a higher preference for travel fare and appeared less willing to pay for comfort than those from inner zones of the city. These findings are in line with the

statement that people value the characteristics of goods, not the good themselves (Joewono, 2009, Walton et al., 2004). However, Russell (1996) has argued that being willing and able to pay for a commodity does not automatically imply being able to afford it, mainly because the social opportunity cost of the payment may be too high to be socially acceptable.

A methodological conclusion is that the use of pictorial choice cards in the presentation of choice scenarios offers a great promise. Not only were all the expected advantages of the approach fully realised, but also the medium was believed to contribute in no little measure to obtaining the choice data and making the exercise more pleasurable to respondents (i.e. less of a burden). The survey instrument contributed to obtaining better responses and a higher response rate than if a different approach had been used. The survey approach is found to be most appropriate and effective to use in cases of hypothetical alternatives, particularly a novel SP survey approach in the context of a developing country with a high proportion of illiterate population.

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## Chapter 3

### **Spatial variation of transit service quality preferences in Dar-es-Salaam<sup>6</sup>**

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<sup>6</sup> This chapter is based on Nkurunziza, A., Zuidgeest, M.H.P., Brussel, M.J.G. and van den Bosch, F. (2012) Spatial variation of transit service quality preferences in Dar-es-Salaam. *In: Journal of transport geography*, 24(2012) pp. 12-21

## Abstract

Commuter preferences for transit service quality are of great importance to transit service providers and regulatory agencies. The point of view of potential passengers is fundamental for evaluating transit service quality as they are envisaged to be the real consumers of the planned services and can therefore be considered the most suitable judges. A stated preference survey of daily commuters to the central business district (CBD) in the city of Dar-es-Salaam was carried out to elicit preferences towards the proposed Dar Rapid Transit (DART) service. Preferences towards the proposed DART service are considered to vary based on the residential location of the potential users. These preferences are evaluated on the attributes of travel time, fare and comfort. A binary logit model was applied to establish utility functions that were analysed spatially in a GIS environment, where a utility value was mathematically computed for each spatial unit. This paper therefore analyses spatial variation of transit service quality preferences for the proposed DART service in Dar-es-Salaam, Tanzania using geo-spatial techniques. The study uses a scenario-based approach to evaluate the effect of the proposed DART service by comparing the '*without DART*' scenario, a case representing the existing public transport (*daladala*), and a '*DART*' scenario, representing the future proposed DART system. The results indicate that the proposed DART attributes considered in the study have a significant effect on DART service quality. The results reveal that utility values are significantly varying spatially, particularly dependent upon distance to CBD. Comfort is more important attribute in zones up to 5 km from the CBD, travel fare is more important in zones between 5 and 15 km from the CBD, while travel time is more important in zones beyond 15 km distance from the CBD. The overall results indicate that the DART is likely to be more attractive than the existing public transport system.

### **3.1 Introduction**

Most cities in the developing world are experiencing rapid urbanization, population growth and dispersal of amenities and activities. These have caused increased demand for and dependence on personal motorized transportation leading to problems such as congestion, accidents, environmental degradation, parking, pollution, stress, noise, and urban sprawl (Zhao, 2010, Abane, 2011, Salon and Aligula, 2012). More recently, however, planners, engineers and decision makers, worldwide, have started to give more and more attention to the development and promotion of more affordable, space and resource-efficient transport systems to alleviate those aforementioned problems (Menckhoff, 2002, Mavoa et al., 2012, Davison and Knowles, 2006). The development of sustainable transport options such as Bus Rapid Transit (BRT) systems has witnessed tremendous growth, most notably cities in developing countries. These large, city-wide transportation projects are often central to larger urban revitalization plans intending to foster economic growth and sustainable development. Crucial to the success of such ambitions is a system that provides equitable access to all residents and one that provides access to a large number of urban opportunities (Delmelle and Casas, 2012). Improving access to opportunities and provision of different mobility options (e.g. accessible public transit) are key policy responses to the problem of low participation rates in urban activities, particularly for those who are transportation disadvantaged (Hine, 2003, Kamruzzaman et al., 2011, Tiwari and Jain, 2012).

The city of Dar-es-Salaam in Tanzania, like many others in the developing world, is urbanizing at a faster rate than its infrastructure is able to cope with. The city being the largest in Tanzania with an estimated population of around 4 million in 2010 has experienced a major transportation crisis. Transport in the city is characterized by extreme traffic congestion, rapid population growth, environmental deterioration, increased automobile ownership, high accident rates, inefficient road space allocation, as well as an excessive and obsolete transit fleet (Olvera et al., 2003, Nkurunziza et al., 2012b). The pattern of urban mobility also reflects the social exclusion existing in the city. The majority of the Dar-es-Salaam population does not own and use private vehicles. In order to save on the costs of transportation, the urban population (mainly the poor) end up landlocked in marginal peripheral areas, without adequate access to urban facilities in the city (Olvera et al., 2008). The current public transport service is provided by obsolete, polluting and unsafe para-transit, mainly dominated by small minibuses called '*daladala*'. The *daladala* service is characterised by the poor state of the majority of buses, untrained bus drivers and conductors driven by the pursuit of daily revenue targets payable to the bus owners, non-adherence to traffic rules and regulations and lack of an organized public

transport system (Sohail et al., 2004, Kanyama et al., 2004). In response to those existing public transport challenges, the Dar-es-Salaam city proposed to introduce a bus rapid transit system "*The Dar Rapid Transit (DART)*" aiming at providing quality and affordable mass transit service for the city residents, which is planned to reduce emissions, enable poverty reduction, lead to sustainable economic growth and act as a pioneer of private and public investment partnership in the City (Logit, 2007, JICA, 2008).

### **3.1.1 The Dar rapid transit (DART) system**

The city of Dar-es-Salaam is among the very few Sub-Sahara African cities that decided to adopt a bus rapid transit (BRT) system branded "*Dar Rapid Transit (DART)*". Other cities that have considered/or are in the process of introducing BRT systems are: Lagos, Accra, Addis Ababa, Kampala and Nairobi (Deng and Nelson, 2011, UN-Habitat, 2011). Following the apparent success of Bogota's Transmilenio that was implemented in the year 2000 in Colombia, the BRT in Dar-es-Salaam 'DART' is developed along similar lines (Gilbert, 2008, Munoz-Raskin, 2010, Logit, 2007). Like the Transmilenio, DART is designed to work with a trunk-feeder set-up system. The DART trunk lines will be implemented on the four major road corridors in the city. It is planned that along those corridors the current minibuses are no longer able to operate. The DART promises to run with high-capacity articulated buses (minimum 140 passengers) operating on designated infrastructure at an average speed of over 22 km/hr. The proposed DART ticket will cost a flat fare of approx. US\$ 0.32 while a daladala ticket (one way) costs between approx. US\$ 0.16 and US\$ 0.19. The DART system will be implemented in six phases with the first phase - earlier planned to start in 2009 - is currently under construction since 2011. The last phase is planned to be completed in 2035 (Logit, 2007, JICA, 2008).

Bus Rapid Transit's popularity has increased worldwide, due to its promise for delivering a relatively low cost, rapidly implemented, flexible and high quality service solution to developing cities' transportation needs (Wright and Hook, 2007, Deng and Nelson, 2011). Despite the increased popularity, implementing a BRT inevitably encounters some challenging technical, operational and institutional issues (Deng and Nelson, 2011). The success of BRT systems elsewhere cannot be taken for granted, as each city has certain inherent characteristics and thus successful BRT experiences from elsewhere need proper modification to be applied in other contexts (Deng and Nelson, 2011). Moreover, the success of such systems will be dependent upon the ability of the operator to provide the level and quality of services expected by the users against a tariff that is affordable. The fundamental issue addressed in this paper therefore is whether the proposed DART system will deliver quality service expected by its potential riders. Also, while most studies on

public transit service quality are based on qualitative measures of user perceived quality and satisfaction ratings, very few or hardly any studies exist that integrate behavioural models with geo-spatial models in the evaluation of public transit service quality. Hence, three underlying questions exist: How do potential users value the proposed DART service quality? How to integrate behavioural models into GIS for spatial analysis of the proposed DART service quality? Where is the proposed DART service highly or less valued compared to the commuting service rendered by the existing public transport? When a planning authority finds answers to these questions, it can compare the spatial distribution of potential user satisfaction derived from DART service to that of the existing public transport and devise means of providing a service desirable to its potential users. The main objective of this study is to answer these questions by deriving behavioral models from commuter stated preferences and integrating them into GIS for spatial evaluation of the proposed DART system service quality.

The remainder of the paper is organised as follows. The next section discusses earlier studies on transit service quality evaluation and how this study relates to similar theoretical frameworks. The third section describes the applied integrated methods to evaluate public transit service quality. The fourth section concentrates on the modelling and discussion of results, followed by conclusions and some planning implications in Section five.

### **3.2 *Earlier empirical research on transit service quality***

Evaluation of public transit service quality is a challenging research theme and of great importance to transit service providers and regulatory agencies (Hensher et al., 2003). From the service providers' perspective, it is essential to identify the most important attributes of service quality that are desired by current and potential users. Moreover, it is also important to allocate resources for transit improvements in directions most consistent with consumer perceptions (Prioni and Hensher, 2000). Measuring which service attributes are important to customers may be more meaningful to managers than measuring customer service expectations. For example, Landrum and Prybutok (2004) indicate that comparing service performance against what customers consider important may be just as useful to managers as comparing performance against what customers expect. However, the challenge in service provision involves gaining a realistic view on service quality delivered in the first place together with a sound understanding of public satisfaction and expectations with respect to public transport services (Mfinanga and Ochieng, 2006). Many researchers consider the customer's point of view the most relevant for evaluating transit performance, for

example; Berry et al. (1990) pointed out that 'Customers are the sole judge of service quality'.

Service quality can be evaluated by considering customer perceptions and expectations, which can be used for measuring the ability of the transit agency to offer services that meet customer expectations (Morpace International Inc, 1999, Deng and Nelson, 2012, Gilbert, 2008). Passenger's perceptions are qualitative measures of transit service quality generally derived from the well-known customer satisfaction surveys, which help transit operators to identify which service quality factors are considered the most important by their customers. Customer satisfaction surveys can also be used to prioritise future quality of service improvement initiatives and to track changes in service quality over time (Eboli and Mazzulla, 2011, Currie, 2006, Cain et al., 2009). Traditional research on perceived quality provides operating companies with knowledge on the impact their decisions have on their customers, while studies on desired quality gives them in-depth information about their customers and what customers want from their service so they can develop more acceptable policies (Dell'Olio et al., 2011, Currie and Wallis, 2008).

Extensive literature is available on the attitudes towards transit services and on service quality as important determinants of travel demand. Some studies have focused on evaluation of public transit service quality from the perspective of ratings of user satisfaction. For example, Ji and Gao (2010) identified significant factors from ratings of people's satisfaction with public transportation as well as accessibility factors and personal attributes using a multi-level logistic regression model. Dell'Olio et al. (2010) used ordered probit models to evaluate how bus users perceive the quality of their public transit service. Stradling et al. (2007) characterised the dimensions of bus service acceptability by examining what bus users disliked and liked about travelling by bus in Edinburgh using factor analysis. Tyrinopoulos and Antoniou (2008) combined factor analysis and ordered logit modelling to assess the quality implications of the variability of the user's perceived satisfaction across public transit systems. Too and Earl (2010) developed and used a SERVQUAL framework to measure public transport services. Their findings revealed a wide gap between community expectations of public transport services and the actual service quality provided.

An alternative approach for capturing customer judgments in terms of expectations and perceptions, or importance and satisfaction ratings, is based on the use of choice analysis which indirectly captures the service attributes that are important and satisfactory to customers. Choice data are collected from experiments based on stated preference techniques, in which the interviewed users make a choice among some alternative services

characterized by some service quality attributes varying on two or more levels. For example, in Prioni and Hensher (2000) a stated preference experiment was proposed to the passengers of some private bus operators in New South Wales (Australia). In this experiment, the interviewed users made a choice between some alternative services characterized by some service quality attributes, varying on three levels. The choice data were used to calibrate a multinomial logit (MNL) model and by model estimation, the importance of each service attribute on the overall service quality was evaluated. In Eboli and Mazzula (2008), a stated preference experiment was proposed to the passengers of an urban bus service in Consezza (Italy) with the main purpose of exploring the optimal design of a stated choice experiment for measuring service quality in public transport. In Marcucci and Gatta (2007) stated preference methods and choice-based conjoint analysis were used for passengers' evaluation of a transit service in some geographical areas of Marche in central Italy. The data were used to calibrate a nested logit model for considering the differences of the geographical segments and to calculate an index of service quality.

On the other hand, some studies have concentrated on the features that are supposed to reflect the appropriateness of public transit systems in view of access and accessibility to public transit (Murray et al., 1998, Murray, 2001, Rastogi and Rao, 2003a, Rastogi and Rao, 2003b, Munoz-Raskin, 2010, Jiang et al., 2012) and accessibility to key nodes of employment, housing, leisure and other social activities (Handy and Niemeier, 1997, Geurs and Ritsema, 2001, Lau and Chiu, 2004, Zhu and Liu, 2004, Delmelle and Casas, 2012). Although accessibility studies shed light on the spatial distribution of availability and reach-ability of opportunities, they do not tell us how public transit service offered has satisfied the users and to what extent is the degree of satisfaction. Other studies use the benefits-driven approach based on the maximization of either the user's or location's benefit (Miller, 1999). Such research deals with network analysis and spatial design of a specific transit system or a single route (Matisziw et al., 2006, Hadas and Ranjitkar, 2012).

While this study draws on all of the aforementioned lines of research, it evaluates public transit service quality from an under-explored perspective, i.e. the integration of behavioural models with geo-spatial models in the evaluation of public transit service quality. Research on user perceptions of different transit service aspects has been performed before, but very few studies deal with analysis of spatial variation of people's preferences in transit service quality evaluation. It could be criticised as the subjective evaluations from the perspective of satisfaction and spatial evaluation of the physical environment are hardly integrated. The integration would be a big step forward for stipulating service quality improvement and spatial

intervention strategies. Linking preferences of (potential) transit riders through stated choice modelling to spatial analysis of transit performance is important in order to allow a transit operation agency to evaluate its service provision in meeting user travel needs and expectations. The objective of this study is to integrate behavioural models derived from stated choice analysis into GIS to evaluate transit service quality with a central focus and application to the proposed BRT system (DART) in Dar-es-Salaam. The paper is aimed at finding out how potential users value the proposed DART service. In other words, how important are the proposed DART service attributes to potential customers? Where is the DART service likely to generate satisfaction and to what extent is the level of satisfaction expected?

### **3.3 Methodology and data**

The evaluation of the proposed DART service quality described in this study involves two steps. The first step is to analyse commuters' preferences towards the proposed DART service in order to identify how the proposed service attributes are important to potential riders. Based on this information, the next step examines the magnitude and spatial variation of the satisfaction (or utility) levels derived from the DART service. Methodologies proposed in this study for the two steps take advantages of stated choice analysis with random utility models and the spatial analysis and visualization capability of GIS. The integration of behavioural models with a geo-spatial model allows for spatial evaluation of the commuter preferences variation in relation to the satisfaction derived from the proposed DART service.

#### **3.3.1 Survey instrument and data collection**

Stated preference (SP) surveys have been widely used in transportation studies given their potential to measure how people choose not-yet-existing travel modes or how people take actions in case of introducing new policies, in this case a new bus transit system (Hensher, 1994). SP experiments examine individual responses to a series of experimentally designed choice alternatives which are described in terms of combinations of attributes with several pre-defined levels (Hensher et al., 2005). Since people in Dar-es-Salaam have not yet experienced the proposed DART system, nor experienced any BRT like system, it was necessary to use stated choice techniques to elicit commuters' preferences. This was aimed at finding out whether the proposed DART service is socially and spatially desirable from the point of view of the potential users.

Therefore, a stated preference survey was conducted in Dar-es-Salaam in September, 2007. Details of the survey development and administration have been described in (Nkurunziza et al., 2012a). In brief, survey samples were obtained from individual commuters at the age of 15 years and above who

travelled on regular basis to the central business district for main activities such as: work, school, business and recreation. The regular commuters were assumed to be a right target group with the potential of using and being able to afford the DART system service, whereas people below 15 years were assumed to not be able to respond to the survey questions independently. The results in the paper are based on a survey questionnaire that comprised of three main types of questions. The first part collected information about individual travel behaviour characteristics. The second and main part of the survey was strictly stated choice questions i.e. a series of binary bus choices (the subject of this paper). The third part collected information related to socio-economic and demographic questions. The summary details of the raw survey data characterisation based on the first and third part of the questionnaire are reported in Table 3.1.

The survey samples were collected from the available pre-defined residential Traffic Analysis Zones (TAZs) of the city. TAZs are partitioned according to variables that are most pertinent to travel choices and are as homogeneous as possible within each spatial unit and heterogeneous between the units with regards to travel choice and factors (Yao, 2007, Ortúzar and Willumsen, 2001). The final selection of the residential TAZs for surveying was based on the distance of the TAZs from the Central Business District (CBD), their locational distance from the proposed DART line stops and the residential density of the TAZs. As Dar-es-Salaam is more of a mono-centric city, where the CBD is the major trip attraction zone, we adopted the concentric zonal survey approach from Goudie (2002). The CBD accommodates most of the public and private activities and it is the destination of most commuting trips in the city (JICA, 2008). The concentric zonal survey allows sampling respondents based on radial distance from the CBD. Using the zonal survey approach, the study area was divided into four buffer rings where the CBD was taken as a reference point. The four buffer rings are residential TAZs within 5 km, 10 km, 15 km and more than 15 km radial distance from the CBD. The buffer rings were purposely constructed to detect spatial variation of commuter preferences towards the proposed DART service with respect to residential location and distance from the CBD. Figure 3.1 shows the residential TAZs where the survey samples were collected.

A total sample of 740 commuter respondents was interviewed randomly from residential TAZs within the different buffer rings, while only 684 well completed questionnaires were taken for analysis. As each respondent was presented with nine choice scenarios (see, Nkurunziza et al., 2012a or available on request), the potential total number of observations (pseudo-individuals) was 6156, a reasonable sample size for choice modelling. Normally, 500 to 1000 sample observations are more than adequate to give good estimations (Hensher et al., 2005). For a more detailed discussion on



agency local staff and the information collected from a pilot survey among a section of current public transport regular commuters to the Central Business District (CBD). This way we managed to increase the realism of the hypothetical choice context to a plausible maximum by bridging the gap between reality and the stated intentions.

The study uses logit modelling based on random utility theory to analyse the choice data which is by far the most used approach for processing stated preference data in transportation research (Ben-Akiva and Lerman, 1985, Louviere et al., 2000). Random utility theory assumes that individuals choose the travel alternative that maximises the individual's utility (MacFadden, 1974). A random utility model in form of binary logit was considered and estimated using maximum likelihood method. The specified random utility model estimated for this study is expressed as:

$$\begin{aligned} U_{bn} &= V_{bn} + \varepsilon_{bn}, \\ V_{bn} &= \sum_k \beta_{bk} X_{bkn} \end{aligned} \quad (1)$$

where  $n$  is an index for individuals,  $b$  is an index for the unlabeled 'DART' type (either 1 or 2, because each scenario comprises of two alternative buses);  $U_{bn}$  is the total utility of the DART gained by an individual;  $V_{bn}$  is the systematic utility component of the DART; the random error component  $\varepsilon_{bn}$  is the non-observable utility component of the DART, which is assumed to be identically and independently standard *Gumbel* distributed across alternatives and observations. It represents individual idiosyncrasies and tastes, as well as any measurement or observational errors made by the modeler. The systematic part of utility  $V_{bn}$  depends on the bus attributes considered in the study. Parameter  $\beta_{bk}$  is the random utility coefficient associated with attribute  $X_{bkn}$  of the DART;  $X_{bkn}$  represents a vector of explanatory variables specific to individual  $n$  and DART type  $b$ ;  $k$  is the  $k^{\text{th}}$  attribute of the DART.

The systematic utility function of the bus alternatives is defined as a linear combination of the DART service quality attribute variables and is expressed as follows:

$$V_{DART}^i = \beta_{TT_r} TT_{DART}^i + \beta_{FARE_r} FARE_{DART}^i + \beta_{CFT_r} CFT_{DART}^i \quad (2)$$

where:  $V_{DART}$  is the systematic utility component of the DART;  $TT_{DART}$  is the one way total travel time of DART;  $FARE_{DART}$  is the one-way total travel fare of DART;  $CFT_{DART}$  is the level of comfort of DART;  $\beta_{TT}$  is coefficient associated with travel time;  $\beta_{fare}$  is the coefficient associated with travel fare;  $\beta_{CFT}$  is the coefficient associated with comfort;  $i$  = residential TAZ; and  $r$  = the buffer ring. The systematic utility is accordingly augmented with the random error

component to get the total utility of the DART service ( $U_{DART}$ ) following equations 1.

As this was an unlabelled experiment, the intercept has not been considered when designing the models and no socio-economic variables have been introduced (Hensher et al., 2005). It was decided to work with categories of commuters (potential users) defined by radial distance from the CBD.

### **3.3.3 Spatial modelling and scenario development process**

To model the commuter preferences towards transit service quality, a geo-spatial multi-modal network was constructed using ArcGIS Spatial Analyst tool. The GIS network data layers included the DART phase 1 corridor network and feeder system, the *daladala* network and the current Dar-es-Salaam city road network. These different road network data layers were built together into a spatial multi-modal network model. With the overlay of other spatial data layers such as; residential TAZs, the CBD zones and the population data, it was possible to conduct spatial analysis. However, the multi-modal network only considers the DART phase 1 corridor and its feeder network and not all the six DART phases since the required information about the other phases is not yet available. This limitation has no effect on the results since the DART system will have similar service attributes in all six phases of the DART for the entire city (Logit, 2007). Hence, the analysis and conclusions drawn in this paper are based on the DART phase 1 corridor and its feeder system. Figure 3.2 shows the detailed methodology of integrating the behavioural models into GIS for spatial modelling of the proposed DART service quality.

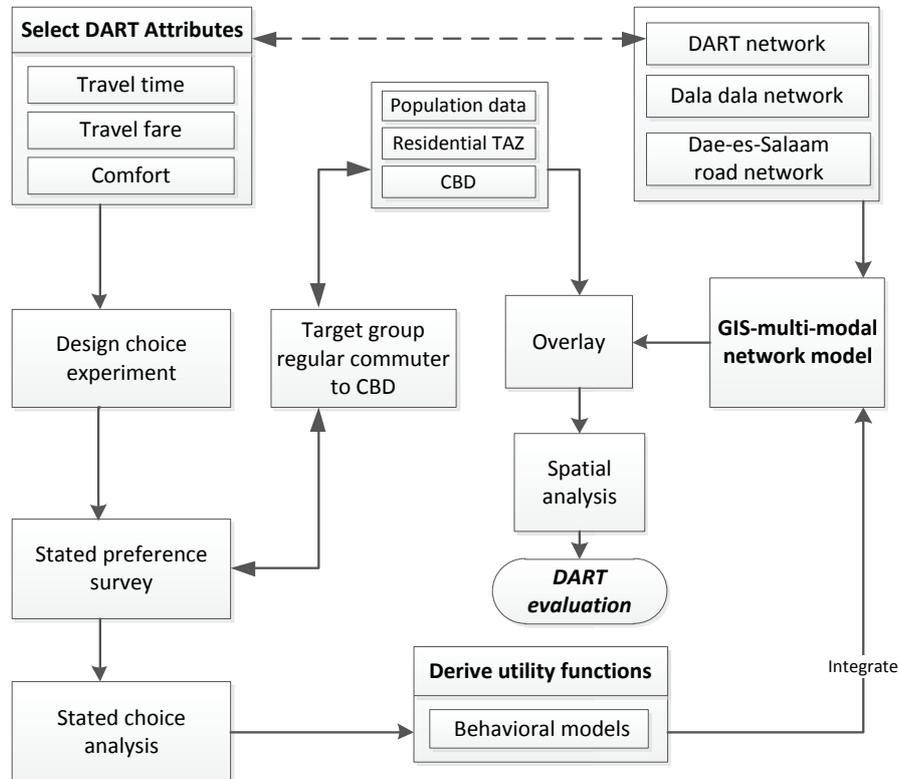


Figure 3.2: Summary of detailed modelling framework

For spatial analysis of the proposed DART service quality, it was required to develop scenarios to be able to examine the effect of the DART in reference to the existing public transport. Two scenarios: the 'DART' and 'Without DART' were developed. The 'Without DART' scenario served as a base (*daladala*) scenario during analysis. When developing this scenario, the lower limits of the attribute levels used in the stated choice experiment (see Nkurunziza et al., 2012a) served as a baseline and represented the *daladala* characterised by overcrowding, longer travel times and unregulated fares among others. During analysis, the 'DART' and 'Without DART' scenarios were represented by the DART Phase 1 corridor and *daladala* route networks respectively. Using a scenario-based approach, behavioural models from stated choice analysis (see Table 3.2) were integrated into the GIS multimodal network model for spatial analysis of the proposed DART quality of service. In order to make the analysis possible, some assumptions were made. First, it was assumed that an individual commuter behaves rationally in making choice and takes the minimum cost route. Second, the DART system will have similar service attributes for all the six DART phases for the

entire city. Third, for both the 'DART' and 'Without DART' scenarios, commuters can only get service at stops. Fourth, the DART will operate on the main trunk corridors and will not have any competition from the *daladala*. To accommodate for this, a multi-modal network was built in such a way that the *daladala* will only operate on the DART feeder routes. Based on these assumptions, it was possible to compute the minimum cost (in terms of travel time, fare and comfort in-bus) route taken by an individual commuter from a given residential zone to the CBD and to spatially estimate the total utility derived from the trip.

### **3.4 Modelling results and discussion**

The summary of descriptive statistics for the sample in Table 3.1 shows that males and females are almost equally distributed in the sample, although the percentage of males appears to be slightly higher. Most people in the sample are between 26 and 64 years of age as expected since this is a working age group and nearly 66% of the respondents are either full time or self-employed and 11.8% are students. Most of the sampled respondents had completed secondary education. About 88% of the sample commute by *daladala* and mainly travel to CBD for business (large-scale business, petty trading, business shopping) activities and for office work.

Table 3.1: Summary of the general characteristics of the respondents (N = 684)

<b>Characteristics</b>	<b>Statistics</b>
1. Gender	Male (53.7 %), Female (46.3%)
2. Age	15-25 (30.3%), 26-64 (68.1%), >64 years (1.6%)
3. Employment Status	Full time (21.2%), Part time (12.9%), Self-employed (44.7%), Student (11.8%), Other (9.4%)
4. Education Level	No education (1.3%), Primary (32.3%), Secondary school (44.9%), Higher (21.2%), Missing data (0.3 %)
5. Main travel mode	Daladala (public transport) (87.9%), Private car (8.9%), Walking (1.8%), Bicycle (0.3%), Other (1.1%)
6. Main travel purpose	Work (28.5%), School (9.5%), Business (49%), Other (12.9%), Missing data (0.1%)

From the stated choice modelling, all models shown in Table 3.2 give significant results and all the attribute variables display the correct signs: negative for travel time and travel fare and positive for comfort. The parameter on the travel time variable is negative and highly significant, reflecting a preference for shorter travel times. The parameter on the travel fare variable is negative showing an aversion to expensive travel fares. The comfort parameter has a positive sign as expected and indicates that commuters prefer travelling in comfortable environment.

Table 3.2: Models estimated for potential users based on radial distance from CBD

	<b>&lt; 5 km</b>	<b>5-10 km</b>	<b>10-15 km</b>	<b>&gt;15 km</b>
Variable	Coef.	Coef.	Coef.	Coef.
<i>Travel time</i>	-0.0272***	-0.0148***	-	-
<i>Travel fare</i>	-0.0015**	-0.0035***	-0.0343***	0.0347***
<i>Comfort</i>	1.11***	1.27***	-0.0062***	0.0041***
Initial LL	-422.13	-923.27	-188.54	-349.35
Final LL	-352.82	-799.27	-153.55	-302.46
LR test	138.618	248.012	69.975	93.774
Observations	n =610	n =1341	n =272	n =504
Rho-square	0.164	0.134	0.186	0.134

\*\*\*1% significance level.

\*\*5% significance level.

The parameter estimates shown in Table 3.2 show mainly the directionality of effect of the DART attributes. However, the relative effects of the attributes are not directly comparable because of the different ranges of the attributes. Stinson & Bhat (2003) propose a simple approach to assess the relative importance of each variable which is to compute the contribution to utility of each variable at its average value when the feature represented by the variable is present. For this case, we therefore computed the contribution to utility of each attribute at its average value when the proposed DART is present.

At this point it is of interest to see the information all together and graphically represent the contribution that each of the DART attribute variables makes to the utility function according to potential user categories based on radial distance from the CBD. Having knowledge of how potential users from different spatial locations of the city value the proposed DART service makes it easier to evaluate its effectiveness and to establish lines of action in improving the quality of service. Figure 3.3 shows graphically that the contribution each variable makes to the utility functions estimated for the different potential user categories follows a very different line in all cases. The comfort variable (with a positive sign) contributes greater weight to the utility function for all the defined potential user categories independent of radial distance from the CBD. The travel fare and travel time variables (with negative signs) contribute greater weight to the utility functions as one goes away from the CBD. These variables can be seen to contribute greater weight to utility functions for potential user categories from zones within (10-15) km and (>15) km radial distance from the CBD and making less contribution to

the utility functions for potential users from zones within (0-5) km and (5-10) km radial distance from the CBD.

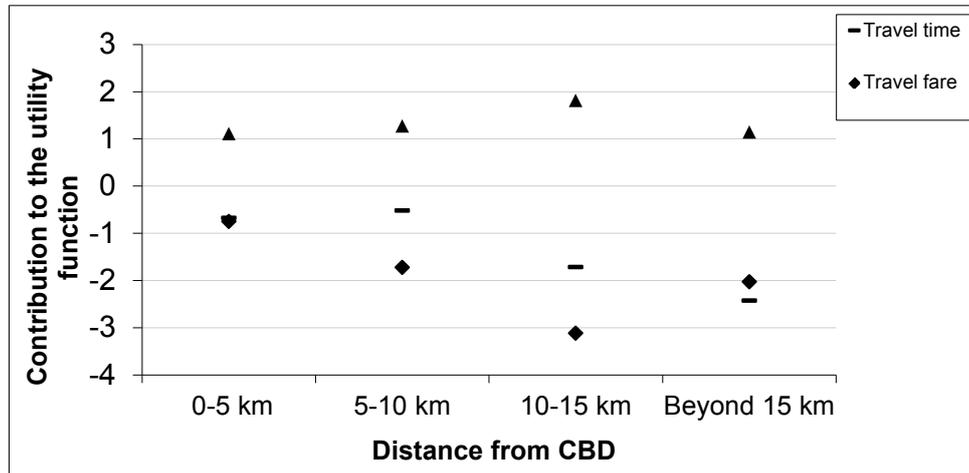


Figure 3.3: Contribution of each DART attribute variable to the utility function

Generally, comfort is the most important attribute variable since it contributes greater weight to the utility functions for all potential user categories, followed by travel fare and travel time respectively. Similar findings have been reported in Dell'Olio et al., (2011) where comfort stood out to be an important variable to define the quality desired from an efficient and safe public transport service. More specifically however, comfort is more important in zones within (0-5) km, travel fare is more important in zones within (5-10) km and (10-15) km while travel time is more important in zones beyond 15 km distance from the CBD. The result seems reasonable since in Dar-es-Salaam people living close to the CBD i.e., within 5 km radial distance from the CBD are mainly the high income business people and the well-educated who would like to travel comfortably and do worry less about travel fare and travel time. People living within (5-15) km radial distance from the CBD are mainly low income people from informal settlements. For these people it sounds reasonable to place more weight to travel fare than comfort and travel time. People from outer zones of the city i.e. beyond 15 km radial distance from the CBD place more importance to travel time than other variables since they spend more time on the way to CBD as a result of poor *daladala* service and traffic congestion.

### 3.4.1 Integrating behavioural models into the GIS multi-modal network model

At this stage, the random utility functions derived from the stated choice modelling (see Table 3.3) were input into the GIS multi-modal network as attributes. The integration of behavioural models into GIS was meant to spatially evaluate and visualise the utility attached to the DART attributes and to estimate the total utility of the DART service gained by an individual commuter from a given residential zone. When integrating behavioural models into the GIS multi-modal network, the travel time, travel fare and comfort attributes as well as the utility value of each of the attributes and the total utility functions were all attributed to the network.

Table 3.3: Derived utility functions from stated choice modelling

DART attributes	
$U_{r_1}^i{}_{DART} = -0.0272TT^i{}_{DART} - 0.00149FARE^i{}_{DART} + 1.11CFT^i{}_{DART}$ $U_{r_2}^i{}_{DART} = -0.0148TT^i{}_{DART} - 0.00353FARE^i{}_{DART} + 1.27CFT^i{}_{DART}$ $U_{r_3}^i{}_{DART} = -0.0343TT^i{}_{DART} - 0.00623FARE^i{}_{DART} + 1.81CFT^i{}_{DART}$ $U_{r_4}^i{}_{DART} = -0.0347TT^i{}_{DART} - 0.00405FARE^i{}_{DART} + 1.14CFT^i{}_{DART}$	Buffer rings $r$

Where:  $i$  = residential TAZ 1, residential TAZ 2, residential TAZ 3, ...

$r_1$  = buffer ring 1 (residential TAZ within 0-5 km radial distance from CBD)

$r_2$  = buffer ring 2 (residential TAZ within 5-10 km radial distance from CBD)

$r_3$  = buffer ring 3 (residential TAZ within 10-15 km radial distance from CBD)

$r_4$  = buffer ring 4 (residential TAZ located more than 15 km radial distance from CBD)

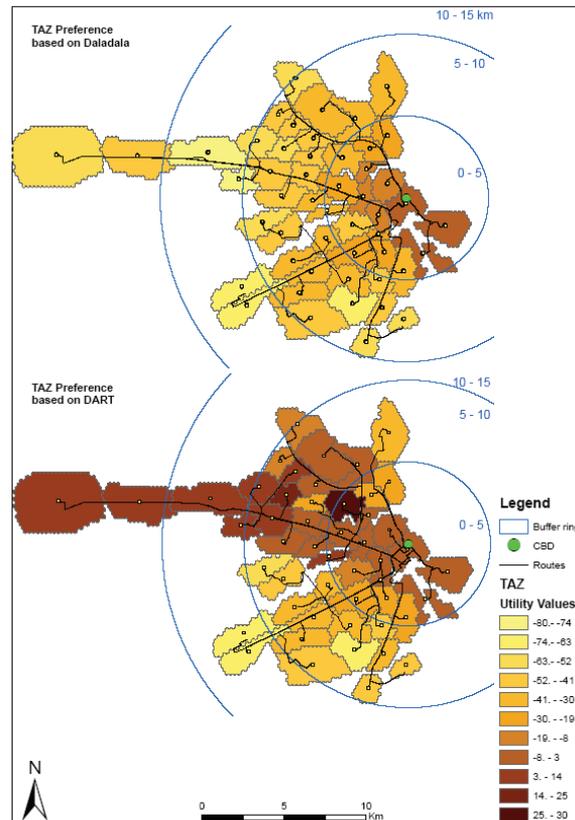


Figure 3.4: Comparison of zonal preferences based on *DART* and *Without DART 'daladala'* scenarios

Figure 3.4 shows the preference differences between different zones by comparing the *DART* and *without DART* scenarios. For purpose of interpretation, a high positive utility value means high preference indicating that the *DART* is more attractive to its potential users whereas a low negative utility value indicates low preference for the *DART* revealing less attractiveness of the *DART* service. The results generally show that zones located along the *DART* phase1 corridor and its feeder route network have considerably high utility values in the *DART* scenario compared to the same zones in the *without DART* scenario. This simply tells us that commuters reveal high preference for the proposed *DART* service compared to the current *daladala* service, implying that the *DART* is more likely to be attractive than the *daladala*. The results further reveal that outer most zones of the city are likely to be more satisfied with the *DART* service than the inner zones in the *DART* scenario. In reference to the *daladala* scenario, the *DART* is likely to improve commuting service significantly to the city peripheral zones. Despite the general improvement in transport service, the results

indicate that the DART is likely to deliver ineffective service to some zones located along the north eastern coastal line of the city especially to those within 5 km and 10 km radial distance from the CBD.

For better understanding of the proposed DART effect on people's satisfaction, a scatter plot of utility values (see Figure 3.5) based on zonal preference differences from the *DART* and *Without DART* scenarios was constructed. The diagonal line serves as a reference line to assess the change in zonal preferences. Zones represented by points located above the diagonal line indicate that the DART service is most likely to increase user satisfaction in reference to the *Without DART* scenario. Zones represented by points located along the diagonal line indicate that the DART introduction is likely to have no effect on improvement of service quality implying that the DART is most likely to offer service similar to that of *daladala* in those zones. While zones located below the diagonal line show a decline in quality of service as a result of the DART introduction. The findings reveal that 68% of the zones are likely to gain more satisfaction from the DART service, 16% are neither likely to increase nor decrease their satisfaction levels from the DART and the remaining 16% of the zones are likely to decrease their satisfaction as a result of the DART introduction. The reason for this decline in satisfaction could be longer access times to the DART feeder line stops and transfer times to the BRT trunk line especially in zones along the north eastern coastline of the city. In this case, *daladala* travel times to the CBD are shorter as in reality one can easily access its service anywhere along the network routes and also one can easily reach the CBD without making a transfer.

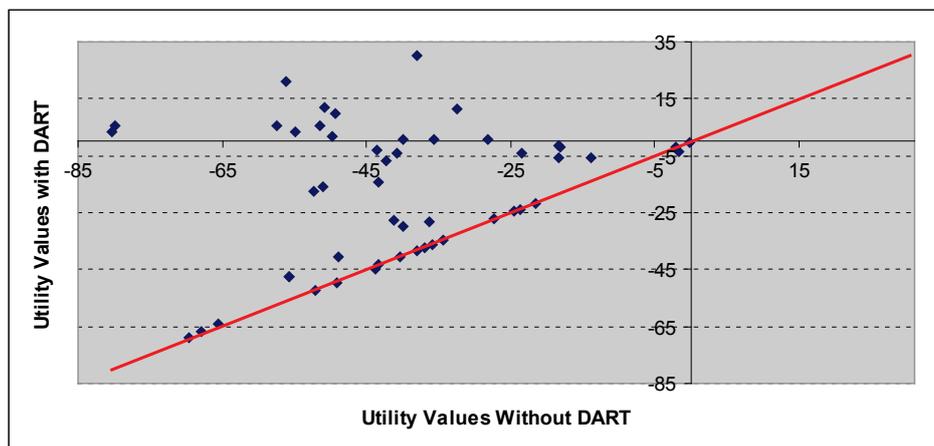


Figure 3.5: Scatter plot of zonal utility differences between the *DART* and *Without DART* scenarios

At this point, it is also important to analyse the DART effect on the potential users from different types of residential zones. The residential zones were

classified as; planned (54%), unplanned (32%) and mixed use residential (14%). The results show that planned residential zones gain relatively high utility both in the *DART* and the *without DART* scenarios (see figures 3.6 and 3.7 respectively) compared to the mixed use and unplanned residential zones. When comparing the utility values of the same zones in the *DART* (figure 3.6) and in *without DART* (figure 3.7) scenarios, it is shown that the utility values in the former is slightly skewed towards higher utility values while in the latter the utility values are slightly skewed towards lower utility values for all residential types i.e. planned, unplanned and mixed use residential. This again supports earlier results and confirms that the *DART* is likely to provide an improved and better service than *daladala*. This is revealed by the decrease in zones with lower utility values and increase in zones with high utility values in the *DART* scenario as compared to the *Without DART* scenario. Although in a different setting and context, the study findings share some similarities with studies elsewhere (Currie, 2006, Cain et al., 2009, Deng and Nelson, 2012). For example, Cain et al., (2009) conducted a study to quantify the importance of image and perception to BRT using a set of tangible and intangible factors to identify the perceived differences among BRT, LRT and Metro. The study found out that the general public had a high perception of the BRT service. Currie (2006) suggests that BRT systems show higher satisfaction than on-street bus and rail corridors based on evidence from Adelaide, Australia.

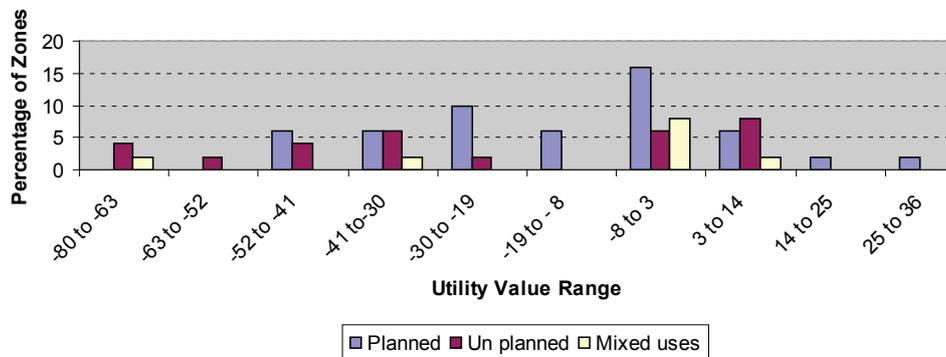


Figure 3.6: Zonal utility differences for the *DART* scenario by residential type

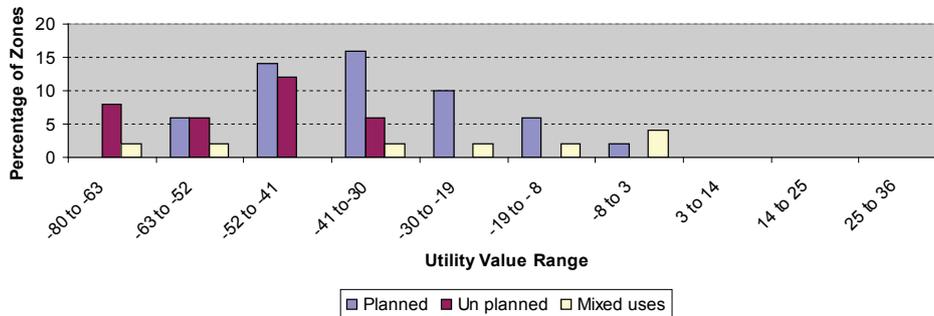


Figure 3.7: Zonal utility differences for the *Without DART* scenario by residential type

### 3.5 Conclusion

The point of view of potential passengers is fundamental for evaluating transit service quality because they are envisaged to be the real consumers of the planned services and can therefore be considered the most suitable judges. This study has provided a framework for analysing urban public transit systems and their potential for providing and improving service quality as desired by the urban population. The study applied stated choice modelling techniques to estimate the most important DART attribute variables and identified how potential users (commuters) value the proposed DART service. The study also attempted to spatially analyse the effectiveness of the DART service by answering the question: Where is the proposed DART service highly or less valued as compared to the existing public transport? The analysis was able to shed light on answers to the research question by integrating behavioural models into GIS. To our knowledge, this is a novel approach, in particular within the context of integrating random utility models into geo-spatial models. Linking the derived random utility functions from stated choice modelling to GIS made it possible to spatially analyse the potential user preferences and to identify the preference variation between zones.

The study results reveal that (in-bus) comfort is the most important variable with great contribution to the DART utility compared to travel fare and travel time variables. More specifically however, the importance of the attributes varies with respect to radial distance from CBD. Comfort is more important in zones within (0-5) km, travel fare is more important in zones within (5-10) km and (10-15) km while travel time is more important in zones beyond 15 km distance from the CBD. The results generally show that the DART is more preferred to the existing *daladala* service. Zones located along the DART main trunk corridor and in the city periphery have indicated higher preferences, suggesting high satisfaction with the DART service. Despite the general high preference for DART service, the DART is likely to have no effect on some zones and in some cases it is likely to decrease service quality. The

study findings revealed that 68% of the residential zones have higher preferences in favour of the DART. 16% of the zones reported neither increase nor decrease of preferences for the DART compared to *daladala*, while the remaining 16% have reported decrease in preferences in favour of *daladala* service.

For transport planners, the study findings suggest that only through providing a commuting service characterised by better comfort, lower travel times and lower travel fares will the DART be attractive to its potential users. Planners should pay more attention and consider all the three attributes important when providing the DART service. However, in priority cases, particular attention should be given to (in-bus) comfort, which proved to be the most important variable in terms of its contribution to the DART utility. To improve the proposed DART service quality, DART feeder route networks should be planned and extended in a more cost effective manner by emphasising on zones with low satisfaction (utility) levels and those with limited access routes to DART. Residential zones with planned DART feeder route networks but indicating low satisfaction indicate a need to check on improvement of location of the DART feeder stops and transfer points. For transit operators, knowledge about the desired service quality provides operating companies with an answer to their investment questions and establishes the basis for designing future policies to encourage greater use of public transit based on the needs and expectations of their potential customers. Knowing variables that are most important to potential users is useful information for the proposed DART service planning as they provide guidelines to follow when required to improve the service. Once the operators know the variables that potential users value most they can define and direct more efficient lines of investment to those specific points.

## Chapter 4

### Identifying potential cycling market segments in Dar-es-Salaam, Tanzania<sup>7</sup>

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<sup>7</sup> This chapter is based on Nkurunziza, A., Zuidgeest, M.H.P. and van Maarseveen, M.F.A.M. (2012) Identifying potential cycling market segments in Dar-es-Salaam, Tanzania. In: *Habitat International: A Journal for the Study of Human Settlements*, 36 (2012)1 pp. 78-84

## Abstract

Most travel behaviour studies that seek to promote cycling define market segments based on socio-demographics, travel mode use or attitudes. They do not address the stages of change process in travel behaviour, whereas this information can be instrumental in influencing travel behaviour change. This paper adopts the stages of change model to identify potential cycling market segments and to analyse and profile each of the market segments based on socio-economic factors, current travel behaviour, attitudes, perceptions and motivations. A survey was conducted among 620 individual regular commuters in the city of Dar-es-Salaam. On the basis of cycling behaviour attitudinal-variable statements, as developed from the stages of change model, the survey data were classified in six different segments: pre-contemplation, contemplation, prepared for action, action, maintenance and relapse. The study revealed that the different segments have different needs and are motivated by different factors suggesting that they need to be treated in different ways. These market segments can have important implications for designing cycling policies and promotional strategies that best serve the needs of each segment. The results indicate that urban policies and marketing strategies which aim to promote bicycle use may first target the contemplation, prepared for action and action segments that are most motivated to change and willing to cycle.

## 4.1 Introduction

The gap between transportation needs and the means to satisfy them is widening in Dar-es-Salaam, the largest city in Tanzania. The current transport system has difficulty in coping with the demographic and spatial growth of the city and in meeting the basic needs of the inhabitants, particularly the poor (Olvera et al., 2003). Unplanned settlements with poor access make up an increasingly large percentage of Dar-es-Salaam as a result of population growth and inflow of migrant population. In a context of economic polarisation and widening social gaps, the major deficiency that affects both urbanisation and the transportation system is reinforcing patterns of urban segregation where existing transportation infrastructure and services are only partially able to remove important physical barriers (Zhao, 2010). This results in numerous obstacles that complicate access to services, limit the use of urban space, and place considerable pressure on household budgets (Olvera et al., 2008, Bryceson et al., 2003). Poor households have to limit their trips to the most essential activities and in such circumstances, priority for funding of daily travel usually goes to those household members who actually help to support it and to those who may do so in the near future, such as students (Olvera et al., 2008). Financing of travel tends to add significantly to household's economic difficulties, while transport-related difficulties can cancel out anticipated progress in other fields of socio-economic development (Gannon and Liu, 1997, Lumsdon and Tolley, 2001). From this perspective, it is essential to make daily travel easier and cheaper for the urban population through the use of bicycles (Dimitriou, 2006).

Bicycles are sustainable, relatively in-expensive and affordable compared to other travel modes (Gatersleben and Haddad, 2010). For example, in Dar-es-Salaam, an ordinary bicycle costs at least Tshs<sup>8</sup> 60,000-80,000, approximately US\$ 50. Moreover, the potential contribution of bicycles in African cities are threefold: first, it may provide better access to activities and facilities that society considers vital for survival such as medical services, education, employment, shopping, basic commercial and social activities (Bryceson et al., 2003). Second, cycling may enhance creation of more employment opportunities, which is vital in maintaining incomes for the most vulnerable urban population (DFID, 2002, Howe and Bryceson, 2000). Third, cycling may enhance the maintenance of social networks and community-based solidarities. Despite its well-known advantages and significance for facilitating mobility (Davies et al., 2001, Dickinson et al., 2003), cycling remains unrecognised as an alternative daily travel mode and does not represent an attractive alternative for the majority population (Pochet and

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<sup>8</sup> One Tanzanian Shilling (Tshs) = US\$ 0.00067 (May 2011).

Cusset, 1999). This suggests that much work is needed to promote and improve the image of cycling.

Although Dar-es-Salaam has initiated programs to increase the availability and use of low cost mobility and its accompanying infrastructure, these interventions have been very limited, and may have contributed to the modest increase in cycling modal share from 3% in 2002 to 5% in 2007 (JICA, 2008, I-CE, 2007). There is lack of more information and detailed knowledge in identifying who are the people with high switching potential and how they may be influenced to change travel behaviour. This suggests the need for segmentation taking into account travel attitudes and behaviour. The segmentation approach may reveal opportunities for designing cycling policies and promotional strategies that best serve the needs of each segment. Therefore, the objective of this study is to identify and profile potential bicycle travel market segments and analyse how these market segments compare to empirical observations on current travel behaviour, socio-economic status, attitudes, perceptions and motivations towards cycling.

The paper is organised as follows. First, we discuss earlier research on market segmentation and travel behaviour change. Second, we describe the survey methodology employed. Third, results from the survey and segmentation analysis are discussed. Fourth, some insights on how market segment information can be used for cycling promotion are given. The paper ends with some conclusions.

## **4.2 Market segmentation and travel behaviour change**

The importance of market segmentation when investigating travel behaviour is well documented (Badoe and Miller, 1998, Shiftan et al., 2008) and analysing travel demand by market segment has become common practice (Teichert et al., 2008). From both marketing and research perspectives, segmentation is the act of defining meaningful sub-groups of individuals or objects (Wedel and Kamakura, 1998). At its core, it is about reducing the number of entities being dealt with into a manageable number of groups that are mutually exclusive and share well-defined characteristics. Once groups are identified, it is possible to make predictions about their responses to various situations, such as marketing strategies and types of policy (Anable, 2005).

The market segments used in transportation planning are often based on general socio-economic characteristics such as income, gender, automobile ownership or travel mode use (Jensen, 1999). However, it seems that few

differences exist when only segmentation on the basis of socio-demographics or travel mode use is considered (Beirão and Cabral, 2007). Moreover, such segments are not necessarily homogeneous in terms of motivation and attitudes, which are increasingly transcending social and demographic lines (Anable, 2005, Bergström and Magnusson, 2003). Recently there has been a growing interest in segmentation by attitude (Anable, 2005, Golob, 2001, Shiftan et al., 2008). These studies showed that attitude-based market segments are very useful in identifying potential 'mode switchers'. However, the available segmentation methods are criticised for usually being cross-sectional and not modelling processes of behaviour change (Davies et al., 1997). They tell us little about how people will undergo change in travel behaviour over time. A systematic segmentation approach to identify where people are positioned in the stages of travel behaviour change and to define who would most likely change travel behaviour is still lacking in empirical research (Anable et al., 2006, Jones, 2003).

Within the public health and psychology disciplines, Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) developed the stages of change model that deals with intentional changes in behaviour. The stages of change model combines motivational factors and behavioural processes and is based on the assumption that the behaviour under investigation is in principle within a person's ability (Prochaska and DiClemente, 1983). The basic elements of the model are both motivational (dealing with intention building, decision making and attitudinal readiness) and behavioural (the adoption process from stages of increased motivation, through tentative performance to regular practice of the behaviour). In this process, five distinct successive stages (see Table 4.1) are discernible: the first two, *Pre-contemplation* (no intention to change) and *Contemplation* (growing intention), are motivational stages without actual performance of the behaviour; the next two, *Prepared for action* (strong intention and possible irregular or tentative performance of the behaviour) and *Action* (recent initiation of regular behaviour), bring a crucial shift into behavioural manifestation. The final stage, *Maintenance*, represents the establishment of permanent behaviour. The model suggests that behaviour change processes occur in successive stages and that movement through these stages is neither unitary nor linear but rather, cyclical, involving a pattern of adoption, maintenance, stagnation, relapse, and re-adoption over time (Prochaska and Diclemente, 1984, Prochaska and Velicer, 1997).

Table 4.1: Stages of change in Prochaska and Diclemente's (1984) Transactional Model

<b>Stage</b>	<b>Characteristics</b>	<b>Change strategy</b>
Pre-Contemplation	Unaware of problems, no intention to change	Increase general problem awareness
Contemplation	Aware of problems, thinking about change	Motivate, encourage specific action
Prepared for Action	Intention to change in the next six months	Assist in developing specific plans
Action	Action being taken	Feedback, social support, reinforcement
Maintenance	Has maintained action for six months or more	Reminders, feedback, social support

The stages of change model, although recently has been under debate (Brug et al., 2004) is applied to research on health enhancing physical activities for example; (Marttila et al., 1998). Many studies have adopted, or slightly modified the operationalization of the stages of change model for example; Marcus & Simkin (1993) generalised the model to exercise behaviour. Others have employed different number of stages (Miilunpalo et al., 2000) or devised separate questions for intentions and for past and current behaviour (Ngyen et al., 1997). Some have applied the stages of change model to studies of travel behaviour in identifying malleable groups for travel behaviour change strategies (Gatersleben and Appleton, 2007, Rose and Marfurt, 2005). These studies determined where people in the target audience are in the stages of change process in cycling behaviour.

However, relatively little research has gone into cycling behaviour, especially, there have been very few attempts to identify cycling market segments based on travel behaviour dynamics. The differences between categories of cycling as travel behaviour are not commonly considered in empirical research, and this information is crucial for effective cycling promotion. There is an information need to better understand how people evolve in response to normative and contextual developments related to travel behaviour especially for cycling in a developing city context. The aim of this paper is therefore to identify and characterise potential cycling market segments using the stages of change model and to show the application of this approach to a city that has little and limited cycling experience.

## **4.3 Methodology**

### **4.3.1 Data collection procedure**

In March 2009, we collected data through a questionnaire-based survey among individual daily commuters in the city of Dar-es-Salaam. The objective of the data collection survey is to sample an adequate number of people in each of the stages of change to be able to identify market segments and to

derive characteristics of the people in each segment. The survey was conducted in pre-defined residential zones located along four major trunk roads in the city i.e. Morogoro, Bagamoyo, Nyerere and Kilwa Road. The choice of the zones was based on experience from previous studies conducted by the authors (Nkurunziza et al., 2012b, Nkurunziza et al., 2012a), as well as inputs from group discussions held with local experts from DART agency, Ardhi university, the university of Dar-es-Salaam and Dar-es-Salaam city council. The definition of the zones followed three criteria:

1. Zones where the bus rapid transit and bicycle lanes are proposed;
2. Zones that are heavily populated and with high trip generation levels based on earlier travel demand studies;
3. Zones that have some commuting cyclists.

We aimed to study only commuter respondents who travel regularly to main daily activities<sup>9</sup>. It was felt that commuters would therefore be a suitable group to approach for questions on transport related issues. Given that bicycle commuting is very low in Dar-es-Salaam, and based on the purpose of the study, which is to identify potential cycling market segments, specific attention was paid to daily commuting population. It was also assumed that this target group has the potential of affording bicycles. The experience drawn from many scientific cycling studies shows that most cycling trips are up to 15 km (Heinen et al., 2011, Ikono et al., 2008). It is shown that distance beyond that threshold makes cycling less attractive and discourages travellers from cycling. Moreover, Prochaska and DiClemente (1983, 1984) stages of change model assumes that the behaviour that is under investigation should be potentially achievable for everyone. Therefore, based on the above empirical evidence and theoretical assumption, it was appropriate to purposively sample only those commuters whose daily journeys are within 15 km distance to key service or activity locations.

The results in this paper are based on records from a questionnaire survey that involved four types of questions. The first part collected some information about socio-demographic questions. The second part asked respondents about their travel habits for daily activities. The third part and main part of the survey inquired about cycling attitudes and perceptions which were used to identify respondent's position on cycling behaviour. This part also comprised of attitudinal-variable statements which were constructed by adopting the Prochaska et al. (1983, Prochaska and DiClemente, 1984) stages of change model to characterise and classify the data samples into segments. In separate questions, the respondents were asked to the state

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<sup>9</sup> Main daily activities in this study are defined as government/private office work; personal commercial business; and school.

stage of cycling behaviour change in which they belong to (see Table 4.2). The fourth part collected information related to socio-economic questions where the respondents were asked to report their income levels and property ownership. These questions are sensitive to answer in a survey, thus we preferred to place them at the end of the questionnaire.

The respondents were approached by conducting face-to-face personal interviews where the respondent immediately answers questions posed from the questionnaire by the interviewer. This approach is useful in minimising time and response errors as the respondents are guided in answering the questionnaire. Given the length and complex nature of the questionnaire with both quantitative and qualitative attitudinal variables, it was required to use personal interviews to clarify any questions when needed. Five graduate students from local universities were recruited as survey assistants and trained to conduct the survey. A mini-pilot survey was conducted to modify the questionnaire and to ensure better understanding of interviewing procedures.

The field survey lasted for one month and a total of 620 respondents were interviewed resulting in 598 well completed questionnaires, a response rate of 96%. This high response rate among respondents is attributed to the interviewing technique employed and the mini-pilot survey done prior the main survey data collection. The survey was conducted during working days to meet the target respondents. However, earlier studies have shown that survey responses given in a situation with lack of peace of mind will always be less promising and unreliable (Rastogi and Rao, 2002). The survey interviews were therefore, conducted in the evenings i.e., between 14.00 hours and 19.00 hours to meet commuters back home as the official working time end at 15.00 hours. This was to ensure peace of mind when answering the questionnaire which would rather have been difficult at the work place or at bus stops during rush hours. The questionnaire took around 20 minutes to complete. All respondents participated voluntarily and no incentives were given. Because of the focus on commuters, the respondents interviewed were aged 15 years and above. People under 15 have no authority and ability to drive and cannot respond the survey questions independently. The questionnaire was presented as an individual travel survey for daily commuters, without the specific focus on bicycle use being stated to avoid any bias or strategic responses.

### **4.3.2 Analysis**

For the purpose of this study, we first categorise the survey samples into homogeneous segments. Then we characterise each of the segments based on their differences in travel behaviour, socio-economic/demographic factors,

attitudes and perceptions. For the segmentation analysis, we applied the stages of change model using qualitative attitudinal-variable statements related to cycling behaviour (see Table 4.2). The stages of change model-based variable statements were constructed following review of earlier uses of the model in studies of cycling behaviour and physical activity. From the survey, it was revealed that there exist a group of people who fall into the 'relapse stage' of behaviour change. This stage captures and takes care of cycling attitudes and perceptions of people who used to cycle in the past but no longer do so currently. Descriptive chi-square ( $\chi^2$ ) statistics were used to test and confirm that the distributions of the attribute variables were associated with the market segments.

It must be stressed, however, that the limited sample size does not permit us to draw conclusions regarding the quantitative importance of the results. The choice of the survey zones was aimed to target the right commuters. Since this study was partly qualitative, we required a small number of respondents to explore the topic in depth and we expected to identify people in different stages of change of cycling behaviour from a sample of 600 respondents. While it is not the aim of this study to generalise the results to the entire city and suggest particular policy interventions, the results may be used to explore strategies likely to be effective for each market segment when planning cycling promotional activities.

Table 4.2: Statements for stages of change in cycling behaviour

<b>Statement shown to respondents</b>	<b>Corresponding stage of behaviour change</b>
I never really think about and not even consider cycling to my daily activity	Pre-Contemplation (PC)
I never used a bicycle but sometimes think about cycling to my daily activity	Contemplation (C)
I rarely or sometimes cycle and seriously consider riding to my daily activity	Prepared for Action (PA)
I have fairly often cycled to my daily activity	Action (A)
I cycle regularly to my daily activity	Maintenance (M)
I no longer cycle to my daily activities	Relapse (R)

## **4.4 Results and discussion**

### **4.4.1 Identifying potential cycling market segments**

Table 4.3 shows how respondents were classified into six stages of change segments. There was unequal gender distribution in the sampled population; female (25%) and male (75%). This is perhaps not surprising due to the

recruitment strategy which targeted only commuters and since most female in Dar-es-salaam stay at home and not engaged in daily commuting activities. Even a few who commute regularly were afraid of providing information without permission of their partners. Most of the commuter respondents were aged between 25 and 35 and had a mean age of 30 (SD = 10.7). Respondents were mainly commuting for private commercial business, government/private office work and school. Private commercial business was having big dominance over other travel purposes in the sample. This is not surprising since most people in Dar-es-Salaam earn their daily living from informal small businesses done alongside their formal work that generates monthly income. In the study, private commercial business was defined by formal and informal commercial activities.

More than half of the sample used public transport as its main mode of transport, 20% used bicycles, 8% used private car and 7% walked. Important to note, however, is that the action segment had more people with modal choice where cycling is mainly alternated with public transport. Travel distance is not likely to appear a barrier for cycling since only respondents within 15 km distance to daily activities were selected. On average, few samples were classified in the action and contemplation compared to other segments. This is as expected since by definition people only stay for a relatively short time in these transition stages. There was a general agreement in perception among the various segments unlike the pre-contemplation that cycling generates good health through physical fitness as a benefit. Generally, enforcement of road safety rules was the frequently cited perceived motivational factor among the segments implying that safety concerns could be the common cycling barrier.

Table 4.3: Distribution of the classified survey samples by stages of change segments

<b>Stage of change segment</b>	<b>Percentage distribution of samples by segment</b>	
	<b>N = 598</b>	<b>%</b>
Pre-contemplation	79	13
Contemplation	40	7
Prepared for action	51	9
Action	34	6
Maintenance	107	18
Relapse	287	47

#### **4.4.2 Characteristics of the market segments**

This section presents the main characteristics of the various market segments. From the stages of change model, it is possible to identify who

cycles and who does not. Based on this information we can establish the differences in socio-demographic/economic, travel behaviour, cycling attitudes and perceptions which can be used to provide a complete profile of each market segment. The result of this analysis provides the following profiles of each segment:

*Pre-contemplation:* this is a segment with a negative attitude towards cycling. This segment is most likely to have more female than male and has a high concentration of female population who never contemplate cycling. It is most likely to be highly educated with mainly university graduates. Its population is predominantly government and private office workers with monthly median income of around Tshs 300,000 (US\$ 201), which is higher than other segments. The segment mainly drives private car and uses public transport to main daily activities. It is likely to perceive that public transport is much faster than cycling for daily commuting. This segment expressed no interest in cycling and viewed cycling as: less safe, comfortable and convenient; not having any benefit at all and related to low status. These cycling deterrent factors were more often cited: distances are quite far to cycle; sweating; cyclists insult other road users and should be prohibited. These perceptions suggest that this segment is less or not likely to cycle at all.

*Contemplation:* this is a segment with high positive attitude towards cycling. It is mainly dominated by secondary school students and is most likely to have more women than men. This segment has a high percentage of female contemplating cycling. Most of its population uses public transport to daily activities. Its monthly median income is around Tshs 90,000 (US\$ 60) and the lowest among other segments. The segment highly perceives that cycling is faster than public transport when commuting to daily activities. Cycling is perceived as being direct, flexible and faster than other modes for short travels and is not affected by traffic congestion. This segment is more likely to cite physical fitness and money savings as the main cycling benefits. Although this segment seems positive to bicycle use, the following reasons were cited for not cycling: cultural barriers where cycling is considered to be for men and looks unusual for women to cycle; fear of injury and safe places to ride; lack of riding experience and no bicycle available to use.

*Prepared for action:* this is a segment with positive attitude towards cycling. No gender issue appearing in this segment; male and female are relative equally distributed. This segment is likely not to own any vehicle and public transport is the dominant travel mode. The travel purpose of the segment is mainly private commercial business and school. Its monthly median income is around Tshs 120,000 (US\$ 80). This segment is most likely to perceive cycling being much faster than public transport based on its flexibility and

directness. For this segment, cycling allows for money savings that would otherwise be spent on transport and generates physical fitness as benefits.

*Action:* this is a segment with low (primary school) education and relatively smaller than other segments. This segment is more likely to be dominated by male than female and more than 80% of its population do private commercial business as daily activity. Its monthly median income is around Tshs 150,000 (US\$ 100). Most people in this segment own bicycles and are more likely to have modal choice i.e., alternating cycling with public transport for daily commuting. This segment is likely to cite cycling benefits as: relatively affordable; no transport fee and generates good health through physical fitness.

*Maintenance:* this is a segment that only accommodates regular bicycle commuters. This segment is most likely to have only male and hardly any female cycling regularly. Its daily activity is dominantly private commercial business and a little bit school. This segment is mainly characterised with low and medium (primary/secondary) education level. Its monthly median income is around Tshs 120,000 (US\$ 80). This segment as expected highly perceives that cycling is much faster than public transport for daily commute travels. It was more likely to describe the benefits of cycling as: income savings, income generation, good for physical fitness, and not affected by traffic congestion due to its flexibility and directness.

*Relapse:* this is rather a heterogeneous segment with mainly medium and high (secondary/university) level of education. The segment is more likely to be occupied by both male and female, with male population relatively higher. The main travel purpose for this segment is most likely to be private commercial business, office work and school. Its monthly median income is around Tshs 150,000 (US\$ 100). More than 70% of its population do not own any vehicle; 11 % own private cars and nearly 8.5% own bicycles. This segment is less likely to cycle and in most cases uses public transport, and a few of its population drives car or motorcycle to daily activities. Although, around 20% of the segment population view cycling as not having any benefit at all, most people in the segment perceives that cycling is much faster than public transport for daily commuting. Cycling for this segment generates benefits such as income savings and provides good health through physical fitness.

#### **4.4.3 Promotional implications**

This section discusses how the different market segments may be motivated to cycle. The cycling motivational information is useful to characterise and provide a complete profile of each market segment. Table 4.4 shows main

perceived motivational factors ranked by percentage share of the samples in each of the stages of change segments. This ranking was based on the percentage share of respondents for each motivational factor by market segment.

Table 4.4: Main perceived motivational factors for cycling by segment ranked by percentage share

<b>Stage of change segment</b>	<b>Perceived motivational factors</b>
Pre-contemplation	Separate bicycle paths (52%) Cycling training and education on traffic rules (15%) Public awareness on cycling (10%) Other factors (23%)
Contemplation	Special bicycle infrastructure (45%) Cycling training and education centres (20%) Reduction of bicycle prices (13%) Enforcement of road safety rules (10%) Other factors (12%)
Prepared for action	Access to bicycle loans (57%) Enforcement of road safety rules (20%) Reduction of bicycle prices (15%) Free bicycles (8%)
Action	Reduction of bicycle prices (65%) Enforcement of road safety rules (20%) Traffic laws and road safety rules should be designed in favour of cyclists (10%) Other factors (5%)
Maintenance	Reduction of bicycle prices (57%) Educating car drivers to change their attitude towards cyclists (35%) Other factors (8%)
Relapse	Special bicycle infrastructure (60%) Enforcement of road safety rules (25%) Shorter travel distances (11%) Other factors (4%)

Generally, people who had never contemplated cycling express negative attitude towards cycling. Many of those who have never contemplated cycling think a bicycle has no benefit at all. According to Prochaska's model (1983, Prochaska and Diclemente, 1984) these people can be brought closer to contemplate cycling by encouraging re-evaluation of their current travel behaviour, self-exploration and increasing their general problem awareness.

The findings show that the *pre-contemplation* segment may be motivated to cycle when separate bicycle paths are provided and when cycling training and education on traffic rules along with public awareness on bicycle use are initiated. In order to promote cycling to this target group, it may be useful for policy makers to consider those cited factors especially if they are to attract more women. However, these people may be hard to reach and in case of limited resources, this segment may be given little attention as promotional initiatives targeted to it may be less successful.

The *contemplation* segment is likely to be easily reached and promotional strategies targeted to this segment are more likely to be successful. Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) suggest that these people need to be motivated and encouraged to develop specific action plans. For example, Gatersleben and Appeleton (2007) suggest that in an environment with few bicycle lanes these people may, for instance, need assistance in determining and testing a good cycle route. However, in a context where there are no cycling facilities existing yet, the study shows that these people may be supported and motivated to cycle in future by introducing especially bicycle infrastructure while also providing bicycle riding training centres together with reducing the cost of bicycles and enforcement of road safety rules.

For the *preparedness for action* segment, people would start cycling when bicycles are available to them and would be motivated to cycle by providing free bicycles and access to bicycle loans. Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) suggests helping these people developing specific action plans to help them juggle their new travel behaviour and eventually establish a new travel habit. This involves identifying and assisting in problem solving, removing cycling obstacles and encouraging taking small initial steps. Moreover, this does not require only individual change but also government support to reduce the price of bicycles and provide easy access to bicycle loans. For example, removing bicycle taxes may lead more of these people to afford bicycles.

The *action* segment is most likely to be alternating cycling with public transport for daily commuting. Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) suggests that these people may be persuaded to cycle more often by means of combating feelings of loss and reiterate long-term benefits as well as providing positive feedback, social support and reinforcement. It is found that these people would be motivated to cycle more regularly when bicycle prices are reduced and when traffic and road safety rules are enforced. Importantly however, this segment stressed that traffic laws and road safety rules should be designed in favour of bicycle users. In addition, feedback information such as fitness improvements, daily

travel cost savings and income generation may increase the number of cycling trips.

People in the *maintenance* segment cycle regularly to their daily activities despite the inexistence of cycling facilities. The reasons being that cycling is flexible and allows to reach activities faster since it is not affected by traffic congestion; cycling helps to save income that would otherwise be spent on daily travel costs when using public transport and improves health through physical exercises. Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) suggests that this segment may be more encouraged to cycle by means of positive feedback, providing reminders and social support. The study reveals that these people may be motivated to cycle more by reducing bicycle prices and educating car drivers to change their attitudes towards bicycle users.

The *relapse* segment used to cycle in the past but no longer cycles currently and seems to be heterogeneous in nature. Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984) suggests that these people may be encouraged and supported to evaluate triggers for relapse, re-assess motivation and barriers and plan stronger coping strategies. Although the segment is likely to be positive on bicycle use, the following reasons were cited for not cycling: high risk of getting car accident, sweat and tiredness, and long distance from home to daily work place. However, it is indicated that this segment is likely to be motivated to resume cycling when special bicycle infrastructure is introduced. On the other hand, provision of special bicycle infrastructure alone will not guarantee that more people will cycle (Gatersleben and Appleton, 2007). Other motivation factors such as enforcement of road safety rules and shorter travel distances cited in the study may bring these people back to cycling, although travel distance considered in this study lies within the acceptable cycling threshold i.e., (15km). According to Davies et al (2001) past behaviour is a good indicator of future behaviour. Persuading those people who already cycled before may be easier than those who have never contemplated cycling.

## **4.5 Conclusion**

This study has demonstrated the utility of the stages of change model in providing a way of extracting naturally occurring and relatively homogeneous travel market segments. To better understand how people would change their travel behaviour, the stages of change model may be required that breaks away from the traditional socio-demographic or mode use segmentation approaches. The stage of change model approach was able to identify six potential cycling market segments. However, the relapse segment seems to be heterogeneous and still needs further investigation.

Our analysis revealed that neither cyclist segments nor non-cyclist segments in the stages of change process are the same, which has important implications for targeting cycling policies and promotional strategies. Policies that aim to influence bicycle use should target market segments (contemplation, prepared for action, action, maintenance and relapse) that are most willing to change since marketing campaigns directed to those segments may probably be successful. The analysis clearly indicates that different strategies addressing different segments may be adopted in order to optimise the chance of influencing travel behaviour change in the short and long term. Long term changes may require general campaigns and provision of bicycle facilities whereas in the short term, cycling may be increased by helping those who are prepared to take action and those in action to cycle more often by reducing the cost of bicycles and enforcing road safety rules.

According to Prochaska and Diclemente (1983, Prochaska and Diclemente, 1984), behaviour change is a slow process which requires constant attention. Even those motivated to cycle need help to get started and especially to continue cycling. The experience of using bicycles must be positive for people to continue cycling and especially for attracting potential switchers. This is particularly true in the context of cities like Dar-es-Salaam where cycling may significantly reduce numerous obstacles such as complicated access to services, congestion and considerable pressure on household budgets amongst others, while improving mobility, livelihood and quality of urban life especially for the majority urban poor.

The analysis and results presented in this paper should be seen as initial explorations in identifying potential cycling market segments based on the stages of change model. Although we acknowledge some selection bias in our study, the results rather indicate that people can be in different stages of change in cycling behaviour and can shed light on who are the 'easy-to-reach' (and 'hard-to-reach') markets. While it is not the aim of this study to make quantitative generalisations of the results and to suggest particular policy interventions for changing travel behaviour, the findings may be used to explore strategies more likely to be effective for each market segment when planning cycling promotional activities.

## **Chapter 5**

### **Promoting bicycle commuting in Dar-es-Salaam: Understanding the potential customer<sup>10</sup>**

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<sup>10</sup> This chapter is under review by: International Journal of sustainable Transportation

## Abstract

This paper investigates various factors influencing one's individual stage of change of cycling behaviour and the role these factors play in explaining bicycle commuting. The study tries to identify how bicycle commuting decisions are influenced by socio-demographic and travel pattern-related factors with an emphasis on the behavioural differences between the different stages of change of cycling behaviour. The analysis is based on multivariate statistical analysis of survey data of individual commuter respondents from the city of Dar-es-Salaam in Tanzania. The study shows that bicycle commuting in Dar-es-Salaam decreases with one's increase in monthly income, having a higher level of education, being a female and having a motorised vehicle at home when examining the different stages of change of cycling behaviour in reference to the pre-contemplation stage. Travelling for private businesses and school commuting has a great positive impact on bicycle commuting in particular for the *maintenance* stage of change of cycling behaviour. Differences between stages of change of cycling behaviour are also attributed to a combination of factors such as individual monthly income, travel distance and frequency of travel to daily activities. The analysis can help planners to develop more focused policies or strategies that best serve the needs of different markets to promote bicycle commuting. The results are consistent with existing research literature with new emphasis on the importance of stages of change of cycling behaviour.

## **5.1 Introduction**

Concerns over traffic congestion, climate change and harmful consequences of private car use have led to efforts of encouraging cycling as a mainstream mode of urban transport all over the world. Cycling for transport makes a key contribution to economic prosperity and has a range of benefits over other transport modes. For example, cycling is a cheap and a low-polluting alternative to motorised transport that reduces traffic congestion and makes efficient use of limited road way capacity. Cycling improves individual health and plays a key role in public health as a source of physical activity especially in this time when levels of obesity are reaching epidemic proportions (Handy et al., 2010). For individuals who do not have motorised transport options available, which is the case in most of Africa's cities, cycling can be an effective means for reaching the necessary urban services and facilities that are too far to walk, or in areas which are not well served by public transport. Moreover, in urban areas, cycling can sometimes prove to be faster than other transport modes and also allows commuter cyclists to avoid traffic jams (Heinen et al., 2010). While these individual and societal benefits of cycling are well documented, only a small section of the urban population in many world cities commutes by bicycle. Even in western European cities including those in the Netherlands with possibly the best bicycle-friendly infrastructure, where bicycle commuting rates are high and the image of cycling is generally positive, still many people choose not to cycle in situations when cycling would be a highly appropriate mode of transport (Heinen et al., 2010). Moreover, the situation is even more critical in the case of African large cities where cycling has remained unrecognized (Pochet and Cusset, 1999, Olvera et al., 2003).

Whereas one of the major challenges facing most large cities in Africa remains provision of reliable, affordable and efficient urban transport, cycling has long been regarded a rural and an urban fringe mode of travel and not considered a transport option for many of the urban population (Nkurunziza et al., 2012d, Salon and Aligula, 2012, Pochet and Cusset, 1999). The city of Dar-es-Salaam in particular is experiencing a major mobility problem as the current urban transport system does not meet the basic travel needs of the urban society. At the same time, the city roads are highly congested and the social and environmental externalities of the urban transport system are huge. The fact that Dar-es-Salaam is the largest and a rapidly growing city in Tanzania, with a large section of its residents living in poverty makes the urban transport challenge significantly larger (World Bank, 2002, Nkurunziza et al., 2012c). In such context, cycling would potentially be a useful transport option to address some of the urban mobility problems while contributing significantly to reducing urban household's economic difficulties (Bryceson et al., 2003, Olvera et al., 2008, Nkurunziza et al., 2012d).

On a positive note cycling is gaining more recognition in many cities around the world, including the developing world, where a wide range of infrastructure, programs and policies to encourage more cycling are implemented (Buehler and Pucher, 2012, Heinen et al., 2010, Pucher et al., 2010, Rietveld and Daniel, 2004, Tiwari and Jain, 2012). Even in large African cities where cycling is less recognised and modest, it is increasingly becoming accepted among urban planners, transport specialists and city authorities that cycling policies should be developed and integrated into urban transport master plans. For example, in some East African cities including Dar-es-Salaam, there is an increasing interest in setting up sustainable transport initiatives which have gained full support of Donor agencies like the World Bank as well as UNEP and UN-Habitat under the 'share the road' project (UN-Habitat, 2011). Specifically, the city of Dar-es-Salaam has decided to invest in cycling infrastructure as an integral part of the already on-going Bus Rapid Transit (BRT) project (DART, 2009, JICA, 2008, Nkurunziza et al., 2012a).

Although there is an increasing interest in policy and development of bicycle infrastructure, little research has been done on cycling compared to other urban travel modes. The fact that cycling is not considered a travel option, let alone an alternative, by many, especially in most African large cities, suggests the need for further investigation into bicycle commuting behaviour. To address this gap, this paper investigates the socio-demographic and travel pattern related factors of bicycle commuting in Dar-es-Salaam. The analysis tries to identify how these factors influence bicycle commuting with emphasis on behavioural differences between the different stages of change of cycling behaviour. As such this paper aims to increase our understanding of the effect of socio-demographic and travel pattern-related factors on bicycle commuting within the different stages of change of cycling behaviour. The investigation would generate information needed for design and development of targeted public policy measures for different market segments, intended to promote cycling as a travel alternative in the city of Dar-es-Salaam.

## **5.2 Previous research and conceptual framework**

### **5.2.1 Socio-demographic and travel pattern-related factors for bicycle commuting**

Several studies on commuting behaviour indicate that the most important factors affecting modal choice for short distance trips, or trips conducted within daily urban systems are travellers' socio-demographic and travel pattern characteristics (Cervero, 2002, Buchanan et al., 2006, Abane, 2011, Pitombo et al., 2011, Limtanakool et al., 2006). However, these studies have also pointed out that socio-demographic characteristics and travel pattern-

related factors are only partly explaining travel behaviour. With regard to cycling behaviour in particular, the existing literature indicate that bicycle use can be influenced by a wide range of other factors such as physical infrastructure, weather and climate, culture and psychological factors like attitudes (Rietveld and Daniel, 2004, Gatersleben and Appleton, 2007, Parkin et al., 2008, Heinen et al., 2010, Heinen et al., 2011, Handy et al., 2010, Nkurunziza et al., 2012b, Buehler and Pucher, 2012, Winters et al., 2011). While all these factors are equally important, this study focuses only on investigating the impact of socio-demographic and travel pattern-related factors on bicycle commuting. Previous research suggests that socio-demographic characteristics, such as gender, age, education level, income, vehicle ownership and general activity patterns are strongly linked to bicycle commuting behaviour.

Beginning with gender, many studies suggest that men cycle more than women (Dickinson et al., 2003, Dill and Voros, 2007, Moudon et al., 2005, Gatersleben and Appleton, 2007, Rietveld and Daniel, 2004, Shafizadeh and Niemeier, 1997). Only few studies find that men do not cycle more than women (Witlox and Tindemans, 2004, Wardman et al., 2007). Moreover, the effect of gender on cycling is found to be context-specific. In countries with low cycling levels, men tend to cycle more, whereas in countries with high cycling rates, such as northern European countries (e.g., the Netherlands and Denmark), cycling is common to both men and women (Garrard et al., 2008, Heinen et al., 2013). Age has an impact through the physical fitness of people, but its relationship with cycling remains unclear. Some studies have identified that cycling levels decrease with age (Pucher et al., 1999, Moudon et al., 2005, Dill and Voros, 2007, Heinen et al., 2010), while others have indicated that age is not a significant factor (Zacharias, 2005, Wardman et al., 2007, Larsen and El-Geneidy, 2011). Income determines vehicle ownership and thus has a clear effect on the choice-set of individuals. However, the relationship between income and cycling is even more unclear. For example, Shafizadeh and Niemeier (1997), Witlox and Tindemans (2004) and Plaut (2005) find that an increase in income is negatively correlated with cycling. On the contrary, Pucher et al., (1999), Stinson and Bhat (2005) and Dill and Voros (2007) find a positive correlation between income and cycling, suggesting that people who earn more tend to cycle more often. Moreover, according to Dill and Carr (2003) and Zacharias (2005), income has no significant effect on cycling. Based on different studies (Cervero and Radisch, 1996, Stinson and Bhat, 2004, Dill and Voros, 2007, Parkin et al., 2008), car ownership leads to less bicycle use, while bicycle ownership increases the likelihood of cycling. An individual's employment status has an impact on bicycle use. For example, Baumans and Harms (2004) in their study find that part-time workers commute more frequently to work by bicycle than full-time workers. Regarding education level, studies generally show that highly

educated people cycle less (Rietveld and Daniel, 2004, Moudon et al., 2005, Parkin et al., 2008).

The demand for travel originates from the necessity of individuals to participate in spatially and temporally diverse activities. For the analysis of decisions about travel behaviour, in this case cycling behaviour, it is important to focus on the relations that exist between different activities and their associated travel behaviour (Pitombo et al., 2011). When examining travel pattern related factors to bicycle commuting, most cycling studies focus on travel distance and activity participation. Travel distance, either for commuting or the distance between activities is mostly taken into account when investigating an individual's choice to cycle (Rietveld, 2000, Heinen et al., 2010). An increase in travel distance results in an increase in the time and effort needed for cycling. Most research into bicycle use identifies that an increase in trip distance results in lower bicycle commuting and modal share (Dickinson et al., 2003, Pucher and Buehler, 2006, Parkin et al., 2008, Heinen et al., 2011). Activity patterns, such as whether individuals go to a job, go to school, go to shopping, and want to visit friends and relatives at particular places, also have an evident impact on travel demand and behaviour (Rietveld and Daniel, 2004, Pitombo et al., 2011).

While knowledge about socio-demographic and travel pattern characteristics and its connection to cycling has undoubtedly increased, no consensus on the strength and direction of this relationship has been reached yet. Most research simply mentions or examines the relationship between socio-demographic and travel pattern-related factors and cycling, but does not identify the impact of these factors on the different stages of change of cycling behaviour, thus limiting inferences about the potential for modal change. Moreover, the effect of socio-demographic characteristics and travel pattern related factors on inducing modal change in cities with much lower cycling levels especially in the context of African large cities has hardly been explored. Most of the limited literature available on urban transport in Africa focuses on motorized travel and expands this realm to include road infrastructure provision and environmental challenges posed by rapid motorization (Salon and Aligula, 2012, Abane, 2011, Olvera et al., 2003). Even the few studies that exist on cycling are embedded within the general framework of non-motorized transport (De Langen and Tembele, 2001, Gwilliam, 2002, Behrens, 2009) or part of public transit studies (Quarshie, 2007). There are as yet very few studies that concentrate on bicycle use (ICE, 2007, Sambali et al., 1998, Nkurunziza et al., 2012d, Pochet and Cusset, 1999) and specifically on bicycle commuting behaviour.

### 5.2.2 Conceptual framework

While explaining, forecasting, and changing travel behaviour remain important goals of transport researchers, traditional approaches such as the random utility theory have been frequently criticized for neglecting subjective outcomes of travel choice (Ben-Akiva et al., 1999, Gärling et al., 1998), not modelling processes of travel behaviour change as well as informing little about who is likely to experience modal change (Gehlert et al., in press, Bamberg et al., 2011). The random utility approach assumes that travellers balance travel costs against travel time to maximise personal advantage when making travel choices (Ben-Akiva and Lerman, 1985). Since sustainable transport has become a major concern, it has motivated a plethora of research on travel behaviour focusing on modal change towards more sustainable travel (Bamberg et al., 2011, Möser and Bamberg, 2008, Rose and Marfurt, 2005). Moreover, successful implementation of new transport policies, measures or technology depends on whether or not people adapt their travel behaviour as intended by these developments. Concerted efforts have, therefore, been directed towards behavioural and cognitive approaches that might be useful for encouraging and supporting sustainable transport initiatives such as cycling (Gehlert et al., in press, Fujii and Taniguchi, 2005). Besides, transport researchers have highlighted the need to use sound theoretical models in an attempt to understand (through research) and influence (through interventions) human behaviour (Bamberg et al., 2011, Krizek et al., 2009). When there are no explicit theoretical links between interventions and their intended effects, one cannot ascertain why the interventions did or did not work (Bamberg et al., 2011). In this regard, transport researchers have been encouraged to use psychologically-grounded theories to improve our limited understanding of changes in travel behaviour (Bamberg et al., 2011, Möser and Bamberg, 2008, Gehlert et al., in press). One of these psychologically-oriented theories that has shown promise is the stages of change model, a construct of the trans-theoretical model of behaviour change (Prochaska and DiClemente, 1983, Prochaska and Velicer, 1997). Other psychological theories that have been applied to explain travel behaviour, most notably the Theory of Planned Behaviour (Ajzen, 1991) and the Value Belief Norm Theory (Stern et al., 1999) have difficulties in accounting for changes in travel behaviour.

In line with the proposed self-regulation theory (Bamberg et al., 2011, Gärling et al., 2002, Carver and Scheier, 1998), the stages of change model states that behaviour change is a staged process in which six discrete successive stages can be distinguished: The *precontemplation* stage (A person has no interest in making a change and is not interested in obtaining any further information about the behaviour), *contemplation* stage (A person starts to weigh the pros and cons of the behaviour, with consideration of

future initiation of the behaviour), *Prepared for action* stage (A person takes some initial steps towards a certain behaviour and commits to start the behaviour), *action* stage (A person has been performing the behaviour for less than six months), *maintenance* stage (A person has maintained regular action of the behaviour for more than six months), and finally the *relapse* stage (A person has performed the behaviour in the past but has since stopped). The model suggests that people move from one stage to another until they eventually incorporate the desired action into a regular and permanent behaviour pattern (see Figure 5.1).

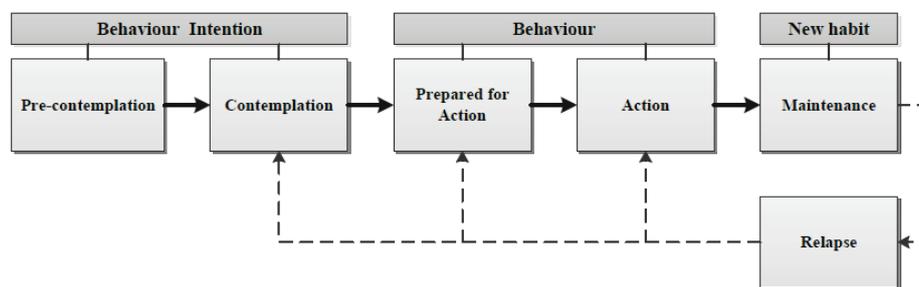


Figure 5.1: The stages of change model

While the stages of change model has received some criticism for being somewhat arbitrary (Brug et al., 2004), it provides a valuable segmentation aid (Armitage, 2009, Bamberg et al., 2011). According to Bamberg et al. (2011), it is suggested to conceptualise modal change as a transition through different stages. This can help to identify how interventions can effectively target individuals who are at different stages of behavioural readiness. More importantly, Reed (1999) states clearly three advantages in using the stages of change model to understand bicycle commuting behaviour. First, using a stage perspective provides researchers with the opportunity to match interventions to the different needs of individuals in each of the stages. Second, adopting a stage of change approach provides researchers with the opportunity to segment the general population into pre-contemplation, contemplation and preparation stages which are helpful in identifying potential mode switchers. Third, an individual's readiness to change can predict the likelihood of that person successfully adopting and maintaining the targeted cycling behaviour.

Despite the stage of change model being widely used in the field of public health especially in physical activity research, the model has seen recent application to studies of travel behaviour (Rose and Marfurt, 2005, Shannon et al., 2006, Bamberg et al., 2011) and more specifically on bicycle commuting behaviour (Gatersleben and Appleton, 2007, van Bekkum and Williams, 2011, Winters et al., 2011, Nkurunziza et al., 2012d). While the

number of such studies is increasing, specifically the effect of socio-demographic and travel pattern related factors on modal change over time has not been rigorously examined. There are as yet very few studies that have examined the effect of these factors on the different stages of change of cycling behaviour. Even the few studies that exist are concentrated in the western world and emerging economies with much higher levels of cycling and established infrastructure. The effect of socio-demographic and travel-pattern related factors on stages of change of cycling behaviour in an African city context with lower levels of cycling has hardly been explored. Although many studies (see section 5.1) have looked at the effect of socio-demographic and travel-pattern related factors on travel behaviour and promising results have emerged, the knowledge base on the effect of these factors on bicycle commuting behaviour still remains fragmented and weak (Zacharias, 2005, Heinen et al., 2010, Banister, 2011, Handy et al., 2010, Ryley, 2006).

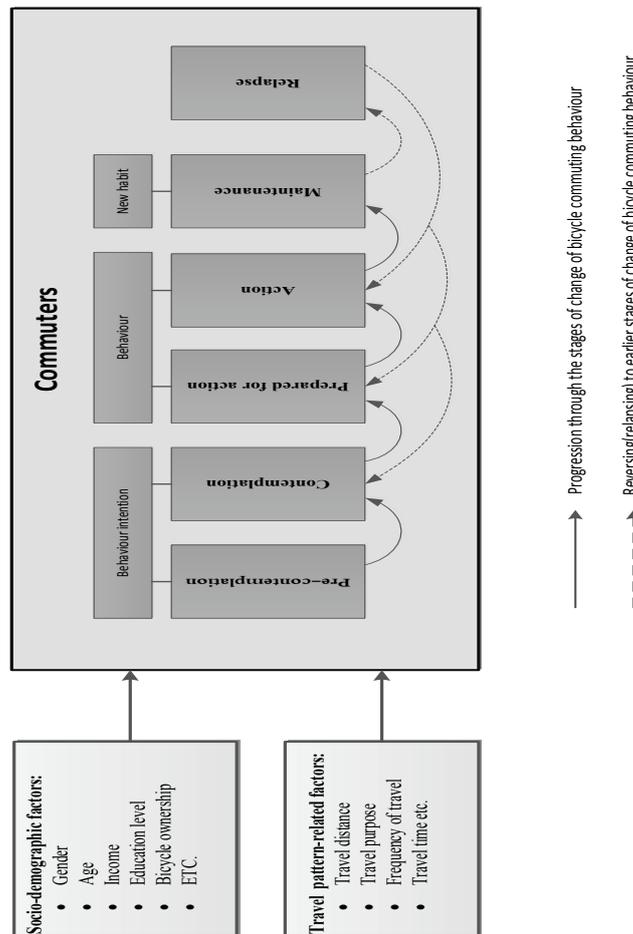


Figure 5.2: Conceptual model

Based on the reviewed literature, Figure 5.2 presents a conceptual model for this research indicating how socio-demographic and travel-pattern related factors are thought to affect travel behaviour and cycling behaviour in particular, thus also likely to be associated with stages of change of cycling behaviour. It is expected that the effect of these factors will differ across the different stages of change of cycling behaviour. Whether different socio-demographic and travel pattern related factors have varying effects on the stages of change of cycling behaviour is a question worthy of investigation, particularly if one needs to devise ways to promote cycling and to encourage travel behaviour change. In order to gain better insights into the transferability of knowledge, it is also argued that bicycle research should be conducted in cities across a wider range of countries since each city is unique and has certain inherent characteristics (Buehler and Pucher, 2012, Heinen et al., 2010). It is thus assumed that socio-demographic and travel pattern determinants of cycling are specific to the local context. This study, therefore, addresses the current void in literature by applying the stages of change model to understanding bicycle commuting behaviour in the city of Dar-es-Salaam.

### **5.3 Research design and methods**

#### **5.3.1 Survey design and participants**

The objective of this study is to determine how the effect of socio-demographic and travel pattern-related factors differ between individuals in different stages of change of cycling behaviour, and to examine the potential effects of these factors on bicycle commuting behaviour among daily commuters in Dar-es-salaam. Data for this study was collected in March 2009 using an administered survey questionnaire through a face-to-face interview approach. In the context of Dar-es-Salaam, this survey approach was thought suitable given that it would be challenging to collect data by self-administered survey approaches such as web-based and postal (mail-back) modes or using telephone interviews. The reason being that many of the urban population are low income, thus have limited access to internet, postal and telephone communication services. The survey questionnaire was introduced as an individual travel survey for commuter respondents. The specific research interest in bicycle use was not revealed to the respondents in order to avoid bias towards cyclists or people with positive attitudes towards cycling as well as strategic responses. The target population was the individual commuter. Commuters in this study are defined as those people who travel regularly to main daily activities in the city such as government office work, private business, and school. Since this study is focused on bicycle commuting behaviour, we define bicycle commuting as cycling from home to main daily activities in the city. The frequency of cycling in this

study ranges from not cycling at all to cycling every day to main daily activities. Our study therefore includes those commuters who do not cycle at all, those who cycle irregularly and alternate with other transport modes, and those who cycle daily to main daily activities. More detailed explanation on survey design and administration procedures have been described in earlier related work (Nkurunziza et al., 2012d, Nkurunziza et al., 2012b).

In short, the survey questionnaire was composed of four main parts. The first part collected information about socio-demographics. The second part asked about commuters' travel patterns and mode of transport. These first and second parts of the questionnaire have generated data to model the influence of socio-demographic and travel pattern-related factors on stages of change of cycling behaviour (the subject of this paper). The third part of the survey asked about cycling attitudes and perceptions to identify respondent's position on cycling behaviour. This information combined with that from the previous parts of the questionnaire enabled to define and characterise potential cycling market segments based on the stages of change model (see Nkurunziza et al., 2012d). The fourth and final part of the survey collected information about potential motivators, barriers and interventions that would influence cycling in relation to the stages of change of cycling behaviour published in Nkurunziza et al.,(2012b). The individual commuter respondents were sampled from pre-defined residential zones along the proposed BRT trunk corridors in the city following earlier related studies (Nkurunziza et al., 2012c, Nkurunziza et al., 2012a). The selection of these zones was based mainly on three criteria. First, the zones should be located in areas where the bus rapid transit lines and bicycle paths are proposed. Second, zones should be densely populated and with high trip generation levels. Third, zones should have at least some commuter cyclists. In addition, the selection of individual commuter respondents was restricted to those within 15 km commuting distance from home to their main daily activity locations. This criterion was set based on the experience from other cycling studies (Rietveld and Daniel, 2004, Heinen et al., 2011) which indicates that a cycling distance beyond 15 km makes cycling less attractive. In total, 620 interviews were conducted. The response rate was 96% equivalent to 598 well completed questionnaires. The high response rate was a result of the face-to-face interviewing approach used (Bayart and Bonnel, 2012) and the mini-pilot survey conducted prior the main survey.

### **5.3.2 Measures**

In this section the variables from the conceptual model in Figure 5.2 are described.

### **Stages of change for bicycle commuting behaviour**

The stage of change model was adopted and used to measure an individual's motivational readiness to change travel behaviour. The model was specifically applied to this study to identify where people in the target population are positioned in relation to current bicycle commuting behaviour. The stage of change model is a key component of the transtheoretical model of behaviour change (Prochaska and DiClemente, 1983), which assumes that an individual progresses through mainly five and sometimes six different successive stages while in the process of changing a behaviour. These successive six stages are: *pre-contemplation*, *contemplation*, *prepared for action*, *action*, *maintenance* and *relapse* (see section 2.2 for more details). In order to define the stages of change in relation to bicycle commuting behaviour, the respondents were asked to state the stage of change of cycling behaviour to which they belong based on the following attitudinal statements. "I never really think about and not even consider cycling to my daily activity (*pre-contemplation*)"; "I never used a bicycle but sometimes think about cycling to my daily activity (*contemplation*)"; "I rarely or sometimes cycle and seriously consider riding to my daily activity (*prepared for action*)"; "I have fairly often cycled to my daily activity (*action*)"; "I cycle regularly to my daily activity (*Maintenance*)"; "I no longer cycle to my daily activities (*Relapse*)". From the main survey (see Table 5.1): 13% of the survey respondents were categorised in the *pre-contemplation*; 7 % in the *contemplation*; 9% in the *prepared for action*; 6% in the *action*; 18% in the *maintenance* while the rest (47%) were categorised in the *relapse* stage. Further details on the characteristics of these stages of change of cycling behaviour are described in (Nkurunziza et al., 2012d).

### **Socio-demographic and travel-pattern related variables**

Socio-demographic data including gender, age, highest completed level of education, employment status and individual monthly income earnings were recorded. Dichotomous variables were constructed for: level of education (low: no education, primary and secondary education; high: college and university level) and employment status (full-time, part-time, self-employed, student and un-employed including those retired).

Travel pattern-related information collected include: travel distance; travel purpose (government/private office work, private business (which includes shopping), school, social activities (which includes recreational and visiting relatives)); travel mode (including bicycle, public transport, private car, walking, mixed modes); vehicle available at home (no vehicle, bicycle, motorized vehicle (including car, motor-cycle, three-motorized wheeler), more than one vehicle) and frequency of travel to daily activities per week measured by the number of travel days to daily activities per week. Table 5.1

provides an overview of the socio-demographic and travel pattern-related variables describing the stages of change of cycling behaviour.

Table 5.1: Description of the six stages of change of cycling behaviour for the sampled respondents (N= 598)

	Stages of change of cycling behaviour						Overall
	PC	C	PA	A	M	R	
	n=79	n=40	n=51	n=34	n=107	n=287	598
<b>Age (years):</b> Mean (SD)	31.8 (12.3)	24.8 (8.3)	28.0 (9.0)	30.9 (9.4)	31.1 (9.8)	30.3 (11.0)	30.11 (10.7)
<b>Travel distance (km):</b> Mean (SD)	5.8 (4.3)	6.3 (5.1)	4.8 (4.9)	3.5 (3.2)	4.3 (3.6)	6.3 (5.0)	5.57 (4.7)
<b>Travel days per week:</b> Mean (SD)	5.2 (1.4)	5.0 (1.3)	5.3 (1.6)	5.3 (1.9)	6.3 (0.86)	5.6 (1.2)	5.57 (1.3)
<b>Monthly Income Tshs(10,000s):</b> mean (SD)	38.5 (38.3)	8.8 (5.1)	16.2 (15.5)	20.3 (19.1)	13.7 (8.6)	29.8 (37.1)	24.96 (31.5)
<b>Gender**</b>							
Male (%)	32.9	22.5	88.2	100	97.2	80.5	75.1
<b>Education level**</b>							
Low (%)	43	67.5	88.2	97.1	90.7	61.3	68.9
High (%)	57	32.5	11.8	2.9	9.3	38.7	31.1
<b>Employment status**</b>							
Full-time (%)	35.4	10.0	11.8	8.8	7.5	20.6	18.1
Part-time (%)	8.9	2.5	7.8	11.8	8.4	7.7	7.9
Self-employed (%)	26.6	27.5	49.0	67.6	72.0	41.5	46.2
Student (%)	19.0	50.0	21.6	2.9	10.3	23.0	20.7
Un-employed (%)	10.1	10	9.8	8.8	1.9	7.3	7.2
<b>Vehicle available at home**</b>							
Bicycle (%)	5.1	0.0	5.9	70.6	100.0	8.4	27.1
Motorized vehicle (%)	30.4	5.0	5.9	0.0	0.0	14.6	11.9
More than one vehicle (%)	1.3	0.0	0.0	5.9	0.0	2.4	1.7
None (%)	63.3	95.0	88.2	23.5	0.0	74.6	59.4
<b>Travel Purpose**</b>							
Government/private office work (%)	25.3	7.5	5.9	2.9	7.5	17.4	14.2
Private business (%)	41.8	40.0	62.7	85.3	80.4	51.6	57.5
School (%)	17.7	50.0	21.6	2.9	11.2	22.6	20.6
Social activities (%)	15.2	2.5	9.8	8.8	0.9	8.4	7.7
<b>Travel mode to daily activity**</b>							
Bicycle (%)	0.0	0.0	0.0	38.2	100	0.0	20.1
Public transport (%)	59.5	72.5	84.3	0.0	0.0	73.9	55.4
Personal car (%)	29.1	0.0	2.0	0.0	0.0	13.9	10.7
Mixed modes (%)	5.1	5.0	2.0	61.8	0.0	4.5	6.9
Walking (%)	6.3	22.5	11.8	0.0	0.0	7.7	7.0

PC= Pre-contemplation, C=Contemplation, PA= Prepared for Action, A= Action, M= Maintenance, R= Relapse

Pearson chi-square showed a statistical difference for all the categorical variables in the table: \*\*p < 0.01.

### **5.3.3 Multivariate analyses**

In order to examine the relationship between bicycle commuting behaviour and the expected factors, the study employs quantitative statistical techniques i.e., multivariate analysis of variance (MANOVA) and multinomial logistic regression models (MLM). MANOVA is used to determine how individuals at different stages of change of cycling behaviour differ along socio-demographic and travel-pattern related factors while MLM is used to examine the potential effects of these factors on bicycle commuting behaviour. Initially, frequency and chi-square analyses are conducted to examine bicycle commuting behaviour distributions among the sampled respondents. Chi-square tests compare the frequency and assess statistical significance of the given categories of characteristics in the analysed stage of change groups. Chi-square analysis is specifically applied to examine stage of change differences by categorical variables. Next, multivariate F tests along with one way analyses of variance (adjusted for multiple comparisons) are performed on continuous variables (socio-demographic and travel pattern-related) to identify the differences between the different stages of change of cycling behaviour. Since there are many variables in this study, MANOVA is preferred to conducting several ANOVAs as it has greater power to detect whether groups differ along a combination of variables. ANOVA can only detect if groups differ along a single variable (Field, 2009). In the analysis, the independent variable is the stage of change of cycling behaviour, while the dependent variables are socio-demographic and travel pattern-related factors. The results of the analysis are shown in Table 5.3.

To determine the relative importance of socio-demographic and travel pattern-related factors in explaining the different stages of change of cycling behaviour, a multinomial logistic regression model is applied. The multinomial logistic model (MLM) is an extension of the simple logistic model for dichotomous dependent variables which is generally effective and used when a study involves polychotomous unordered dependent variables. It is a useful statistical technique for examining the simultaneous influence of multiple predictors (both categorical and continuous) when the dependent variable is a nominal variable with three or more categorical values (Wright, 1995, Field, 2009). When the research focus is on categorical dependent variables, the ordinary least square (OLS) estimator is an inappropriate estimator for the coefficients on the independent variables. Instead, maximum likelihood estimators (MLE) should be used. According to Kwak and Clayton-Mathews (2002), the MLM method has three important advantages over other methods applied to unordered categorical dependent variables: (1) It is widely available and almost every statistical package includes the MLM model. (2) Computers can calculate estimates relatively quickly, especially when there

are many categories. (3) The model results are easy to interpret, allowing for convenient odds measures in addition to probability measures.

In this study, categories in the dependent variable are discrete, nominal and naturally unordered, thus allowing the MLM to be the appropriate method. The independent variables include factors that have potential effect on stages of change of bicycle commuting behaviour i.e., socio-demographic and travel pattern-related characteristics. In the MLM, the estimates for the parameters can be identified compared to a reference category. In this case, the pre-contemplation stage was specified as the reference category (see Table 5.2). In the model, individuals categorised in the pre-contemplation stage are compared to those in other stages of change of cycling behaviour. The regression coefficients and their standard errors are used to calculate odds ratios and their 95% confidence intervals. The results are shown as odds ratios (OR) with 95% confidence intervals (CI). All p-values are set as statistically significant at  $p < 0.05$ . All statistical analyses applied in the study are performed using SPSS 18.

Table 5.2: Description of the multivariate model variables

<b>Variable name</b>	<b>Description</b>
<b>Dependent variable</b>	
Stages of change of cycling behaviour	PC = Pre-contemplation; C = Contemplation; PA= Prepared for action; A: Action; M: Maintenance; R: Relapse. Reference category is pre-contemplation stage
<b>Independent (explanatory) variables</b>	
<b>Socio-demographic factors:</b>	
Age	Age in years
Gender	Male = 1 (reference category); Female = 0
Income	Monthly income in ten thousands
Education level	Highest level of education : Low =0 (reference category); 1= High
Employment status	Full-time employed, part-time employed, self-employed, student, un-employed (reference category).
<b>Travel pattern-related factors</b>	
Travel distance	Distance to daily activity place from home in kilometres
Vehicle available at home	Bicycle, motorised vehicle, more than one vehicle, none (reference category)
Travel purpose	Government/private office work; private business; school; social activities (reference category)

## **5.4. Results**

### **5.4.1 Differences between stages of change of bicycle commuting behaviour**

A one way multivariate analysis of variance (MANOVA) was conducted to examine whether there would be one or more mean differences between the different stages of change of cycling behaviour (*pre-contemplation, contemplation, prepared for action, action, maintenance and relapse*) depending on the socio-demographic and travel-pattern related characteristics. A statistically significant MANOVA effect was obtained, pillai's trace F-ratio for the combined variables =  $F(20, 2368) = 6.713$ ;  $p < 0.001$ . A series of one-way ANOVA on each of the four dependent variables was conducted as a follow-up test to the MANOVA. As can be seen in Table 5.3, all of the ANOVA results were statistically significant  $p < 0.05$ .

From the results (Table 5.3), it is shown that for this study there are clear and significant differences across the six stages of change of cycling behaviour. The differences appear mainly to be between those in the *pre-contemplation, contemplation, maintenance* and the *relapse* stages. Individuals in the pre-contemplation and relapse stages have higher mean income than those in other stages of change of cycling behaviour. Individuals across various stages of change of cycling behaviour have nearly same age except for the contemplation stage. Also higher mean distances travelled to daily activities are recorded among the non-cyclist stages of change i.e. *pre-contemplation, contemplation* and *relapse* compared to those in the cycling stages of change of travel behaviour (*prepared for action, action* and *maintenance*). With regard to the weekly frequency of travel to daily activities, individuals in the late stages of change of cycling behaviour i.e., *maintenance* and *relapse* stages, travel more days than those in the earlier stages of change of bicycle commuting behaviour.

### **5.4.2 Socio-demographic and travel pattern correlates of bicycle commuting behaviour**

In this section, the effect of socio-demographic and travel-pattern related factors is examined on the different stages of change of cycling behaviour. Table 5.4 summarises the most important variables that have an influence on being in different stages of change of cycling behaviour as compared to being in the pre-contemplation stage. The results indicate that many of the factors play an important role in determining an individual's stage of change of cycling behaviour and consequently affecting an individual's decision to cycle. Among these factors, it was found that gender, income, education level, travel purpose including private business and school as well as vehicle

availability at home such as bicycle and motorized vehicle influence an individual's stage of change of cycling behaviour. With regard to specific stages of change of cycling behaviour, these findings are explained in detail in the following paragraphs.

*Contemplation.* Positive correlates of being in the contemplation stage compared to the pre-contemplation stage include school commuting. Individuals in the contemplation stage are also strongly related to having low monthly income compared to those in the pre-contemplation stage. These findings are as expected since most of the individuals in the contemplation stage are mainly students and thus have low or earn no monthly income (see Nkurunziza et al., 2012d). Surprisingly gender is not correlated with being in the contemplation stage. Some of the factors for instance travel distance, traveling to government/private or office work, private business and having a vehicle available at home show no effect.

*Prepared for action.* Individuals in the prepared for action stage are strongly correlated with being male and having low education level compared to those in the pre-contemplation stage. Other factors appeared to have no impact on being in the preparation stage of cycling behaviour.

*Action.* Having a high education level decreases the probability of being in the action stage whereas having a bicycle available at home strongly influences an individual to be in the action stage compared to the pre-contemplation stage. Other variables in the model appeared insignificant in relation to the action stage.

*Maintenance.* Being a female, an increase in income and having a high level of education as expected decreases the probability of being in the maintenance stage compared to the pre-contemplation stage. On the contrary, commuting to private business and school has a strong positive effect to being in the maintenance stage.

*Relapse stage.* Commuting to school has an important effect on being in the relapse stage as compared to the pre-contemplation stage. On the other hand, being a woman, having a high education level and having a motor-vehicle available at home is negatively correlated to being in the relapse stage compared to the pre-contemplation stage.

In the analysis, age and employment status appeared insignificant and were excluded from the model. In particular, it was expected that employment status would have an effect. One explanation for this may be that in the model, employment status is probably correlated with other factors such as travel purpose. The lack of contribution of age in the model may be explained

by the fact that individuals across the six stages of change of cycling behaviour have nearly the same mean age, a reason that can be emphasized by looking at its small and less significant effect (MANOVA F-ratio = 3.092\*\*, Table 5.3), in differentiating the stages of change of cycling behaviour compared to other factors.

Table 5.3: One way MANOVA results for socio-demographic and travel-pattern related factors between stages of change of cycling behaviour

	PC	C	PA	A	M	R		
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	df	F ratio
Income Tshs(10,000s)	38.5 (38.3)	8.8 (5.1)	16.2 (15.5)	20.3 (19.1)	13.7 (8.6)	29.8 (37.1)	5	10.935***
Age (years)	31.8 (12.3)	24.8 (8.3)	28.0 (9.0)	30.9 (9.4)	31.1 ( 9.8)	30.3 (11.0)	5	3.092**
Travel distance (km)	5.8 (4.3)	6.3 ( 5.1)	4.8 (4.9)	3.5 (3.2)	4.3 (3.6)	6.3 (5.0)	5	4.76***
No. of Travel days per week	5.2 (1.4)	5.0 (1.3)	5.3 (1.6)	5.3 (1.9)	6.3 (0.86)	5.6 (1.2)	5	9.53***

PC: Pre-contemplation, C: Contemplation, PA: Prepared for Action, A: Action, M: Maintenance, R: Relapse

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; Otherwise considered insignificant

N.B: Pillai's Trace F-ratio for all the combined variables is:  $F(20, 2368) = 6.713$ ;  $P < 0.001$ .

Table 5.4: Multivariate logistic model for bicycle commuting by stage of change

	Stage of Change of cycling behaviour				
	C	PA	A	M	R
	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Travel distance	1.05(0.96-1.15)	0.98(0.89-1.07)	0.91(0.80-1.03)	0.94(0.84-1.06)	1.04(0.98-1.11)
Income Tshs (10,000s)	<b>0.91(0.86-0.97)***</b>	0.98(0.96-0.99)	0.99(0.96-1.00)	<b>0.95 (0.92-0.98)***</b>	1.0(0.99-1.00)
Gender: Female (Male)	1.21(0.46-3.16)	<b>0.05(0.02-0.15)***</b>		<b>0.01(0.002-0.08)***</b>	<b>0.09(0.05-0.17)***</b>
Education level: High (Low)	0.82(0.29-2.28)	<b>0.15(0.05-0.46)***</b>	<b>0.04(0.00-0.38)***</b>	<b>0.12(0.03-0.52)***</b>	<b>0.46(0.24-0.88)**</b>
<b>Travel purpose</b>					
Government/private office work	2.74(0.23-33.03)	0.73(0.12-4.28)	0.45(0.03-7.45)	18.97(0.99-360.87)	1.66(0.60-4.61)
Private business	8.3(0.91-74.65)	2.16(0.58-8.06)	2.03(0.32-12.67)	<b>24.67(1.87-325.10)**</b>	2.17(0.86-5.45)
School (Social activities)	<b>12.37(1.33-114.80)**</b>	2.68(0.59-12.09)	0.97(0.06-14.99)	<b>49.36(2.60-936.60)***</b>	<b>3.11(1.08-9.02)**</b>
<b>Vehicle available at home</b>					
Bicycle		0.50(0.09-2.70)	<b>19.17(4.29-85.63)***</b>		0.80(0.24-2.65)
Motorized vehicle	0.45(0.09-2.41)	0.26(0.06-1.09)			<b>0.36(0.16-0.80)**</b>
More than one vehicle (None)			9.04(0.44-185.56)		0.91(0.09-8.98)
n	598				
Nagelkerke Pseudo R <sup>2</sup>	0.740				
Deviance	$\chi^2(2865) = 1033.138$ ( $p > 0.05$ )				
-2LL initial	1764.00				
-2LL final	1040.00				
Model $\chi^2$	$\chi^2(55) = 724.000$ ***				

PC: Pre-contemplation, C: Contemplation, PA: Prepared for Action, A: Action, M: Maintenance, R: Relapse

\* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ ; Otherwise considered insignificant.

- The category in brackets for the categorical variables is the reference

- The reference category for the multivariate model: Pre-contemplation (PC)

## 5.5 Discussion and conclusion

This paper studied bicycle commuting behaviour among individual daily commuters in the city of Dar-es-Salaam. The work tries to understand the effect of different socio-demographic and travel pattern-related factors on an individual's stage of change of cycling behaviour. It was expected that socio-demographic and travel pattern-related factors would not only influence the different stages of change of cycling behaviour, but also help to determine the differences between these stages. Multivariate statistical analyses were applied and offered insights into which the socio-demographic and travel pattern-related factors affect bicycle commuting behaviour and specifically the stages of change of cycling behaviour.

The study suggests that the most important factors are individual monthly income, gender, level of education, travel purpose and vehicle availability at home. These findings are consistent with earlier studies on bicycle commuting behaviour (Dickinson et al., 2003, Plaut, 2005, Parkin et al., 2008, Heinen et al., 2010). Most importantly, the results indicate that the different stages of change of cycling behaviour differ markedly along a combination of socio-demographic and travel-pattern related factors such as monthly income, number of travel days per week and travel distance as well as on each of these factors independently. The differences seem to be mainly between the non-cyclist stages of change (*pre-contemplation* and *relapse stages*) and the rest of the stages of change of cycling behaviour (*contemplation, prepared for action, action* and *maintenance*). Individuals in the pre-contemplation and relapse stages of change have higher incomes and travel longer distances than those in other stages of change of cycling behaviour. These differences between stages of change of cycling behaviour imply that cycling promotion aimed at change of travel behaviour should be stage-matched and thus supports findings in earlier studies (Gatersleben and Appleton, 2007, Rose and Marfurt, 2005, Nkurunziza et al., 2012d).

The results further indicate that an increase in income, being a female and having a higher level of education decreases the probability of bicycle commuting. With regard to the specific stages of change of cycling behaviour, income is negatively correlated with *contemplation* and *maintenance* stages compared to the *pre-contemplation* stage. These results reinforces our earlier findings in previous work (Nkurunziza et al., 2012d) where it is shown that most of the individuals in the contemplation stage are mainly students who earn less or no incomes whereas those in the maintenance stage are mainly low income earners doing private informal businesses. In agreement with these findings, Witlox and Tindemans (2004) and Plaut (2005) find a negative correlation between income and cycling, although their analysis was not based on the stages of change of cycling behaviour. With regard to gender, being a female is negatively correlated to the *prepared for action, maintenance* and *relapse* stages compared to the *pre-contemplation* stage. This finding supports prior work by Gatersleben and Appleton (2007) where it is shown that most women are in the *pre-contemplation* stage and in Dickinson et al. (2003) where it is indicated that women cycle less as compared to men. Higher education levels are negatively related to *prepared for action, action, maintenance* and *relapse* stages compared to the *pre-contemplation* stage. This implies that highly educated people are less likely to take up bicycle commuting, a result demonstrated in other previous studies (Rietveld and Daniel, 2004, Parkin et al., 2008).

Regarding the effect of travel purpose on stages of change of cycling behaviour, travelling for private business and school commuting are

positively related to being in the *maintenance* stage. This finding is also in line and supports our earlier related work (Nkurunziza et al., 2012d). School commuting has also a positive relationship with *relapse* stage compared to the *pre-contemplation* stage. With regard to vehicle availability at home, bicycle availability at home is positively correlated with the *action* stage, which implies that having a bicycle at home is likely to influence an individual to cycle more often to daily activities. Whereas the availability of motorised vehicle at home is negatively correlated to being in the *relapse* stage compared to the *pre-contemplation* stage. Most people in the *relapse* stage, although no longer cycling are less likely to have motorised vehicles.

In addition, several factors had an insignificant effect, including travel distance, age, employment status and travel purpose attribute variables such as travelling to government/private office work. Some of these variables were to some extent correlated with significant variables, which explain bicycle commuting to a larger extent. For instance, employment status was expected to have an effect on the different stages of change of cycling behaviour but turned out to have no impact. One explanation for its insignificance could be that employment status is probably correlated with other factors such as travel purpose. Age is revealed to have no effect on bicycle commuting behaviour and more specifically neither on any of the stages of change of cycling behaviour. This finding also confirms and strengthens our earlier related work described in (Nkurunziza et al., 2012d), where it is shown that age is likely to have no influence on cycling behaviour among the stage of change segments as most of the commuting population is relatively young. Travel distance, although remained in the model, had no effect on either of the stages of change of cycling behaviour. This was expected since only individual commuter respondents within 15km distance from their homes to daily activity places were considered for this study. It was expected that a cycling distance of not beyond 15 km is more attractive and encourages people to cycle based on experiences from elsewhere (Heinen et al., 2011, Rietveld and Daniel, 2004). This was in line to meeting one of the assumptions of the Prochaska and DiClemente's stage of change model, which assumes that the behaviour under investigation should be potentially achievable for everyone. Although it appeared to have no impact in this study due to the mentioned reasons, based on relevant findings from previous studies, travel distance still has an important impact on bicycle commuting behaviour. This means that in order to facilitate bicycle commuting, the distance between an individual's working and living locations should be ideally relatively short.

The results of this study showed that the approach of stage of change model is useful in capturing the heterogeneity of commuters and identifying the potential bicycle commuters. The market segmentation approach helps to

identify commuters with homogeneous attitudes, socio-demographic and travel pattern-related characteristics. The study provides grounds for policy makers to design and strive for better and effective bicycle commuting promotion strategies. Individual commuters within each stage of change of cycling behaviour have particular desires or needs when making decision on choosing cycling or not. Thus, policies and strategies for promoting bicycle commuting need to be developed specifically to well serve the needs of travellers in each stage of change of cycling behaviour. The study results lend support to the need to develop interventions differently for individuals with different characteristics.

In conclusion, this study was directed towards developing a better understanding of bicycle commuting behaviour and its relationship with socio-demographic and travel pattern-related characteristics. The study results shed light on the nature of people's behaviour and on the way they make decisions and the importance of socio-demographic and travel pattern-related factors on these decisions for the various stages of change of cycling behaviour. The differences in the effect of these factors across the various stages support the need to segment the population. Interventions aiming to promote bicycle commuting should take into account stages of change of cycling behaviour in order to enhance effectiveness and facilitate travel behaviour change. This study confirms many of the findings found in the research literature and shows them for the first time for an African large city. The main conclusions from the study include: (i) Socio-demographic and travel pattern-related factors influence an individual's stage of change of cycling behaviour. (ii) Differences were found between the stages of change of cycling behaviour in regard to a combination of socio-demographic and travel pattern related factors. (iii) Estimating the effect of socio-demographic and travel pattern related factors on different stages of change of cycling behaviour indicate that travelling for private businesses and school commuting have a great positive impact on bicycle commuting in Dar-es-Salaam and in particular for the *maintenance* stage of cycling behaviour. On the contrary, an increase in one's level of income, having a higher level of education, being a female and availability of motorised vehicle at home generally decreases the probability of bicycle commuting behaviour.

This study is one of the very few empirical evidences to investigating bicycle commuting behaviour among regular individual commuters in a large African city. In fact, bicycle commuting as a key sustainable transport mode has not been a prime focus for urban planning experts and transport professionals in many African cities. Along with such a socially undervalued context, there has been very limited research into bicycle commuting behaviour in these cities including Dar-es-Salaam. However, taking into account that currently the city of Dar-es-Salaam experiences a dynamic development of modern

infrastructure for BRT and cycling, promotion of bicycle commuting seems important and reasonable. Our findings thus could be of particular importance in this context and for other sub-Saharan African cities with similar plans. Noteworthy, since each city is unique and has certain inherent characteristics (Buehler and Pucher, 2012, Heinen et al., 2010), experiences from elsewhere need proper understanding of the determinants of bicycle use so as to be replicated effectively in other contexts.

*Promoting bicycle commuting in Dar-es-Salaam: Understanding the potential customer*

## Chapter 6

### **Examining the potential for modal change: motivators and barriers for bicycle commuting in Dar-es-Salaam<sup>11</sup>**

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<sup>11</sup> This chapter is based on Nkurunziza, A., Zuidgeest, M.H.P., Brussel, M.J.G. and van Maarseveen, M.F.A.M. (2012) Examining the potential for modal change: motivators and barriers for bicycle commuting in Dar-es-Salaam. *In: Transport policy, 24* (2012) pp. 249-259

## **Abstract**

The paper examines the effect of various motivators, barriers and policy related interventions (i.e., personal, social and physical-environmental factors) on bicycle commuting in Dar-es-Salaam, Tanzania. The research shows that these factors have different effects on people depending on the stage of change of cycling behaviour these people are in. In particular, the effects vary among people in the early stages of change of cycling behaviour (pre-contemplation, contemplation) and those in the late stages of change (action, maintenance). Importantly, results indicate that addressing physical barriers alone is likely to have little impact on encouraging bicycle commuting. More specifically, the research shows that perceived motivator variables (e.g. low bicycle price, quality of bicycle, cycling training, direct cycling routes) are strongly associated with bicycle commuting. Physical barriers including weather, absence of safe parking at home and at work, lack of bicycle paths and water showers at work places as well as personal barriers like social status, social (in)security and not feeling comfortable on a bicycle have the most negative influence on bicycle commuting. Policy related interventions like exemption of bicycle import tax, car congestion charges, and guarding bicycles at public places have a strong impact on bicycle use. The study findings provide a clear understanding of the key influencing factors which can serve as an empirical basis for development of more effective targeted measures to encourage modal change.

## 6.1 Introduction

Cycling as an important commuter mode of transportation is getting more and more attention in cities worldwide due to its environmental and health benefits and its potential to integrate with public transportation. With the rising pressures of climate change, volatile gas prices, illnesses related to physical inactivity and strained capital budgets, there is an increasing interest in shifting the car dependence culture towards active transportation modes (Xing et al., 2010, Handy and Xing, 2011). Cycling is a low-cost alternative to driving, requiring no more than the purchase of a bicycle and related gear. For individuals who do not have the option of driving, whether for financial or other reasons, cycling can be an important means to get to destinations, particularly for trips that are too long to walk or not served by transit (Handy and Xing, 2011). Moreover, the potential contribution of cycling for inhabitants of African cities is immense: first, it may provide better access to urban services such as medical, education, employment, shopping, basic commercial and social activities (Bryceson et al., 2003). Second, cycling may enhance creation of more employment opportunities, which is vital in maintaining incomes for the most vulnerable urban population (DFID, 2002). Third, cycling may enhance the maintenance of social networks which are even more essential at times of economic crisis. In this context, cycling is a potential transport mode to overcome travel financing constraints which tend to add significantly to urban household's economic difficulties.

Despite all those benefits, cycling for transportation is still a major challenge in many cities around the world (Handy and Xing, 2011, Pucher and Buehler, 2008, Pucher and Buehler, 2006, Vandenbulcke et al., 2011). Moreover, for most large cities in Africa, cycling has remained unrecognised and is seen as an inferior urban transport mode (Sambali et al., 1998, Pochet and Cusset, 1999, Olvera et al., 2008). For example, in a city like Dar-es-Salaam in Tanzania, cycling has a low modal share, estimated at around 5% in 2007, whereas the market share of other transport modes such as personal motorized vehicles is around 10%, public transport is around 60%, while that for walking is estimated at around 25% (JICA, 2008). An interesting question is whether and how the bicycle can play an important role in the urban transport system of this city given its individual and social benefits and its flat coastal terrain with sea breezes, making cycling a potentially suitable transport option.

Recently, reacting to issues of widespread traffic congestion in the city and issues of climate change, Dar-es-Salaam has started the development of sustainable urban initiatives like the Bus Rapid Transit (BRT) system (Nkurunziza et al., 2012a, Nkurunziza et al., 2012b). Next to this, the city authorities have started to recognise the importance of cycling where it is planned to incorporate bicycle feeder networks to the proposed BRT system

development (JICA, 2008). Alongside these initiatives, plans are underway to formulate policies for integrating cycling into the city transport master plan. The importance of Dar-es-Salaam as a touristic destination in the region has also raised an interest in the design of a bicycle network for the entire city (DART, 2009). While investment in bicycle infrastructure plays a pivotal role in cycling promotion, experience from research (Moudon et al., 2005; Parkin et al., 2008) shows that using merely a supply driven policy may not be effective to increase cycling levels. Establishing bicycle infrastructure will undoubtedly bring the possibility of cycling closer to more people (Martens, 2007). However, bicycle infrastructure alone will not guarantee that more people will cycle (Gatersleben and Appleton, 2007, Parkin et al., 2008), especially not amongst those who do not usually cycle. In particular in the context of African cities, there is a great need for clear empirical evidence on the kind of initiatives that could create a conducive environment for cycling, and induce positive long term changes in travel behaviour. Therefore, this paper aims to develop a better understanding of the factors that can potentially influence bicycle commuting with a focus on the city of Dar-es-Salaam, Tanzania.

## **6.2 Conceptual model and literature review**

The conceptual model in this study draws mainly from the theory of stages of behaviour change, in particular the stages of change model (Prochaska and DiClemente, 1983, Prochaska and Velicer, 1997). The model is widely applied to many domains of health promotion research with a focus on physical activity (Marttila et al., 1998, Miilunpalo et al., 2000, Kloek et al., 2006). In line with the proposed self-regulation theory of travel behaviour change (Bamberg et al., 2011), the stages of change model posits that behaviour change is a transition through a time-ordered sequence of stages reflecting the cognitive and motivational difficulties people encounter in implementing a general behaviour change goal into concrete actions. The model deals with intentional changes in behaviour and focuses entirely on the decision making of the individual. The basic elements of the model are both motivational (dealing with intention building, decision making and attitudinal readiness) and behavioural (the adoption process from stages of increased motivation, through tentative performance to regular practice of the behaviour). The model views behavioural change as a process rather than an event that occurs in five distinct successive stages (see figure 6.1). The first two stages, *Pre-contemplation* (no intention to change) and *Contemplation* (growing intention) are motivational stages without actual performance of the behaviour; the next two stages, *Prepared for action* (strong intention and possible irregular or tentative performance of the behaviour) and *Action* (recent initiation of regular behaviour) bring a crucial shift into behavioural manifestation. The fifth stage, *Maintenance* represents the establishment of permanent behaviour. Some studies have proposed to add a sixth stage,

*Relapse*, that occurs when individuals no longer practice certain behaviour or when individuals revert to an earlier stage of change from either *Action* or *Maintenance*.

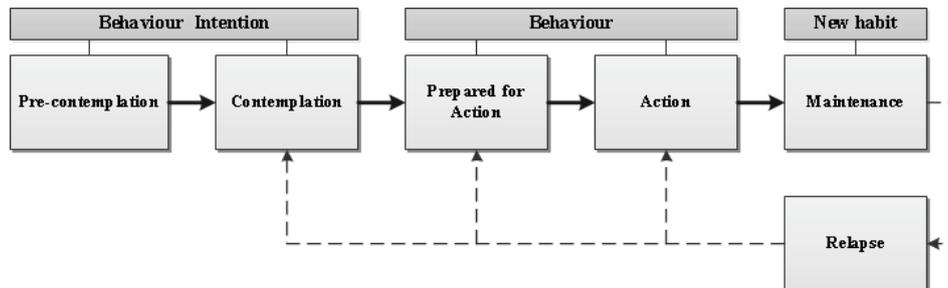


Figure 6.1: The stages of change model

The stages of change model, although most common to physical activity research, has recently been applied to several transportation studies (Rose and Marfurt, 2005, Shannon et al., 2006, Bamberg et al., 2011) and more specifically on cycling behaviour (Gatersleben and Appleton, 2007, van Bekkum and Williams, 2011, Winters et al., 2011, Nkurunziza et al., 2012c). Cycling, as a form of physical activity as well as a means of travel to destinations, suggests that the model provides a useful conceptual framework for understanding travel behaviour. In agreement with studies of consumer behaviour and marketing (Wedel and Kamakura, 1998, Anable, 2005, Shiftan et al., 2008), the model recognises that different people will be in different stages of cycling behaviour and that appropriate interventions can be developed for each stage. For example, some studies (Gatersleben and Appleton, 2007, Nkurunziza et al., 2012c) have applied the stages of change model to determine where people in the target audience are positioned in relation to cycling behaviour. These studies have identified malleable groups to target travel behaviour change strategies. The studies have shown that people go through a series of stages of cycling behaviour and take a relatively long time before progressing to the next new stage of travel behaviour.

Most travel behaviour research deals with the impacts of policy measures applied to all people in the target population without any distinction (Bamberg et al., 2011). Traditional interventions often assume that all people are ready for an immediate and permanent behaviour change. Even in cases where travel market segmentation is employed to examine the potential for modal change, segmentation is most often based on general socio-demographics such as gender, age, vehicle ownership or travel mode use, e.g. cyclists and non-cyclists (Jensen, 1999). These segmentation approaches are criticised for not modelling processes of travel behaviour change and tell us little about who is likely to experience modal change (Davies et al., 1997,

Bamberg et al., 2011). Moreover, such segments are not necessarily homogeneous in terms of attitudes and motivations, which are increasingly transcending socio-demographic lines (Bergström and Magnusson, 2003, Anable, 2005). It also appears that few differences exist when only segmentation on the basis of socio-demographics is considered (Beirão and Cabral, 2007). Conversely, attitude-based market segments are shown to be more helpful in identifying potential mode switchers (Anable, 2005, Shiftan et al., 2008, Nkurunziza et al., 2012c). Of particular importance, Bamberg et al. (2011) suggests to conceptualise modal change as a transition through different stages. If modal change is considered a transition through different stages, more flexibility is needed, allowing to match the measures employed to particular stages of change of travel behaviour. Such conceptualisation is useful to create an understanding of the extent to which individuals perceive particular motivations and/or barriers to change.

Conventional analysis of cycling behaviour is often based on utility theory, assuming people decide on the best available mode of travel considering costs, time and effort. These analyses offer insight into modal choice and its determinants, focussing on level-of-service characteristics of transport systems. These analyses, however, fail to explain why individuals in similar situations and with corresponding socio-economic characteristics make different decisions about whether to cycle or not (Heinen et al., 2011). Development and implementation of transport supply measures (e.g. providing bicycle infrastructure) alone appears insufficient to engender higher levels of cycling (Moudon et al., 2005, Parkin et al., 2008). Also, current transport policies often tend to tackle the symptoms (e.g., cycling infrastructure) but fail to tackle the underlying constraints (attitudes, perceptions and preferences) (Dickinson et al., 2003, Heinen et al., 2011). While infrastructure improvements are necessary (McClintock and Cleary, 1996, Hopkinson and Wardman, 1996, Tilahun et al., 2007), these alone may not be sufficient in realising travel behaviour change, suggesting that other factors need to be clearly addressed as well.

There is a vast literature on factors influencing bicycle commuting (Noland and Kunreuther, 1995, Dill and Carr, 2003, Wardman et al., 2007, Parkin et al., 2008, Heinen et al., 2011, Handy and Xing, 2011). These studies have shown that individual (personal) factors, social-environmental factors and physical-environmental factors may all affect cycling behaviour. Several studies that have looked at the relationship between these factors and cycling have used single-level analyses where these factors are investigated separately and applied to the general population of interest. Although this can be helpful for general understanding of cycling behaviour, examining these factors separately as independent predictors or determinants of cycling can lead to a too simplistic model of the factors that affect a person's

decision to cycle (Alfonzo, 2005, Handy and Xing, 2011). It is also not well understood which of these factors are most salient in inducing modal change, nor is it clear how or whether these factors can affect a person's stage of change of cycling behaviour. Recognising that most transport challenges are too complex to be adequately understood and addressed from single-level analyses, emphasises the need for a more comprehensive approach that integrates multiple factors of influence. As individual, social and physical environmental factors do not exist in vacuum, it is critical to understand how and when these factors come into play within the cycling decision-making process, not only to understand their roles theoretically but also to better translate research results into effective policies, programme interventions, and design guidelines. Placing these factors into a socio-ecological model and treating them as predictors of the decision to cycle for people in different stages of change of travel behaviour, can create a more complete dynamic framework within which to investigate their effect on bicycle commuting.

Socio-ecological models are also largely applied to public health research and recognise that behavioural influences can come from the person as well as one's social and physical environments (Sallis and Owen, 2002, Robertson-Wilson et al., 2008). These models postulate that traditional approaches that focus on behaviour change through individual level change strategies alone often neglect the social and environmental context in which those behaviours occur and are reinforced. A socio-ecological approach thus focuses on the environmental context in which a behaviour occurs and suggests that behaviours are affected by multiple levels of factors. These factors begin with the individual and expand outward to include the social and physical environments. Individual factors include attitudes, preferences, and beliefs, as well as confidence in one's ability to engage in the behaviour. Social-environmental factors include cultural factors, the social norms of the community, including behaviours considered normal or appropriate. The physical environment is generally defined as encompassing both the natural and built physical environments, where the natural environment includes topography, climate, geography and others. The built environment includes land use patterns and transportation infrastructure (Alfonzo, 2005, Handy and Xing, 2011).

From this perspective, when examining the potential for modal change, there is a need to consider multiple levels of influence on travel behaviour (Alfonzo, 2005, Krizek et al., 2009, Handy and Xing, 2011). Also, since the behaviour change process may not be explained by the stages of change model alone (Sallis and Owen, 2002), the cycling decision-making process should be conceptualised within the context of the stages of change model together with a social-ecological approach to fully understand the potential for modal change. As such, encouraging bicycle commuting especially in developing

world cities where cycling is uncommon, requires interventions that target multiple levels of influence, in multiple settings, and for diverse populations. With so many of the transport disparities experienced by most people in these cities being grounded in social-cultural realities and conditions (Bryceson et al., 2003, Brussel and Zuidgeest, 2012), it is essential to identify key motivators, barriers and policy related interventions from a socio-ecological perspective, if we are to understand how to develop effective interventions that encourage bicycle commuting. It is equally important to acknowledge that these factors will affect people in the distinct stages of change of cycling behaviour differently (Gatersleben and Appleton, 2007, Nkurunziza et al., 2012c).

The conceptual model outlined here (figure 6.2) integrates a social-ecological model to the stages of change model, and posits that individual, social and physical-environmental factors affect people in different stages of change of cycling behaviour and that some factors are more prominent in the cycling decision-making process than others. Hence, this article is aimed to fill the research gaps through an analysis of cycling behaviour in the city of Dar-es-Salaam. The results contribute to an improved understanding of the role of various factors on bicycle commuting and provide a strong empirical evidence for a targeted policy and programs aimed at promoting bicycle commuting.

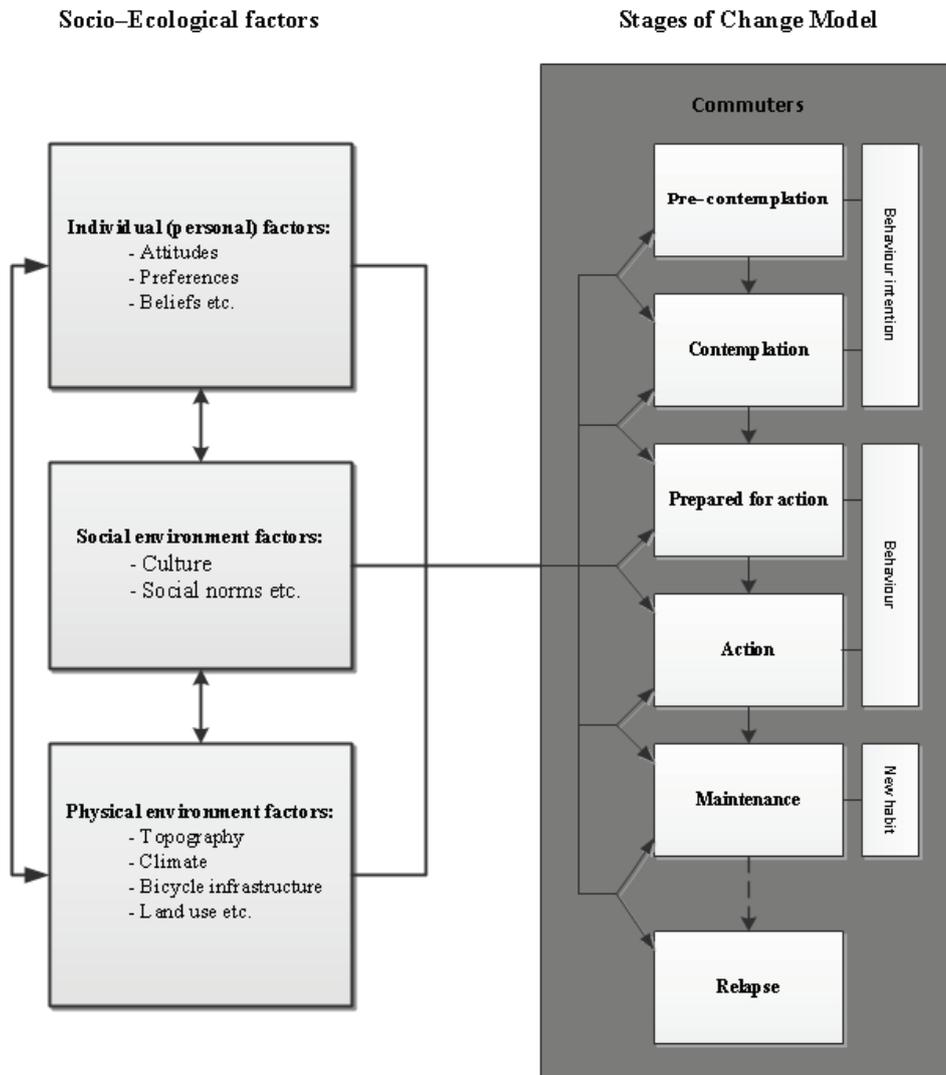


Figure 6.2: Conceptual model linking the socio-ecological factors to the stages of change model

## 6.3 Methods

### 6.3.1 Survey design and administration

The study examines a broad array of explanatory factors that can influence bicycle commuting. Data used in the analysis come from a travel survey conducted among daily commuters in the city of Dar-es-Salaam, Tanzania in 2009. The unit of analysis is an individual commuter. Commuters in the context of this study are defined as those people who travel regularly to main

daily activities in the city, i.e. government/private office work, personal commercial business, and school. Details of the survey development and administration have been published in (Nkurunziza et al., 2012c). In brief, survey samples were collected from pre-selected zones of the city based on whether the zones are: i) located where bus rapid transit lines and bicycle paths are proposed, ii) densely populated and with high trip generation levels, and iii) have some regular commuter cyclists. In addition, the survey was restricted to those commuters whose daily journeys were within 15 km distance to a key activity or service locations, since cycling literature indicates that a distance beyond 15 km makes cycling less attractive (Rietveld and Daniel, 2004, Heinen et al., 2011, Kingham et al., 2001).

The data were collected through a face-to-face interview approach using an administered survey questionnaire that was presented as an individual travel survey for commuter respondents. There was no specific mentioning of the research interest in bicycle use at the start to avoid any bias or strategic responses. The survey approach was deemed suitable in the Dar-es-Salaam context where it would be difficult to collect data by self-administered survey techniques such as web-based and postal (mail-back) modes or using telephone interviews. This is due to limited access to internet, postal and telephone communication services for the largely low income population. The questionnaire comprised four main parts. The first part collected information about socio-demographics summarized in Table 6.1. The second part asked about commuters' travel patterns and travel mode. The third part of the survey asked about cycling attitudes and perceptions to identify respondent's position on cycling behaviour. This information together with that from the previous parts of the questionnaire enabled to define and characterise potential cycling market segments based on the Prochaska and DiClemente (1983, 1984) stages of change model. The defined segments are: *Pre-contemplation* 'someone who never really thinks about and not even considers cycling to a daily activity'. This segment has a negative attitude towards cycling and is dominated by people with high education, high incomes and high car ownership. *Contemplation* 'someone who never used a bicycle but sometimes thinks about cycling to a daily activity'. This segment is dominated by students who mostly commute by public transport and have a high positive attitude towards cycling. *Prepared for action* 'someone who rarely or sometimes cycles to a daily activity'. This segment is characterised by a positive attitude towards cycling and is occupied by private commercial business people who mainly commute by public transport. *Action* 'someone who has fairly often cycled to a daily activity'. This is a segment mainly composed of low educated people with private business activities and a high bicycle ownership. *Maintenance* 'someone who cycles regularly to a daily activity'. This segment only accommodates daily commuter cyclists who are predominantly men, and commute for private commercial activities. *Relapse*

'someone who no longer cycles to a daily activity'. This is a heterogeneous segment with mainly medium (secondary/college) level educated people and low car ownership.

In order to define the segments, the respondents were asked to state the stage of change of cycling behaviour to which they belong based on the following attitudinal statements: "I never really think about and not even consider cycling to my daily activity (*pre-contemplation*)"; "I never used a bicycle but sometimes think about cycling to my daily activity (*contemplation*)"; "I rarely or sometimes cycle and seriously consider riding to my daily activity (*prepared for action*)"; " I have fairly often cycled to my daily activity (*action*)"; "I cycle regularly to my daily activity (*Maintenance*)"; "I no longer cycle to my daily activities (*Relapse*)". The final part collected stated preference information about potential motivators, barriers and bicycle policy interventions. This information is crucial for the subject of this paper, and enables to analyse the stages of change of cycling behaviour in relation to motivators, barriers and policy interventions. In total 620 commuter respondents were interviewed resulting in 598 well completed questionnaires, a high response rate of 96%. The high response rate was a result of the face-to-face survey technique applied and the mini-pilot survey conducted prior to the main survey.

Table 6.1: Summary of the socio-demographic information of the sample respondents (N= 598)

	Stages of change of cycling behaviour						Overall
	PC	C	PA	A	M	R	
	n=79	n=40	n=51	n=34	n=107	n=287	598
<b>Gender</b>							
% Male	32.9	22.5	88.2	100	97.2	80.5	75.1
<b>Age in years</b>							
% 10-25	31.6	75.0	43.1	29.4	29.9	34.1	36.3
% 26-45	55.7	20.0	52.9	58.8	63.6	56.8	55.1
% > 45	12.7	5.0	3.9	11.8	6.5	9.1	8.6
<b>Education</b>							
% No education	2.5	0.0	3.9	5.9	1.9	0.7	1.7
% Primary school	16.5	30.0	33.3	64.7	56.1	20.2	30.4
% Secondary school	24.1	37.5	51.0	26.5	32.7	40.4	36.8
% College	24.1	12.5	7.8	2.9	5.6	25.1	17.9
% University	32.9	20.0	4.0	0.0	3.7	13.5	13.2
<b>Employment status</b>							
% Full-time	35.4	10.0	11.8	8.8	7.4	20.6	18.1
% Part-time	8.9	2.5	7.8	11.8	8.4	7.7	7.9
% Self-employed	26.6	27.5	49.0	67.6	72.1	41.5	46.2
% Student	24.0	57.5	27.5	11.7	11.2	26.0	24.5
% Retired	5.1	2.5	3.9	0.1	0.9	4.2	3.3
<b>Bicycle available for use</b>							
% Yes	6.3	0.0	5.9	76.5	100.0	9.4	28.1
% No	93.7	100	94.1	23.5	0.0	90.6	71.9
<b>Median monthly income (1000's)Tshs</b>							
	300	90	120	150	120	150	150

PC= Pre-contemplation, C=Contemplation, PA= Prepared for Action, A= Action, M= Maintenance, R= Relapse

### 6.3.2 Variables

To determine which factors might be the most likely to influence bicycle commuting, we examined a broad array of factors (i.e. personal, social and physical-environmental) in relation to the stages of change of cycling behaviour. An extensive list of these factors was compiled from several studies done elsewhere (Dill and Carr, 2003, Rietveld and Daniel, 2004, Wardman et al., 2007, Gatersleben and Appleton, 2007, Hopkinson and Wardman, 1996). The list was adapted and validated based on inputs from a mini-pilot survey among daily commuters as well as group discussions held with local experts from the Dar-es-Salaam Rapid Transit (DART) agency, Dar-es-Salaam city council, Ardhi University, the University of Dar-es-Salaam and members of the local cycling advocacy group UWABA. This way we managed to obtain and keep the list of factors realistic to the local context in relation to bicycle use. A number of different factors were categorised under

motivators, barriers and policy interventions in the survey questionnaire and were analysed for their potential influence on people in the various stages of change of cycling behaviour (see Table 6.2).

Table 6.2: Description of the variables in the models

Variable name	Range	Description
<b>Dependent variables</b>		
Stages of change of cycling behaviour	0,1	PC-C = Pre-contemplation (PC) = 0 versus Contemplation (C) =1; C-PA = Contemplation (C) = 0 versus Prepared for Action (PA) =1; PA-A = Prepared for action (PA) = 0 versus Action (A) = 1; A-M = Action (A) = 0 versus Maintenance (M) =1; R-M = Relapse (R)= 0 versus Maintenance (M)=1
<b>Explanatory variables</b>		
Motivators:		1= Extremely not at all important, 2 = Not at all important, 3= Not important, 4 = Somewhat important, 5 = Important, 6 = Very important, 7= Extremely very important
<i>Low bicycle price, shades along cycling paths, quality of bicycle, cycling training, water facilities along cycling paths, direct cycling routes</i>	1-7	
Barriers:		
<i>Environmental</i>	1-7	
<i>Personal</i>	1-7	
Policy interventions	1-7	

Depending on the specific stage of change of cycling behaviour, the survey questions were modified accordingly to determine the respondents' likelihood to change current travel behaviour towards cycling. The respondents were asked to rate the importance of each of the variable items recorded under motivators, barriers and policy interventions in relation to using bicycles for daily commutes. The importance a respondent attached to each of the individual items was determined by survey questions which asked "How would (*item x*) influence you to travel by bicycle to your daily activity place?" Respondents could rate the items on a scale ranging from 1 to 7 as shown in Table 6.2.

### 6.3.3 Data compilation and analyses

The survey data were then entered to an electronic database and statistically analysed using the SPSS, version 18. Binary logistic regression models were employed to identify the relationship between the perceived motivators, barriers and policy intervention items and stages of change of cycling behaviour. The perceived variable items were the independent variables in the models, whereas the stages of change of cycling behaviour were the dependent variables in the models (see Tables 6.2-6.6). Since the adapted stages of change model assumes that behaviour change occurs in six distinct successive stages, each stage of change of cycling behaviour was compared to the immediate next stage during analysis (see Table 6.2). This allowed a series of binary logistic models to estimate the probability of changing from one stage of cycling behaviour to the next. Five different models were then estimated and the order in which the models were created was consistent with the stage of change progression from the *pre-contemplation* to the *relapse* stage of cycling behaviour (figure 6.2). The explanatory independent variables were entered separately as sets defined according to motivators, barriers and policy interventions into the different five models. At each modelling step, only the statistically significant variables were retained and insignificant variables were dropped using the backward stepwise method (Field, 2009).

In interpreting the binary logistic models, odds ratios with 95% confidence intervals were used instead of variable coefficients since they are easy to understand and explain. An odds ratio that is greater than 1 indicates that the concerned explanatory variable leads to a higher likelihood of cycling and vice versa. In this context the odds ratios were interpreted as the likelihood that an individual progresses from the current stage of cycling behaviour to the next after a one-unit change in a predicting variable. For example, an odds ratio of 1.5 for a specific explanatory variable indicates that with every unit of increase in the variable, the likelihood of that individual being in the next stage of cycling behaviour increases by multiples of 1.5.

To evaluate the significance and predictive power of the models, the change in deviance was determined by comparing the log likelihood functions between the unrestricted models and the restricted models with the following expression (Field, 2009, Sze and Wong, 2007):

$G = -2[LL(c) - LL(\theta)]$	(1)
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where  $LL(c)$  is the log likelihood function of the restricted model and  $LL(\theta)$  is the log likelihood function of the unrestricted model. Under the null hypothesis that the coefficients for the predictive models are equal to zero,  $G$

is chi-square distributed with  $p$  degrees of freedom, where  $p$  is the number of variables that are considered. If  $G$  is significant at the 5% level, then the null hypothesis would be rejected, and one would conclude that the proposed model generally fits well with the observed outcome. The Nagelkerke's  $R^2_N$  statistic was used to further assess the validity of the models in respect to their effectiveness in predicting the relationship between dependent variables and possible explanatory variables.

## **6.4 Results and discussion**

### **6.4.1 Potential influences on stages of change of cycling behaviour**

The study looks at the impact of perceived motivators, barriers and policy related interventions on the likelihood of bicycle commuting to people in the different stages of change of cycling behaviour. Table 6.3 shows the results of odds ratio estimations for the different models. The models offer a decent quality of fit and allow for identification of variables with a strong impact on bicycle commuting.

The models reveal that respondents who cite low bicycle prices, quality of a bicycle and cycling training as key motivators, show a positive likelihood of being in the *contemplation* stage rather than the *pre-contemplation* stage. These findings are as expected. People in the *contemplation* stage are mainly low income earners who have never cycled before but have a highly positive attitude towards cycling (see Nkurunziza et al., 2012c). For these people, reducing the cost of bicycles, providing good quality bicycles and having cycling training would undoubtedly motivate them to think about trying cycling. Moreover, low bicycle prices and direct cycling routes are also more likely to positively influence being in the *maintenance* stage than *relapse*. Also, direct cycling routes are positively associated to the *maintenance* stage compared to the *action* stage. These results were unsurprising since people in the *maintenance* stage are experienced commuting cyclists with low monthly income earnings who travel daily to their activities irrespective of the presence of cycle facilities.

Table 6.3: Models for potential motivators depending on stages of change of cycling behaviour

	PC-C	C-PA	PA-A	A-M	R-M
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Low bicycle price	1.425***	0.981	1.053	0.996*	1.705***
Shades along cycling paths	1.068	0.866	0.965	0.993	1.132
Quality of bicycle	1.620***	0.831	0.936	1.016	1.052
Cycling training	1.448***	0.622***	0.554**	1.315	0.908
Water facilities along cycling paths	0.695	1.371	0.856	1.025	1.007
Direct cycling routes	1.210	0.863	0.929	1.023**	1.253**
n	119	91	85	141	394
Pseudo R <sup>2</sup>	0.45	0.24	0.15	0.10	0.29
-2LL initial	151.948	124.820	114.412	155.772	460.836
-2LL final	105.034	105.091	104.580	147.593	374.324
Model $\chi^2$	$\chi^2(3)=46.91***$	$\chi^2(1)=19.73***$	$\chi^2(1)=9.83***$	$\chi^2(2)=8.18**$	$\chi^2(2)=86.51***$

PC-C: Pre-contemplation versus Contemplation, C-PA: Contemplation versus Prepared for Action, PA-A: Prepared for Action versus Action, A-M: Action versus Maintenance, R-M: Relapse versus Maintenance

\* 10% significance level, \*\* 5% significance level, \*\*\* 1% significance level, otherwise considered insignificant

On the other hand, cycling training is strongly associated with a lower likelihood of being in the *prepared for action* and in the *action* stages. This may be reasonable due to the fact that people in the *prepared for action* stage are ready to take up cycling and only need a trigger to jump on their new travel behaviour, whereas those in the *action* stage are already cycling and may not need cycling training. Other items, which include provision of shades and water facilities along cycling paths, were found to be insignificant in all models. This is not as expected, since in Dar-es-Salaam the weather is usually hot and humid. The reason could be that people do not care or the non-experience of the respondents with such cycling facilities in the area which may have made it hard to be judged.

The model results summarised in Table 6.4 show that the following perceived environmental factors may lead to lower likelihood of being in the *contemplation* stage compared to *pre-contemplation*: weather, far distance to work place, absence of water showers at work place, car driver attitude and behaviour. The nature of the findings may be tied to a lack of cycling experience, hot weather in the area and fear of car traffic. Moreover, weather, lack of safe parking at work place and inexistence of cycling paths are significantly more likely to deter being in the *prepared for action* stage as

compared to being in the *contemplation* stage. This result seems reasonable since people in the *prepared for action* stage are ready to take up cycling and would only be hindered by hot weather and absence of those cycling facilities.

Table 6.4: Models for perceived environmental barriers depending on stages of change of cycling behaviour

	PC-C	C-PA	PA-A	A-M	R-M
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Hilliness	1.118	1.047	0.874	1.054	0.985
Weather	0.964*	0.723***	0.879	1.255	1.035
Far distance to work place	0.832*	1.007	1.046	0.964	0.834***
No safe parking at work place	1.135	0.733**	1.293	0.931	0.895
No safe parking at home	0.787	1.053	1.192	0.683**	0.706**
No water showers at work place	0.525***	1.120	0.994	0.752	0.607***
No bicycle crossing signals at road intersections	0.952	0.952	0.978	0.664**	0.696***
Car drivers' attitude and behaviour	0.940*	0.865	0.800**	0.962*	1.066
No cycling paths	1.127	0.796**	0.899	0.934	0.814***
n	119	91	85	141	394
Pseudo R <sup>2</sup>	0.23	0.26	0.13	0.16	0.37
-2LL initial	151.948	124.820	114.412	155.772	460.836
-2LL final	130.273	104.884	109.212	140.057	343.539
Model $\chi^2$	$\chi^2(4)=21.68^{**}$ *	$\chi^2(3)=19.94^{**}$ *	$\chi^2(1)=5.20^*$ *	$\chi^2(3)=15.72^{**}$ *	$\chi^2(5)=117.3^{**}$ *

PC-C: Pre-contemplation versus Contemplation, C-PA: Contemplation versus Prepared for Action, PA-A: Prepared for Action versus Action, A-M: Action versus Maintenance, R-M: Relapse versus Maintenance

\* 10% significance level, \*\* 5% significance level, \*\*\* 1% significance level, otherwise considered insignificant

Absence of safe bicycle parking at homes and lack of bicycle crossing signals at road intersections are more likely to decrease the likelihood of being in the *maintenance* stage as compared to being in the *action* stage. The results sound reasonable as people in the *maintenance* stage are regular commuter cyclists who always experience these infrastructural barriers. Car drivers' attitude and behaviour towards cyclists is also strongly associated with lower likelihood of being in the *action* and *maintenance* stages compared to the *prepared for action* and *action* stages respectively. This may be resulting from direct interaction with motor-vehicles during cycling given the inexistence of cycling paths in the city. Similarly, far distance to work place, absence of safe bicycle parking at homes, lack of showers at work places, lack of bicycle crossing signals at road intersections and inexistence of cycling paths are strongly associated with lower likelihood of being in the

*maintenance* stage compared to *relapse*. Hilliness was insignificant in all models suggesting no influence on bicycle commuting in Dar-es-Salaam, as many parts of the city lie on a flat terrain.

With regard to perceptions of personal barriers (see Table 6.5), the attitude that cycling is not comfortable, is more likely to have a negative influence on being in the *contemplation* stage than *pre-contemplation*. Social status and not confident in cycling skills are strongly associated with lower likelihood of being in the *prepared for action* stage as compared to *contemplation*. The suggested reasons for this may be that people in the *prepared for action* stage though ready to take up cycling are not well experienced with cycling especially on the main roads. Also some people in the *prepared for action* stage, mainly university students, tend to perceive a feeling of shame to cycle. Social (in) security is negatively related to being in the *maintenance* rather than in the *action* stage. This result seems unsurprising since regular commuter cyclists (those in the *maintenance* stage) are usually exposed and may have encountered such cases of feeling socially insecure especially in Dar-es-Salaam where the cycling culture is very low and usually tied to one being poor. Also being in the *maintenance* stage was found to be negatively affected by lack of safety on the road, not feeling comfortable on a bicycle, having many commitments before and after work and not having confidence in cycling skills compared to being in the *relapse* stage. In general, these results suggest that working on the physical barriers alone is likely to have little impact on encouraging bicycle commuting.

Table 6.5: Models for perceived personal barriers depending on stages of change of cycling behaviour

	PC-C	C-PA	PA-A	A-M	R-M
	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio	Odds Ratio
Social (in) security	0.840	1.140	1.058	0.851**	0.930
Not comfortable on bicycle	0.701***	0.906	1.019	0.777	0.632***
Many commitments before & after work	0.904	0.944	1.078	0.710	0.563***
Social status	0.863	0.717**	1.119	0.902	0.904
No safety on the road	1.082	0.832	0.900	1.038	0.745***
Not confident in cycling skills	1.030	0.569***	0.804	0.893	0.661***
n	119	91	85	141	394
Pseudo R <sup>2</sup>	0.27	0.45	0.05	0.12	0.44
-2LL initial	151.948	124.820	114.412	155.772	460.836
-2LL final	126.618	87.626	114.412	148.104	318.910
Model $\chi^2$	$\chi^2(1)=25.33***$	$\chi^2(2)=37.19***$	$\chi^2(-) = 2.23$	$\chi^2(1)=7.67**$	$\chi^2(4)=141.93***$

PC-C: Pre-contemplation versus Contemplation, C-PA: Contemplation versus Prepared for Action, PA-A: Prepared for Action versus Action, A-M: Action versus Maintenance, R-M: Relapse versus Maintenance

\* 10% significance level, \*\* 5% significance level, \*\*\* 1% significance level, otherwise considered insignificant

Considering the results of the models on perceived policy interventions as summarised in Table 5.6, exemption of bicycle import tax was significantly associated to being in the *contemplation* and *maintenance* stages compared to being in *pre-contemplation* and *relapse stages* respectively. This result can be justified by the low income earnings characterising the *contemplation* and *maintenance* stages (see Nkurunziza et al., 2012c). Guarding bicycles at public places is more likely to increase the likelihood of being in the *action* and *maintenance* stages compared to *prepared for action* and *relapse stages* respectively. This may be due to the good cycling experience by people in the *action* and *maintenance* stages. Surprisingly however, guarding bicycles is strongly associated with a lower likelihood of being in the *maintenance* stage than being in *action* stage. A possible explanation for this may be that people in the *maintenance* stage are experienced commuter cyclists who find their own ways of protecting bicycles without guards.

Table 6.6: Models for perceived policy interventions depending on stages of change of cycling behaviour

	<b>PC-C</b>	<b>C-PA</b>	<b>PA-A</b>	<b>A-M</b>	<b>R-M</b>
	<b>Odds Ratio</b>	<b>Odds Ratio</b>	<b>Odds Ratio</b>	<b>Odds Ratio</b>	<b>Odds Ratio</b>
Car free zones	1.041	1.087	0.983	1.067	1.159**
Park and ride policies	1.095	0.800*	1.040	1.052	0.838**
Car parking charges	1.114	1.196	0.775	0.889	0.778**
Guarding bicycles at public places	0.931	1.019	1.491**	0.763**	1.213**
Traffic congestion charges	0.782*	1.186	0.894	0.951	1.016
Exemption of bicycle import tax	1.238**	0.966	0.940	1.107	1.314***
n	119	91	85	141	394
Pseudo R <sup>2</sup>	0.12	0.05	0.134	0.10	0.18
-2LL initial	151.948	124.820	114.412	155.772	460.836
-2LL final	143.243	121.100	105.531	150.935	412.041
Model $\chi^2$	$\chi^2(2)=8.71^{**}$	$\chi^2(1)=3.72^*$	$\chi^2(1)=8.88^{***}$	$\chi^2(1)=4.84^{**}$	$\chi^2(5)=48.8^{***}$

PC-C: Pre-contemplation versus Contemplation, C-PA: Contemplation versus Prepared for Action, PA-A: Prepared for Action versus Action, A-M: Action versus Maintenance, R-M: Relapse versus Maintenance

\* 10% significance level, \*\* 5% significance level, \*\*\* 1% significance level, otherwise considered insignificant

## 6.4.2 Discussion

The study examines the relationship between the perceived motivators, barriers and policy related interventions and bicycle commuting among regular commuters in the different stages of change of cycling behaviour. The analysis provides an understanding of the key influencing factors to target specific stages of change segments with an intention to promote bicycle commuting. The results indicate that the various factors are likely to be differentially effective. It is shown that there are clear differences in the effect of these factors to people in different stages of change of cycling behaviour. The effect appeared to vary especially among non-cyclists in early stages of change of cycling behaviour (pre-contemplation, contemplation) and cyclists in the late stages of change (action, maintenance). These results corroborate earlier findings reported in (Nkurunziza et al., 2012c), where it is shown that distinct groups need to be served differently to optimise the chance of realising changes in travel behaviour. The findings are in line with studies of consumer behaviour and marketing (Wedel and Kamakura, 1998), as discussed in section 2.

The study reveals some new insights specific to the Dar-es-Salaam context such as; reducing the cost of bicycles, exemption of bicycle import tax, providing good quality bicycles and introducing cycling training centres. These measures are shown to be important when promoting bicycle commuting, and are likely to be more effective when targeting commuters in their early stages of change of cycling behaviour especially those in the *contemplation* stage. Implementing those measures would encourage more people in the *contemplation* stage to think about trying cycling and consequently making transition into the *prepared for action* stage. The results further indicate that at least for commuters in the *maintenance* stage (commuter cyclists), a focus on the directness of cycling routes might be more important than other motivating factors. At the moment only people in the maintenance stage appear to cycle to daily activities despite the lack of direct routes and good cycling facilities (Nkurunziza et al., 2012c). In order for these motivational measures to have a strong impact on cycling promotion, it would require not only individual efforts but also government support. For instance, introducing a policy measure related to reducing the cost of bicycles by the government would allow many people to afford bicycles. Likewise, providing direct routes would undoubtedly have a strong impact on commuter cyclists to maintain their cycling behaviour and enhance coping with lapses.

The study results share some similarities with other findings from previous work. For instance, commuters in early stages of change of cycling behaviour (*pre-contemplation, contemplation, prepared for action*) perceive more barriers than their colleagues in the late stages of change of cycling behaviour (*action, maintenance*) (e.g. Gatersleben and Appleton, 2007; Shannon et al., 2006). Moreover, the study findings appear to have some consistencies with other research related to the impact of physical and personal barriers such as weather, lack of cycling paths, distance, lack of safety on the road, bad driver attitude and behaviour, not feeling comfortable on a bicycle and social (in)security on bicycle commuting (Davies et al., 2001, Gatersleben and Appleton, 2007, McClintock and Cleary, 1996, Wardman et al., 1997). Of most importance, however, the results suggest that working on the physical barriers alone is likely to have little impact on encouraging and increasing bicycle commuting levels. This finding supports prior research by Parkin et al (2008) where it is shown that provision of cycling infrastructure alone appears insufficient to engender modal change towards bicycle use. Giving more attention to personal barriers may be even more important than providing infrastructure, though what would matter most is working on a change of attitudes towards cycling such as social status, social (in)security and not feeling comfortable on a bicycle. At the moment many of those who have never contemplated cycling (*pre-contemplators*) believe they would feel strange on a bicycle, and for others, a

bicycle is perceived as an urban fringe mode of travel meant for the poor (Nkurunziza et al., 2010). Similar findings have also been found in other countries where the car is the dominant mode of travel (Pucher et al., 1999, Vandenbulcke et al., 2011, Pucher et al., 2010). In order to overcome such attitudinal barriers, a cultural change is essential, suggesting a need to improve the image of cycling so that it is seen as a daily travel mode that can be undertaken by almost any one. Although changing attitudes of commuters has traditionally not fallen within the realm of transportation planners, some studies suggest using information campaigns to improve the image of cycling (Pochet and Cusset, 1999, Daley and Rissel, 2011). Others propose encouraging more young people to cycle (Gatersleben and Appleton, 2007), and in doing so, one might create a generation of confident cyclists who view cycling as a more common activity.

While a focus on attitudinal changes and provision of favourable cycling environments remain important, the study indicates that some commuters would still face such barriers as many commitments before and after work and not being confident in cycling skills. This supports previous research by Handy and Xing (2011) where it is found that the need to run errands on the way to or from work discourages bicycle commuting. Planners will have to consider strategies that would assist to reduce these barriers. The results, moreover, do show a strong influence of barriers such as lack of cycling paths and lack of bicycle crossing signals at road intersections on bicycle commuting. Absence of these facilities seem to be important barriers for cycling especially to those who do not usually cycle since they cannot find direct and safer cycling routes to their activities. The importance of bad attitude and behaviour of car drivers towards commuter cyclists is also revealed, giving support to previous research by Basford. et al (2002) which shows that car drivers have a negative view regarding cyclists. Similarly, in an environment where cycling is very uncommon, Gatersleben and Appleton (2007) find that car drivers are not used to dealing with cyclists on the roads, suggesting a clear need for safer cycling routes.

Regarding the impact of the perceived policy interventions on bicycle commuting, 'pull' interventions such as exemption of bicycle import tax and guarding bicycles at public places are very important. In relation to bicycle import tax in Dar-es-Salaam, the charge on each imported bicycle is fixed at US\$5. This is around 12.5 % to 25% of the cost of a bicycle (second hand) from the industry before importation, estimated between US\$20-US\$40. Therefore, an intervention related to reduction or removal of this barrier would increase the likelihood of bicycle commuting. On the contrary, most 'push' interventions like car free zones, park and ride policies as well as car parking charges have indicated little influence on cycling. Although the little influence of these 'push' interventions may be tied to a limited experience

with such measures in the study area, some studies on acceptability of various transport policy measures show that people are more likely to accept positive (pull) measures than negative (push) measures (Anable, 2005).

While Pucher et al. (2010) suggest that a comprehensive approach produces much greater impact on cycling than individual measures, the findings in this study indicate that the very same individual motivators, barriers and/or policy interventions have different impacts on people in the different stages of change of cycling behaviour, making it risky to generalise about the effectiveness of any individual measure. When focusing on the various influencing factors, the results indicate that they can be harnessed by initially targeting efforts where there is potential for modal change i.e. those who are contemplating cycling and those who are confident they can cycle. Also, reducing the drop-out rate amongst those already cycling (commuter cyclists) presents a useful initial focus for efforts to promote bicycle commuting.

## **6.5 Conclusion**

This study identifies new and potentially important insights into the factors associated with bicycle commuting. The analysis reveals that the effect of the various motivators, barriers, and policy related interventions (i.e. personal, social and physical-environmental factors) varies among people in the different stages of change of cycling behaviour, which has major implications for targeting cycling promotional strategies. Most importantly, the results indicate that eliminating physical barriers alone is likely to have little impact on bicycle commuting promotion. Moreover, the stage of change model although traditionally associated with health promotion research, can indicate the potential for modal change and can be useful in transportation planning and policy development. The stages of change model along with the social-ecological approach can facilitate a process analysis and guide the modification and improvement of an intervention. For example, an analysis of the patterns of transition from one stage to another can determine if the intervention would be more successful with individuals in one stage and not with individuals in another stage. The approach has helped to identify key influencing factors which can be considered in preparation of more targeted measures to encourage modal change, whilst providing an understanding of how progression through the transitional stages of change of cycling behaviour would occur among individual commuters.

Factors including a low bicycle price, quality of bicycle and cycling training are the major influencing perceived motivators likely to have dramatic impact on bicycle commuting, especially among non-cyclists in the early stages of change of cycling behaviour. Direct cycling routes show a strong impact among the daily commuting cyclists. Physical factors like weather, lack of

safe parking at home and work place, lack of cycling paths and water showers at work place as well as personal factors such as social status, social (in)security and not being comfortable on a bicycle have the most negative influence on bicycle commuting. Policy related measures like exemption of bicycle import tax, car congestion charges, and guarding bicycles at public places are the most important perceived policy interventions. Certain factors that are reported to be strongly influential, like hot weather, may however, not seem modifiable. The study findings provide an indication to the aspects policy makers may want to address to promote bicycle commuting.

In order to have successful cycling policies in cities, there is a need to design the most appropriate package of policies for local conditions (Pucher et al., 2010). Moreover, designing policies for each city's particular situation requires careful planning and on-going citizen input. In this respect, the study findings are specifically more informative in a developing world city context where bicycle commuting is uncommon and the reported cycling influential factors have not yet been addressed. Finally, while this study provides richer and insightful information to increase the effectiveness of future cycling campaigns, it also suggests a need to expand the realm of strategies planners typically consider and to partner with other organisations with experience in bringing about attitudinal changes.

## **Chapter 7**

### **A retrospective study of behavioural transitions in bicycle use of commuters in Dar-es-Salaam<sup>12</sup>**

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## Abstract

Travel behaviour literature focusses on factors that influence individual travel behaviour, whether socio-demographic, related to urban form and land use or to attributes of available transport modes. Less attention is given to investigating changes in travel behaviour and a possible relation with events or stages in the life of individuals. This paper examines transitions in cycling behaviour of daily commuters in Dar-es-Salaam, Tanzania. The study adopts the stages of change model to profile individuals with respect to their bicycle use. A retrospective survey was conducted among 448 daily commuters with a stratified sampling method. Stratification was based on current behaviour and related to the stages: prepared for action, action, maintenance and relapse. The study reveals that the majority of people start to cycle around primary school age. At that age cycling provides prestige and is considered to be fun, and it is more attractive than walking when covering larger distances. No differences in this respect are found between people living in the city at that time and those in the rural areas, although in the latter case trip purposes for bicycle use show differences. Analysis of people in the relapse stage, i.e. when they have stopped cycling, indicates that transitions into the relapse stage occur from all other stages considered. In a considerable number of cases stopping to cycle coincides with an event in the life of the individual, e.g. leaving school, moving to the city, broken or stolen bicycle, involved in traffic accident, got married. A variety of reasons is reported as motivation to stop cycling, of which lack of (perceived) traffic safety is dominant. Moreover cycling experiences a strong competition from the dala dala, the local minibus shared taxis.

## **7.1 Introduction**

The recognition that transport systems need to become more sustainable is growing worldwide. In developing countries, high economic growth goes hand in hand with fast motorisation. It elicits the potential conflict between the strive for more sustainable transport and the ambition to improve the standard of living of people. In policy discussions on sustainable transport non-motorized transport is gaining importance (Brussel and Zuidgeest, 2012). The majority of Africans travel on foot, or to a lesser extent, by bicycle. Cycling levels in urban areas, however, are generally lower than one might expect. In Dar-es-Salaam, it is estimated that only 5% of the trips are made by bicycle (I-CE, 2007). Nevertheless, the future potential of cycling should not be underestimated: i) African cities are expanding fast and will continue to do so, making distances larger and unsuitable for walking; ii) good quality cycling infrastructure and facilities can contribute to reduction of poverty, particularly in the African context where access to jobs and services is poor because of long travel times, discomfort and unsafe conditions; iii) in cities cycling can provide a substantial contribution to the reduction of greenhouse gases in urban transport (Massink et al., 2011).

Although the city of Dar-es-Salaam has initiated programs to increase the availability and use of low cost mobility such as BRT (JICA, 2008), there is a lack of detailed knowledge about and understanding of current travel behaviour, and more specific the identification of groups of people that are transport policy responsive and might consider shifts in modes of travel, i.e. use a bicycle. In earlier work (Nkurunziza et al., 2012c, Nkurunziza et al., 2012b), the authors applied a market segmentation method that was based on a behavioural approach. In this approach, intentions to behaviour and actual behaviour are considered to be stages in a process. These stages were identified as market segments, and revealed to have different attitudes towards policy related interventions. The current paper presents the results of a retrospective study about the occurrence of transitions in behaviour (from one stage to another) and addresses the questions when these transitions take place in the life cycle of an individual, under what circumstances and why.

## **7.2 Conceptual model**

The conceptual model in this study is derived from the theory of behavioural change and builds upon the transtheoretical model of Prochaska *et al* (1984, 1997). This stage of change model posits that behavioural change is a transition through a time-ordered sequence of stages reflecting the cognitive and motivational difficulties people encounter in implementing a general behaviour change goal into concrete actions. The basic elements of the model are both motivational (dealing with intention building, decision making and

attitudinal readiness) and behavioural (the adoption process from stages of increased motivation, through tentative performance to regular practice of the behaviour).

The model has been developed and is widely used in health behaviour and health promotion research with a focus on physical activities (Marttila et al., 1998, Miilunpalo et al., 2000, Kloek et al., 2006). From this perspective, a link with cycling behaviour, or in a broader sense travel behaviour, is easily made. However, still few studies (Gatersleben and Appleton, 2007, Rose and Marfurt, 2005) have adopted the stages of change model for identifying and targeting pliable groups for travel behaviour change strategies. Previously, Nkurunziza *et al* applied the stages of change model to bicycle commuters in Dar-es-Salaam to investigate its potential for market segmentation (Nkurunziza et al., 2012c), and to study the different motivators and barriers for cycling for each of the segments (Nkurunziza et al., 2012b). As has been done in other studies, they slightly modified the operationalization of the stages of change model, and employed a different number of stages by adding a sixth stage (table 7.1).

Table 7.1: Stages of change

Stage	Characterization Prochaska <i>et al</i> [8,9]	Operationalization (w.r.t. daily activity) Nkurunziza <i>et al</i> [6,7]
Pre-contemplation	No intention to change	I never really think about or consider cycling
Contemplation	Thinking about change	I never used a bicycle but sometimes think about cycling
Prepared for Action	Intention to change shortly	I rarely or sometimes cycle but seriously consider to ride a bicycle
Action	Action being taken	I fairly often cycle
Maintenance	Has maintained action	I cycle regularly and almost everyday
Relapse	-	I no longer cycle

Nkurunziza *et al* (2012c) demonstrated the usefulness of the stages of change model in identifying homogeneous market segments in cycling attitudes and behaviour. The analysis revealed that neither cyclist segments nor non-cyclist segments in the stages of change process are the same, which has important implications for targeting cycling policies and promotional strategies. Their research also reveals that the effect of various motivators, barriers and policy interventions (i.e. personal, social and physical-environmental factors) varies among people in the different stages of cycling behaviour (Nkurunziza et al., 2012b).

This paper presents the results of a second survey where opposed to earlier work the focus is on transitions in the stages of change model, in particular the ones between cycling segments. In a retrospective study transitions between stages are investigated in coherence with events and stages in the life cycle of individuals.

### **7.3 Data collection**

The study was aimed at commuters who travel to main daily activities regularly and who currently use or have used the bicycle in the past for at least some or all of their trips. Main daily activities in this study are government/private office, personal commercial business and school/university. The restriction on commuters with bicycle experience implies that the study is constrained to the stages prepared for action, action, maintenance and relapse in the stages of change model. Based on local knowledge and earlier experiences (Nkurunziza et al., 2012c, Nkurunziza et al., 2012b, Nkurunziza et al., 2012a) the survey was conducted in pre-defined residential zones located along four major trunk roads in the city i.e. Morogoro, Bagamoyo, Nyerere and Kilwa Road.

In November and December 2010, data was collected through a questionnaire, where respondents were approached with face-to-face personal interviews in the evenings, i.e. between 14.00 and 19.00 hours, to meet commuters back home as official working time ends at 15.00 hours. The interview technique was used because of the length and complex nature of the questionnaire, which had separate sections after the initial phase in which the main purpose was to classify the respondent in a particular stage of change enabling appropriate subsequent questions about travel behaviour in the past. This approach is efficient, enables clarification of questions when needed, and reduces response errors.

The objective of the survey was to sample an adequate number of people in each of the four stages considered, and to collect data on current travel behaviour as well as (motivations for) changes in behaviour in the past on the one hand, and data on events and changes in the life cycle of respondents on the other. Data items in the latter category include year and location of changes in residence, school, jobs/work and marital status. Thereby, the survey has a retrospective nature and the sampling technique is stratified, where the strata correspond to the four stages of change. The targeted sample size for the stratum relapse was set 50% larger than for the other strata, because of the specific interest in why, when and where people quit using the bicycle.

## **7.4 Survey statistics**

Table 7.2 presents the main statistics of the survey. Within the time and budget constraints 448 well completed questionnaires were collected, of which some 100 for the stages prepared for action, action and maintenance each, and a little less than 150 for the stage relapse. Analogously to earlier experiences (Nkurunziza et al., 2012c), sufficient sample sizes for the stages prepared for action and action were the hardest to get. The unequal gender distribution in the sampled population is caused by three factors: i) most females in Dar-es-Salaam are not engaged in daily commuting activities, ii) less females in Dar-es-Salaam use a bicycle, and iii) some females were part of the non-response group, because they were afraid to provide information without permission of their partner.

Table 7.2: Sample distribution by segment, gender and place of birth.

Stage of change segment	Males N=390	Females N=58	Total N=448	% born in Dar 42
Prepared for action	89	16	105	45
Action	87	13	100	54
Maintenance	92	6	98	43
Relapse	122	23	145	32

A striking feature in the sample population is that the majority of respondents (58%) was born outside Dar-es-Salaam. It shows, as in most developing countries, the strong influx of migrants from rural areas into cities. Dar-es-Salaam is one of the fastest growing cities on the African continent with an average annual growth rate of 4.67% over the period 1990-2010, and an estimated population of more than 3.3 million inhabitants in the year 2010 (UN-Habitat, 2012). The vast majority of respondents born elsewhere moved to Dar-es-Salaam in their twenties.

The age of respondents varied between 15 and 70 years, but most of them (73%) were aged between 20 and 40 years. The average age of the sample population, 30.6 years, was identical to an earlier survey (Nkurunziza et al., 2012c), although there were tiny differences between the segments: prepared for action (30.8), action (28.8), maintenance (27.8) and relapse (33.7). In the sample population 48% of the respondents were married (46% of the males, 62% of the females).

Table 7.3 indicates that there is a correlation between bicycle use and the type of daily activity. Private commercial business is dominant in both the action and maintenance segment. This is not surprising since a lot of people in Dar-es-Salaam, alongside their formal work, earn their daily living from

informal small business for which they often use a bicycle. On the other hand, office work - whether private or governmental-is represented considerably in the stages prepared for action and relapse. The representation in the relapse stage suggests a link between bicycle use and status/income, since as a rule office work pays better. The modest share of students in the sample is influenced by the survey design, allowing only respondents of 15 years and older.

Table 7.3: Sample distribution by daily commuting activity and segment.

Daily commuting activity	Prepared for action N=105	Action N=99	Maintenance N=95	Relapse N=144
School/university	18%	18%	14%	8%
Office work	50%	31%	25%	66%
Private commercial business	32%	51%	61%	26%

## 7.5 Results

In a retrospective survey - in the context of an African city - it is hard, if not impossible, to collect detailed, reliable and accurate data for all transitions in the stages of change model. Some of the transitions, e.g. between prepared for action and action, and between action and maintenance, are supposed to pass off gradually, and might be difficult to reconstruct by respondents. Two exceptions are prominent: the start of the bicycle career, and the (temporary) ending of it. All respondents have been asked a number of questions about the start of their bicycle career (e.g. timing, location, motivations, bicycle use). Respondents categorized in the relapse stage were also asked questions about timing, location and motivations when they stopped cycling, as well as their bicycle use just before the stopping moment. All these data are combined with the historical data of the respondents (schools, jobs, places of residence, year of marriage, etc.).

### 7.5.1 Start of the bicycle career

Table 7.4 shows, as expected, that most people start to cycle at a very young age and many before, at the start or during primary school. In this respect no differences are found between males and females in the sample. Table 7.5 shows the main drivers for adopting the bicycle as a mode of transport. Respondents were allowed to mention multiple motivations. The results indicate that at those ages social norms ('seeing others cycling') and peer pressure play an important role to start cycling. It provides young bicyclists prestige and cycling is considered to be fun. For young people the bicycle has a positive image: it is a step forward in their mobility career, in which previously walking was the main mode of transport. Bicycle availability at

home stimulates cycling at earlier ages, and in quite a number of cases the purchase of a bicycle by parents was decisive. Convenience of the bicycle is another important driver: for travel over larger distances it saves considerable time, the bicycle is suitable as a means of transport to carry goods, and it is often the only affordable alternative mode for walking. Other reasons were mainly health and sports related.

Table 7.4: Age and life cycle stage at the start of the bicycle career.

Age	N=440	Life cycle stage	N=440
0-9 years	33%	before school	primary 17%
10-14 years	47%	at start school	primary 22%
15-19 years	14%	during school	primary 44%
20-24 years	4%	later in career	school 7%
25 years and older	2%	during career	work 10%

Table 7.5: Categories of drivers for adopting the bicycle.

Drivers for adopting the bicycle	Sample N=448
Conforming behaviour / peer pressure	266
Prestige and fun	126
Convenience / travel distances	117
Bicycle availability at home	94
Lack of alternative travel mode options	60
Means of transport	56
Other reasons	20

The dominant trip purpose of initial bicycle use (table 7.6) is social and recreational activities: visiting relatives and friends, and sports/playing activities. For home related activities, e.g. fetching water and firewood or going to the farmland, the bicycle is also popular, in particular in rural areas where the supporting role of young family members is strong and distances are substantial. Some 27% of the young cyclists use the bicycle to go to school (primary, secondary, college or university); although bicycle use for school trips in rural areas is somewhat higher, the difference is not notable.

For the small proportion of respondents, for whom the starting moment of cycling falls outside the education period or before and coincides with their

working phase (table 4), the following characteristics apply: at that stage they are predominantly between 15 and 25 years old, have no or only primary education, earn a living in personal commercial business, and use the bicycle to carry goods over larger distances. They live more in the city than outside.

Table 7.6: Trip purposes of initial bicycle use, broken down by place of residence.

Trip purpose	Total sample	Living in Dar-es-Salaam	Living outside Dar-es-Salaam
	N=446	N=219	N=227
Social/recreational	71%	81%	62%
Home related activities	48%	25%	70%
School	27%	24%	30%
Business/work	13%	17%	10%
Market/shopping	7%	7%	7%

Analysing the data in more detail by market segment, i.e. stage of change, reveals that no significant differences can be found with respect to timing, conditions, drivers and trip purposes of initial bicycle use. Therefore, the circumstances under which bicycle use has started, has no demonstrable correlation with cycling behaviour in a later stage, at least with respect to the categorisation in behavioural stages of change as applied in this study.

### 7.5.2 Stopping with cycling

Historical data of respondents in the relapse stage, i.e. people who have cycled before but do not cycle anymore, provides information about the decision to stop the use of the bicycle.

Table 7.7: Relapse stage sample by previous stage and length of cycling period.

Previous stage	Cycling period			Sample N=145
	One year or less	From 1 to 5 years	More than 5 years	
Prepared for action	3	8	33	44
Action	2	9	16	27
Maintenance	-	15	59	74
Total	5	32	108	145

Table 7.7 shows that transitions occur from all other stages considered: it suggests that the stages of change model the way it is applied in this study does not follow a time-ordered sequence of stages, but that cyclists in both the prepared for action, the action and the maintenance stage can make a direct transition into the relapse stage. It occurs most often from the maintenance stage (51%), followed by the prepared for action stage (30%). The table also shows that most people (74%) have cycled for a considerable time period, i.e. more than 5 years. From a marketing and transport policy perspective, it is worth mentioning that the people who have cycled on an everyday basis (i.e. the maintenance segment) for at least 5 years or more constitute the largest subgroup of the relapse segment.

The average age at which people from the relapse segment end their cycling career is 23.0 years after an average cycling period of 11.4 years. In the survey respondents were interviewed extensively about timing and motivations for stopping. These data were compared, checked and analysed with the historical data collected in another part of the questionnaire dealing with retrieving main events in the life cycle of the individual. The objective of this analysis was to investigate whether a behavioural change in bicycle use, i.e. in this case ending to cycle, coincides with events in a person's life.

Table 7.8: Mapping the end of the cycling career upon (timing of) events.

End time of cycling career	Sample	
	N=145	
No event detected	53	
Coincides with event	92	
of which		
moving to the city		38
start/change of work/job		31
end/change of school		29
involved in road accident		16
got married		10
moving within the city		5

Remarkably, in 63% of the cases a direct relationship could be found with an event in a person's life (table 8). This result indicates that people often reconsider their travel mode choice at time instants when major changes take place in location and/or nature of daily activities, or due to personal conditions/experiences. From a transport policy perspective this is an important finding. Moving to the city Dar-es-Salaam appears to be a reason

to stop cycling. This event often coincides with a change in school (college or university) or a change in work/job. Many factors can explain this behaviour: i) people do not take their bicycle along when moving, ii) people settle in neighbourhoods far from the main activity centres, iii) the city offers affordable alternative travel modes, and iv) cycling infrastructure is absent or has poor quality, and therefore cycling is perceived as very unsafe. These explanations are confirmed by the answers of respondents to the question which factors contributed to quit cycling: no bicycle available anymore (28 times), travel distances too far and thereby too time consuming (21), other transport options e.g. the local minibus shared taxis, dala dala (18), lack of adequate bicycle infrastructure (30) and fear for road accidents (75). The (perceived) lack of traffic safety for cyclists in Dar-es-Salaam appears to be alarming: this finding is affirmed by the substantial number of people that stopped cycling immediately after they or their relatives were involved in a road accident on a bicycle (table 7.8).

There are also social and cultural factors involved in why people stop cycling. After a certain juvenile age, the originally positive image of the bicycle (at the start of the cycling career) changes dramatically, and the bicycle gets associated with a poor man's mode of transport. Answers in the survey like "feel ashamed to ride a bicycle" and "fellow students laughed at me when riding a bicycle" are manifestations of this huge change of image. As soon as people envisage a higher status in the future and can afford other modes of transport, they quit cycling and fully neglect potential advantages of bicycle use (e.g. avoiding traffic jams, flexibility, pollution reduction, health issue). This behaviour reinforces the negative image of the bicycle. Currently, low income people doing private informal business is the dominant group in the maintenance segment [6]. If one is interested in promoting bicycle use, one has to break this vicious circle.

Although the number of females in the sample is rather low, it should be noted that a number of them explicitly stated that they had to stop after marriage or after giving birth to a child, because their husband did not give permission to continue to cycle. Females also said to stop because they were afraid of losing their virginity. It shows that there are still many fallacies on this subject.

Another group of people (some 16%) stop cycling as soon as they own a car or a motor-cycle. Although the purchase of a car or motor-cycle could also be considered as an event in a person's life, this group belongs to the category 'no event detected' in table 7.8. The group is rather homogeneous and consists of males aged between 25 and 50, who do office work (private or governmental), belong to the highest income class, and use their vehicle on a daily basis to their work.

The final subgroup in the relapse stage (some 20%) decided to stop cycling based on an appraisal of attributes of the bicycle system (e.g. costs, time, comfort, safety) in comparison with alternative modes of transport. According to the information contained in the survey, their decision cannot be related to any specific event. Factors mentioned are: purchase costs of a bicycle, travel time by bicycle, weather conditions, physical effort, and lack of road safety. The majority of these people use dala dala for the travel to their daily activity. Others use private motorized transport (car/motor-cycle owners) or walking (shorter distances).

### **7.5.3 Other findings**

As has been mentioned earlier, other transitions between stages are hard to catch in a retrospective survey in the African context, because they usually take place gradually and more slowly. However, respondents in the prepared for action, action and maintenance stage were asked whether they have stopped cycling temporarily in the past. A small minority (less than 10%) confirmed that they did. Causal factors mentioned are: attending boarding school, health issues and loss of the bicycle (stolen or broken). Time periods in which they did not ride a bicycle vary from a few months till 4 to 5 years.

In section 5.2 it was shown that a large proportion of people in the relapse stage stopped with cycling when moving from the country to the city. In this respect it is interesting to look also at the people, that started cycling before coming to Dar-es-Salaam, and that continued to cycle after arriving in the city. The data base does not allow to calculate the percentage of people that falls into this category because of the stratified sampling method. However, analysis of the data per stratum reveals that it concerns 51% of the prepared for action, 40% of the action and 49% of the maintenance segment. At the time of the survey they were on average for a period of 9.6 years living in Dar-es-Salaam and still cycling. These findings indicate that also a substantial part of the population that migrated to the city continues to ride a bicycle for a considerable period of time as well. Therefore, one needs to be careful in drawing conclusions: moving to Dar-es-Salaam does not necessarily imply that people quit cycling, but for a number of people the decision to quit cycling coincides with their move to the city.

## **7.6 Discussion and conclusions**

Cycling has a huge potential in African cities: it provides better access to activities and facilities, creates more employment opportunities and enhances the maintenance of social networks and community cohesion (Bryceson et al., 2003). For most Tanzanians bicycles are relatively inexpensive and affordable compared to other travel modes (Brussel and Zuidgeest, 2012). Many Tanzanians are introduced to cycling when they are young, both in

rural areas and in cities. This study shows that at that age the bicycle is supportive and attractive in saving time in home and school related activities. Dar-es-Salaam is the commercial centre of Tanzania and a hub that connects the country to the rest of the world. Its employment opportunities attract many people to migrate to the city, and the city grows fast in population size and in area. The main structure of the city road network consists of four major arterials radiating from the city centre areas Kariakoo and Kivikuni to the north, north-west, west and south, complemented with a dense road network in urban areas. Most roads do not have footways or separate lanes for bicycle traffic, and many roads have poor surface conditions. Existing bicycle lanes, where they exist, fail to ensure connectivity and access to popular destinations.

The absence of basic requirements for a fit-for-purpose bicycle network and the lack of road safety, together with a poor government transport policy regarding non-motorized transport (JICA, 2008), explain why many people in the city quit cycling and why only a low percentage of trips in Dar-es-Salaam is made by bicycle. People migrating to the city often decide not to use the bicycle anymore as soon as they arrive in the city, and also many residents take that step and change their travel mode in due time, often simultaneously with a change in school, work or place of residence. As a consequence, these decisions generate a loss in mass and variety of bicycle use, make the bicycle appearance even more rare and thereby more dangerous, and strengthen the image that cycling is for captive users with low incomes.

A remarkable finding is that the originally positive image that young people attribute to the use of the bicycle (prestige, fun, convenience) changes completely and to the worse within a number of years. At the time they leave school, they feel ashamed to ride a bicycle. Social norms and peer pressure play an important role in this respect. It suggests that promotional campaigns to promote cycling should include educational programmes for primary and secondary schools focussing on cycling-inclusive transport and the aspects of sustainability, liveability and health. Such campaigns could be made even more effective by the supply of a larger variety of fancy (and more expensive) bicycles, since status appears to be important and new generations are sensitive for making steps in their mobility pattern and behaviour.

Behavioural changes with respect to using the bicycle appear to occur when activity locations of people change: school/college/university, business/office and home. Then travel modes are reconsidered, and in many cases the dala dala seems to be a tough competitor with the bicycle. It implies that integrated spatial and transport policies need to be developed where planning

of bicycle networks and parking facilities is integrated with spatial planning of main activity centres. Taxing and financing schemes that relieve and/or spread out the costs of purchase of a bicycle could further strengthen the position of the bicycle in competition with other transport modes.

From a methodological perspective, it can be concluded that the stages of change model appears to be very useful. In this retrospective study with the objectives of detecting transitions in behaviour in bicycle use in the city of Dar-es-Salaam, investigating the coincidence with important events in the life cycle of individuals and deriving motivations for behavioural change, new insights have been gained that can be useful for transport policy development and planning with a focus on promoting bicycle use. As such it adds to earlier experiences with behavioural market segmentations (Nkurunziza et al., 2012c) and deriving segment- specific motivators and barriers for changing attitudes and behaviour of cycling (Nkurunziza et al., 2012b).

## **Chapter 8**

## **Synthesis**

## **8.1 Introduction**

Most of the urban transport problems affecting developing world cities relate to a combination of historical shortcomings in policy and planning, and recent worldwide trends in urbanization and motorization. While the historical deficiencies are mainly a consequence of the lack of both human and financial resources, the recent problems are essentially an extension of the strong reliance on the automobile as the main transport alternative to provide mobility to urban citizens. Urban mobility issues have been treated in Dar-es-Salaam until recently essentially as a question of provision of transport services. The results of this process can be described by the provision of road transport infrastructure, the prioritization of individual transport to the detriment of public transport, the disregard of non-motorized modes and the complete separation between urban and transport planning. These uncoordinated actions have resulted in the loss of financial resources, the lack of social control and the disregard of environmental questions in the planning of urban transport in Dar-es-Salaam.

These issues were already noted some years ago by Kanyama et al.(2004) who state that poor transit supply, low accessibility, badly maintained vehicles, discomfort, congestion, pollution and accidents are daily problems faced by most people living in Dar-es-Salaam. Sohail et al. (2006) also observed that the socio-political and economic structural conditions maintain social exclusion, poverty and unemployment and confine the decision-making process to selected groups. Moreover, private motorized transport has often been favoured and local public transportation and non-motorized modes have been neglected. The consequential worsening of the resulting urban mobility problems of the city and its transport system has stimulated the development of sustainable transport options such as the introduction of the bus rapid transit (BRT) system and cycling. The city of Dar-es-Salaam has decided to implement a bus rapid transit system called the *Dar Rapid Transit (DART)* and also to invest in cycling infrastructure as an integral part of the BRT project (JICA, 2008). These sustainable transport initiatives are intended to address poverty and inequality including the effects on improving health and wellbeing, the environment and people's access to urban basic services.

While there is an increasing interest in policy and development of sustainable transport infrastructure i.e. BRT and cycling, there is a lack of understanding about how these sustainable travel modes can effectively realise their potential to address the daily urban mobility problems and their consequences in Dar-es-Salaam. With respect to the BRT specifically, the success of such system will be dependent upon the ability of the operator to provide the level and quality of service expected by the users against a tariff that is affordable. Also, the fact that cycling is not considered a travel option, let alone an alternative, by many, in most African large cities, suggests the

need for thorough investigation into bicycle commuting behaviour. This thesis addressed a number of key questions related to this: First, how do commuters perceive and value the proposed BRT service quality? Second, how does this perception of service quality vary over space? Third, how to define and characterise potential cycling market segments? Fourth, what socio-demographic and travel pattern-related factors affect bicycle commuting behaviour? Fifth, what motivators, barriers and policy-related interventions are likely to influence bicycle commuting behaviour? Sixth, what life cycle events influence bicycle commuting behaviour? More specifically, when do transitions in cycling behaviour occur in the lifecycle of an individual, under what circumstances and why?

In short, this thesis has investigated whether the proposed BRT system will deliver quality service expected by its potential users. The thesis has also tried to identify who are those likely to take up cycling and to explain how and why individual commuters vary in their decision to (not) commute by bicycle. This knowledge will enable policies to be formulated that improve and promote the use of sustainable travel modes, thus creating a more sustainable and healthy society.

The remainder of this chapter is organized as follows. First, the findings of the six papers are summarized, each addressing one research question (Section 8.2). Section 8.3 reflects on the results. Next policy implications of the findings are discussed (Section 8.4). This chapter ends with directions for future research and final remarks (Sections 8.5 and 8.6).

## **8.2 Overview of main findings**

This section provides an overview of the findings by answering the six sub-questions, followed by the outcome of the main research question.

### **1. How do commuters perceive and value the proposed BRT service quality?**

Chapter 2 attempted to evaluate the proposed BRT service quality on the basis of travel time, travel fare and in-bus comfort attributes through analysis of commuters' stated preferences. The results obtained through estimating a binary logit model show - in order of importance - that generally commuters are willing to pay the highest price for travelling in a more comfortable environment, followed by shorter travel times and paying lower travel fares. More important, the results indicate the differences in valuation of the attributes based on spatial location of the sampled population in the city. A higher preference for in-bus comfort is indicated by commuters from zones close to the central business district (CBD) while commuters from the

city peripheral zones seemed to have a higher preference for travel fare and travel time.

**2. How does the perception of the proposed BRT service quality vary over space? Specifically, where is the proposed BRT service highly or less valued compared to the commuting service offered by the existing public transport?**

Chapter 3 was able to integrate behavioural models into GIS to spatially analyse the effectiveness of the BRT service. Integrating the derived random utility functions from stated choice modelling to GIS made it possible to spatially analyse the potential user preferences and to identify the user preference variation between residential zones. A scenario-based approach is used to evaluate the effect of the proposed BRT service by comparing the 'without DART' scenario, a case representing the existing public transport (daladala), and a 'DART' scenario, representing the future proposed BRT system. The study findings show that (in-bus) comfort is the most important variable with great contribution to the BRT utility compared to travel fare and travel time attributes. More importantly, the findings further revealed that the importance of these attributes varies with respect to radial distance from the central business district (CBD). Comfort is more important attribute in zones up to 5 km from the CBD, travel fare is more important in zones between 5 and 15 km from the CBD, while travel time is more important in zones beyond 15 km distance from the CBD.

The results generally show that the BRT is more preferred to the existing daladala service. Zones located along the BRT main trunk corridor and in the city periphery have indicated higher preferences, suggesting high satisfaction with the BRT service. Despite the general high preference for the BRT service, the BRT is likely to have no effect on some zones and in some cases it is likely to decrease service quality. The study findings revealed that 68% of the residential zones have higher preferences in favour of the BRT. 16% of the zones reported neither increase nor decrease of preferences for the BRT compared to daladala, while the remaining 16% have reported decrease in preferences in favour of daladala service.

**3. How to define and characterise potential cycling market segments? Who are the 'easy to reach' (and 'hard-to-reach') markets for bicycle commuting?**

Chapter 4 demonstrates the utility of the stages of change model in providing a way of extracting naturally occurring and relatively homogeneous travel market segments for cycling. To better understand how people would change their travel behaviour, the stages of change model was able to identify six potential cycling market segments i.e. *pre-contemplation* stage,

*contemplation stage, prepared for action stage, action stage, maintenance stage and relapse stage.* The results show that neither cyclist segments (*prepared for action, action, maintenance*) nor non-cyclist (*pre-contemplation, contemplation, and relapse*) segments in the stages of change process are the same, which has important implications for targeting cycling policies and promotional strategies. The results indicate that urban policies and marketing strategies, which aim to promote bicycle use, may first target the *contemplation, prepared for action and action segments* that are most motivated to change and willing to cycle. The results also demonstrate that different strategies addressing different segments may need to be adopted in order to optimise the chance of influencing travel behaviour change in the short and long term. Long term changes may require general campaigns and provision of bicycle facilities whereas in the short term, cycling may be increased by helping those who are prepared to take action and those in action to cycle more often by reducing the cost of bicycles and enforcing road safety rules.

#### **4. What socio-demographic and travel pattern-related factors affect bicycle commuting behaviour?**

The fourth paper (chapter 5) tries to identify how bicycle commuting decisions are influenced by socio-demographic and travel pattern-related factors with an emphasis on the behavioural differences between the different stages of change of cycling behaviour. The main findings in this chapter show that socio-demographic and travel pattern-related factors influence an individual's stage of change of cycling behaviour. The results show that bicycle commuting in Dar-es-Salaam decreases with one's increase in monthly income, having a higher level of education, being a female and having a motorised vehicle at home when examining the different stages of change of cycling behaviour in comparison to the pre-contemplation stage. Travelling for private businesses and school commuting has a positive impact on bicycle commuting in particular for the maintenance stage of change of cycling behaviour. Conversely, an increase in one's level of income, having a higher level of education, being a female and availability of motorised vehicles at home generally decreases the probability of bicycle commuting behaviour. Differences were found between stages of change of cycling behaviour based on a combination of factors such as individual monthly income, travel distance and frequency of travel to daily activities. The differences in the effect of these factors across the various stages support the need to segment the population. The results lend support to the need to develop different interventions for individuals with different characteristics.

**5. What motivators, barriers and policy-related interventions are likely to influence bicycle commuting behaviour in Dar-es-Salaam?**

Chapter 6 shows that the stages of change model along with the social-ecological approach can facilitate a process analysis and guide the modification and improvement of an intervention. This chapter shows that an analysis of the patterns of transition from one stage to another can determine if the intervention would be more successful with individuals in one stage and not with individuals in another stage. The approach has helped to identify major influencing factors which can be considered in preparation of more targeted measures to encourage modal change, whilst providing an understanding of how progression through the transitional stages of change of cycling behaviour would occur among individual commuters. The findings show that the effect of the various motivators, barriers, and policy related interventions (i.e. personal, social and physical-environmental factors) varies among people in the different stages of change of cycling behaviour, which has major implications for targeting cycling promotional strategies. In particular, the effects vary among people in the early stages of change of cycling behaviour (pre-contemplation, contemplation) and those in the late stages of change (action, maintenance). Most importantly, the results reveal that eliminating physical barriers alone is likely to have little impact on bicycle commuting promotion.

The perceived motivators that are likely to have strong impact on bicycle commuting include low bicycle price, quality of bicycle and cycling training especially among non-cyclists in the early stages of change of cycling behaviour. Direct cycling routes show a strong positive impact among the daily commuting cyclists. Physical factors like weather, lack of safe parking at home and work place, lack of cycling paths and water showers at the work place as well as personal factors such as social status, social (in)security, and not being comfortable on a bicycle have the most negative effect on bicycle commuting. Bicycle import tax exemption, car congestion charges, and guarding bicycles at public places are the most important perceived policy related interventions. The study findings provide an understanding of the key influencing factors that can serve as an empirical basis for development of more effective targeted measures to encourage modal change towards bicycle use.

**6. What life cycle events influence bicycle commuting behaviour? More specifically, when do transitions in cycling behaviour occur in the lifecycle of an individual, under what circumstances and why?**

To answer this question, a retrospective survey was used and the study adopts the stage of change model to investigate the possible relationship between changes in travel behaviour and events or stages in the life cycle of individual commuters (see chapter 7). The findings show that people migrating to the city often decide not to use the bicycle anymore as soon as they arrive in the city, and also many residents take that step and change their travel mode in due time, often simultaneously with a change in school, work or place of residence. The results reveal that the majority of people start to cycle around primary school age. At that age cycling provides prestige and is considered to be fun, and it is more attractive than walking when covering longer distances. No differences in this respect are found between people living in the city at that time and those in the rural areas, although in the latter case trip purposes for bicycle use show differences. Analysis of people in the relapse stage, i.e. when they have stopped cycling, indicates that transitions into the relapse stage occur from all other stages considered. In a considerable number of cases stopping to cycle coincides with an event in the lifecycle of the individual, e.g. leaving school, moving to the city, broken or stolen bicycle, involved in traffic accident, got married. A variety of reasons is reported as motivation to stop cycling, of which lack of (perceived) traffic safety is dominant. Moreover cycling experiences a strong competition from the daladala, the local minibus.

These findings combined allow us to answer the main research questions:

**7. To what extent is the proposed BRT system likely to deliver quality service expected by its potential users? Who are the potential bicycle commuters and in what way do individual commuters differ in their decision to commute by bicycle? To what extent are these differences in bicycle commuting decisions affected by personal, social, physical-environmental factors and events that occur in the life cycle of an individual?**

To answer these, the thesis attempts to identify the key spatial factors, attitudinal factors and perceptions that can explain people's preferences for sustainable transport modes, such as cycling and Bus Rapid Transit (BRT). The thesis further investigates how such factors may vary over space and by identifiable group of individuals, and how changes in behaviour coincide with life events. The research demonstrates how these factors can be used to derive sustainable urban transport policy in the context of Dar-es-Salaam. The main conclusions drawn from the research are briefly discussed.

With respect to the proposed BRT service quality, the research indicates that the BRT is likely to be more attractive than the existing public transport system (*daladala*). The study findings suggest that only through providing a commuting service characterised by better comfort, lower travel times and lower travel fares will the BRT be attractive to its potential users. However, the results have clearly shown that (in-bus) comfort is the most important attribute with great contribution to the BRT utility compared to travel fare and travel time. More importantly, the results reveal that the BRT utility varies spatially, particularly dependent upon distance to CBD. Comfort is the more important attribute in zones up to 5 km from the CBD, travel fare is more important in zones between 5 and 15 km from the CBD, while travel time is more important in zones beyond 15 km distance from the CBD.

With regard to cycling, the research is able to show that the approach of stage of change model is useful in capturing the heterogeneity of commuters and identifying the potential bicycle commuters. The study results reveal that urban policies and marketing strategies which aim to promote bicycle use may first target the *contemplation, prepared for action* and *action segments* that are most motivated to change and willing to cycle. The research findings show that the effect of the various perceived motivators, barriers, and policy related interventions (i.e. personal, social and physical-environmental factors) varies among people in the different stages of change of cycling behaviour. In particular, the effects vary among people in the early stages of change of cycling behaviour (pre-contemplation, contemplation) and those in the late stages of change (action, maintenance). Of particular importance, the research reveals that eliminating physical barriers alone is likely to have little impact on bicycle commuting. A remarkable finding in relation to analysis of changes in travel behaviour with respect to the lifecycle of an individual is that the originally positive image that young people attribute to the use of the bicycle (prestige, fun, convenience) changes completely and to the worse over time. At the time they leave school, they feel ashamed to ride a bicycle. Social norms and peer pressure have been shown to play an important role in this respect. The research clearly show that neither cyclist segments (*prepared for action, action, maintenance*) nor non-cyclist (*pre-contemplation, contemplation, and relapse*) segments in the stages of change process are the same, which has important implications for targeting cycling policies and promotional strategies.

This thesis provides evidence that different groups of commuters exist and that the modal choice decisions of individual commuters and the potential for modal change within these groups depends on different factors. The research results also lend support to the need to develop interventions differently for individuals with different characteristics.

### **8.3 Reflection**

In most developing countries, population preferences are hardly taken into account by planners and policy makers, consequently not meeting the desires of the society under question. The stated preference (SP) approach and the logit model derived in this research can be used to integrate the views of the society in planning especially in evaluating new public transit services or changing existing ones. This gives logit models a very strong policy role by assisting analysts and planners in evaluating the impact of many policies as defined by specific mixes of attributes modelled in utility expressions. Moreover, the use of pictorial choice cards in the presentation of choice scenarios offers a great promise. Not only were all the expected advantages of the approach fully realised, but also the medium was believed to contribute in no little measure to obtaining the choice data and making the exercise more pleasurable to respondents (i.e. less of a burden). The survey instrument contributed to obtaining better responses and a higher response rate than if a different approach had been used. The survey approach is found to be most appropriate and effective to use in cases of hypothetical alternatives, particularly in the context of a developing country with a high proportion of illiterate population.

This research has provided a framework for analysing urban public transit systems and their potential for providing and improving service quality as desired by the urban population. The study attempted to spatially analyse the effectiveness of the proposed BRT service by integrating behavioural models into GIS. Using a scenario-based approach, behavioural models from stated choice analysis were integrated into the GIS multimodal network model for spatial analysis of the proposed BRT service quality. To my knowledge, this is a novel approach, in particular within the context of integrating random utility models into geo-spatial models. Linking the derived random utility functions from stated choice modelling to GIS made it possible to spatially analyse the potential user preferences and to identify the preference variation between residential zones.

This study has also demonstrated the utility of the stage of change model in providing a way of extracting naturally occurring and relatively homogeneous travel market segments. The model can help to indicate the potential for modal change and to identify how interventions can effectively target individuals who are at different stages of behavioural readiness. More interesting is that this research has tried to integrate the stages of change model with the social-ecological approach which can facilitate a process analysis and guide the modification and improvement of an intervention. For instance, an analysis of the patterns of transition from one stage to another can determine if the intervention would be more successful with individuals in one stage and not with individuals in another stage. The integrated approach

has helped to identify key influencing factors which can be considered in preparation of more targeted measures to encourage modal change, whilst providing an understanding of how progression through the transitional stages of change of travel behaviour would occur among individual commuters. Furthermore, the stage of change model also appears to be very useful in retrospective studies with the objective of detecting transitions in travel behaviour, investigating the coincidence with important events in the life cycle of individuals and deriving motivations for behavioural change, new insights have been gained that can be useful for transport policy development and planning with a focus on promoting sustainable travel modes such as BRT and cycling.

#### **8.4 Implications for policy**

This thesis provides policy implications of the research findings which can be useful in promoting use of sustainable travel modes. This section reflects on the usefulness for planners and policy makers and the possibilities to transfer the study findings in policy strategies. First, the importance of segmenting the travel market is explained. Second, possible practical incentives for marketing of sustainable travel modes such as BRT and cycling are explored.

##### ***Different focus by different population segments***

This research revealed that the decision to commute by sustainable modes such as BRT and cycling is based on different factors for different commuter groups. This information is critical to designing transit services that meet the needs of target market segments and for encouraging bicycle commuting, as the different groups are motivated to cycle in different ways. This information is also very useful in indicating 'who are the easy to reach' markets to target travel behaviour change strategies. Policies might be more effective in their aim to encourage and market sustainable modes such as BRT and cycling if they addressed one specific group at a time.

With regard to the BRT, the research findings suggest that only through providing a commuting service characterised by better comfort, shorter travel times and lower travel fares will the BRT be attractive to its potential users. These findings imply that planners and policy makers should pay more attention and consider all the three attributes important when providing the BRT service. However, in priority cases, particular attention should be given to (in-bus) comfort, which proved to be the most important factor in terms of its contribution to the BRT utility. More importantly, planners have to consider that the BRT utility varies spatially, particularly dependent upon distance to CBD.

To improve the proposed BRT service quality, BRT feeder route networks should be planned and extended in a more cost effective manner by emphasising on zones with low satisfaction (utility) levels and those with

limited access routes to BRT. Residential zones with planned BRT feeder route networks but indicating low satisfaction indicate a need to improve the locations of the BRT feeder stops and transfer points. For transit operators, knowledge about the desired service quality provides operating companies with an answer to their investment questions and establishes the basis for designing future policies to encourage greater use of public transit based on the needs and expectations of their potential customers.

With regard to cycling, the research clearly revealed that different strategies addressing different cycling segments may be adopted in order to optimise the chance of realising the potential for modal change in the short and long term. Long term changes may require general campaigns and provision of bicycle facilities whereas in the short term, cycling may be increased by helping those who are prepared to take action and those in action stages to cycle more often by reducing the cost of bicycles and enforcing road safety rules. In terms of improving the image of cycling, the research suggests that promotional campaigns to promote cycling should include educational programmes for primary and secondary schools focussing on cycling-inclusive transport and the aspects of sustainability, liveability and health. Such campaigns could be made even more effective when targeting individuals in the contemplation stage of change by the supply of a larger variety of fancy (and more expensive) bicycles, since status appears to be important and new generations are sensitive for making steps in their mobility pattern and behaviour. In relation to competition of cycling with other modes, the research results imply that integrated spatial and transport policies need to be developed where planning of bicycle networks and parking facilities is integrated with spatial planning of main activity centres. Taxing and financing schemes that relieve and/or spread out the costs of purchase of a bicycle could further strengthen the position of the bicycle in competition with other transport modes.

#### ***Possible Incentives***

The government could exempt taxes on the purchase of bicycles to encourage bicycle commuting. The study has shown that the bicycle is expensive to afford for most of the urban population and thus initiatives taken to reduce or removing taxes on imported bicycles can have a great positive impact.

### ***8.5 Directions for future research***

This thesis provides an example of how a multi-disciplinary approach mainly using methods from economic, travel behaviour, marketing and psychological theories can give results that may help to improve the understanding of sustainable travel behaviour, contribute to the design of effective and better

targeted policy strategies to market BRT and cycling. In this final section few valuable directions for future research are highlighted.

Our findings have several implications for research and practice. The study shows that the stages of change model is a useful method for analysing changes in travel behaviour and allowed us to determine the potential for modal change. However, we could not answer thoroughly why the specific stages of change segments need more attention to proceed in the behavioural change process. Therefore, future research should focus on why people decide to change travel behaviour by further analysis of causal links between stages of change of travel behaviour and lifecycle of individual commuters. Also, most of the commuting population in Dar-es-Salaam are categorised in the relapse stage and the fact that this group of people seems heterogeneous, emphasizes the need for further investigation. Further research on the choice of more attributes for the BRT to be included in questionnaires while keeping in mind the context and nature of conducting such surveys in developing cities, various model structures and the use of more advanced logit models for more complex modelling of travel behaviour decisions is required.

This research mainly used cross-sectional study design methods and provides a starting point for interventions aimed at promoting sustainable transport modes and a baseline level from which to evaluate these interventions, however, developmental trends in stages of change of cycling behaviour cannot be observed. The best approach for establishing causality is to measure behaviour before and after the intervention for those individuals targeted by the intervention, and for a control group of individuals not exposed to the intervention (Krizek et al., 2009). Therefore, this study suggests using experimental and longitudinal research designs to examine the stability of the different bicycle commuting predictors across time.

Despite their increasingly recognised potential as a solution to several transportation problems, sustainable travel modes such as BRT and cycling, remain the understudied and least understood, especially in African large cities. The research on these modes is still rather rare and sparse despite that there are many important research questions remaining. For example, what makes cycling so different from policy makers' point of view that it is hardly regarded as a transport mode and also neglected in transport research and policy? This emphasizes the need for further research into cycling behaviour. Possibly another research could be done in the study area after the implementation of the BRT and cycling projects to evaluate their effectiveness and test the validity of the current research results.

## **8.6 Final remarks**

The increasingly alarming urban transport problems in the city of Dar-es-Salaam, characterized by a high degree of traffic congestion, constrained resources for urban transport and deteriorating air quality, lies in the forefront of concerns. In Dar-es-Salaam, the problems of public transport are synonymous with the problems of urban transport because public transport vehicles (daladala) serve such a large proportion of total trip demand. The present public transport system in the city is highly unsatisfactory from the perspectives of all stakeholders: the public, the city authorities, the operators and the users. In response to these urban transport challenges in the city, an urban development strategy was developed and the Dar-es-Salaam Urban Transport Policy and System Development Master Plan was designed in 2007. The government has proposed introduction of the bus rapid transit (BRT) with an integration of cycling infrastructure. A key consideration in this regard is that, most certainly within the near-term planning horizon, the need to move people must take precedence over the need to move vehicles.

However, there is lack of knowledge on how these sustainable transport initiatives can generate services that meet the needs of the target market. This research is a first attempt to probe the individual, social and spatial factors (with respect to attitudes, perceptions and motivations) that determine how (potential) users of cycling and BRT in Dar es Salaam perceive these systems. The study also explains what are the appropriate measures and strategies to motivate people to use these sustainable transport modes. The research contributes to a better understanding of people's travel needs, information useful to improve the quality of life and sustain the development of the city and its residents in the future.



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## Summary

Transportation planning and the implementation of transportation facilities in the cities of the developing world have been heavily weighted towards private motorised transportation (MT), despite the fact that public transportation (PT) and non-motorised transportation (NMT) constitutes a significant proportion of all trips in urban areas, and that they can provide viable alternatives to most motorised trips. Not until the last two decades, many researchers and practitioners have recognised the importance and advantages of NMT and PT. Their investigations and findings have contributed much towards identifying, if not mitigating, some of the more glaring problems of urban transport. However, most of these studies have been performed in a piece-meal and disjointed fashion, and have focused mainly on the developed world context. Moreover, there is a need for a better understanding of how these sustainable travel modes can effectively realise their potential to address the daily urban mobility problems and their consequences in developing world cities such as Dar-es-Salaam in Tanzania.

Sustainable transport policy can serve as a lever to alleviate poverty, while stimulating economic growth and climate change mitigation, by providing socially-equitable and environmentally sound transport alternatives to the people. For such policy development to be effective, efficient and equitable, it is important to understand the key factors and motivators for people to choose their mode of transport. This understanding allows to better target policies to specific groups of users (thus targeting equity), which allows for a more efficient and effective deployment of (scarce) transport resources.

Behavioural factors are of particular importance when looking at modal choice given the multitude and complexity of factors that determine people's preferences for one mode over the other. These factors are for example known to depend strongly on aspects like location (spatial factors) and traveller characteristics (socio-demographic, travel pattern related factors, attitudinal factors and perceptions).

The aim of this study is to investigate and explain commuters' attitudes and preferences towards cycling and bus rapid transit (BRT) in the context of the city of Dar-es-Salaam in Tanzania, and use the knowledge generated to suggest better targeted policies to market sustainable transport modes.

The study thus discusses the individual attitudes, perceptions and preferences that play a key role in understanding people's choices for sustainable travel modes such as cycling and BRT. For cycling, knowing and understanding these factors may help in identifying and overcoming key social and spatial barriers to its use, whereas for BRT understanding these

factors can serve to make the BRT system a more viable alternative to private motorized modes, crucial for achieving a sustainable urban transport development. The study further attempts to probe the key spatial factors, attitudinal factors and perceptions that can explain people's preferences for sustainable transport modes. It also investigates how such factors may vary over space and by identifiable group of individuals, and how changes in behaviour coincide with life events like relocation and marriage. The study demonstrates empirically how these factors can be used to derive sustainable urban transport policy in the context of Dar-es-Salaam.

With respect to the proposed BRT service quality, the study indicates that the BRT is likely to be more attractive than the existing public transport system (*daladala*). The study findings suggest that only through providing a commuting service characterised by better comfort, lower travel times as well as lower travel fares will the BRT be attractive to its potential users. These findings imply that planners and policy makers should pay more attention and consider all the three attributes important when providing the BRT service. More importantly, the results reveal that the BRT utility varies spatially, particularly dependent upon distance to the central business district (CBD). For transit operators, the knowledge about the desired service quality provides them with an answer to their investment questions and establishes the basis for designing future policies to encourage greater use of public transit based on the needs and expectations of potential customers.

With regard to cycling, the study demonstrates that the approach of the stage of change model is useful in capturing the heterogeneity of commuters and identifying the potential bicycle commuters. The study clearly shows that neither cyclist segments (*prepared for action, action, maintenance*) nor non-cyclist segments (*pre-contemplation, contemplation, and relapse*) in the stages of change process are the same, which has important implications for targeting cycling policies and promotional strategies. The study findings show that urban policies and marketing strategies which aim to promote bicycle use may first target the *contemplation, prepared for action* and *action segments* as people in those segments are most motivated to change and willing to cycle. The study further shows that the effect of the various perceived motivators, barriers, and policy related interventions (i.e. personal, social and physical-environmental factors) varies among people in the different stages of change of cycling behaviour. In particular, the effects vary among people in the early stages of change of cycling behaviour (*pre-contemplation, contemplation*) and those in the late stages of change (*action, maintenance*). The study also reveals that eliminating physical barriers alone is likely to have little impact on bicycle commuting.

The study provides evidence that different groups of commuters exist and that the modal choice decisions of individual commuters and the potential for modal change within these groups depends on different factors. This study lends support to the need to develop interventions differently for individuals with different characteristics.

In short, the study investigates whether the proposed BRT system will deliver quality service expected by its potential users. The study also tries to identify who are those likely to take up cycling and to explain how and why individual commuters vary in their decision to (not) commute by bicycle. This knowledge can enable policies to be formulated that improve and promote the use of sustainable travel modes, thus creating a more sustainable, equitable and healthy society in cities such as Dar-es-Salaam.



## **Muhtasari Tasnifu wa Shahada ya Uzamivu**

Mipango ya usafiri na utekelezaji wa vifaa vya usafiri katika miji ya nchi zinazoendelea imeelekezwa zaidi katika usafirishaji kwa vyombo vya moto vya binafsi (VM), licha ya ukweli kwamba usafirishaji kwa vyombo vya umma (VU) na usafirishaji kwa vyombo visivyo vya moto (VVM) hufanya sehemu kubwa ya safari zote katika maeneo ya mijini, na vinaweza kutoa njia mbadala zinazofaa zaidi kuliko usafirishaji kwa vyombo vya moto. Katika miongo miwili iliyopita, watafiti wengi na watendaji wametambua umuhimu na faida za VVM na VU. Uchunguzi wao na matokeo umechangia sana katika kutambua, kama si kupunguza, baadhi ya matatizo dhahiri ya usafiri mijini. Hata hivyo, tafiti nyingi zimekuwa zikifanyika vipandevipande bila kuunganishwa, na kuwa na mkazo zaidi juu ya nchi zilizoendelea. Aidha, kuna haja kwa uelewa mzuri wa jinsi mifumo hii endelevu ya usafiri inavyoweza kuleta ufanisi katika kushughulikia matatizo ya kila siku ya usafiri mijini na matokeo yake katika miji ya nchi zinazoendelea kama vile Dar-es-Salaam.

Sera ya usafiri endelevu inaweza kutumika kama nyenzo ya kupunguza umaskini, huku ikichochea ukuaji wa uchumi na kukabiliana na mabadiliko ya hali ya hewa, kwa kuwapa watu njia mbadala za usafiri zinazofaa kijamii na bora kwa mazingira. Ili uendelezaji wa sera kama hiyo ufanikiwe, ni muhimu kuelewa mambo muhimu na vivutio kwa watu kuchagua mifumo hiyo ya usafirishaji. Uelewa huu unawezesha utungaji wa sera kulenga makundi maalum ya watumiaji (yaani usawa), na unawezesha ufanisi zaidi katika matumizi ya rasilimali (adimu) za usafirishaji.

Sababu za kitabia zina umuhimu pekee katika kuangalia uchaguzi wa mfumo kati ya mifumo mingi na vigezo vingi ambavyo hutumiwa na watu kupendelea mfumo mmoja badala ya mwingine. Vigezo hivi ni pamoja na masuala kama mahali na tabia za msafiri (kijamii, idadi ya watu na mitizamo).

Lengo la utafiti huu ni kuchunguza na kuelezea mitazamo ya wasafiri kwenda na kutoka kazini na upendeleo wa matumizi ya baiskeli na mabasi ya haraka (BRT) katika mazingira ya jiji la Dar-es Salaam-Tanzania, na kutumia maarifa hayo kupendeleza sera bora kwa walengwa wa mifumo ya usafirishaji.

Utafiti huu unajadili mitazamo binafsi na upendeleo ambao una umuhimu mkubwa katika kuelewa uchaguzi wa njia za usafiri kama vile baiskeli na BRT. Kwa utambuzi wa matumizi ya baiskeli, kujua na kuelewa mambo haya kunaweza kusaidia katika kutambua na kukabiliana na vikwazo muhimu vya kijamii na vikwazo vya ki-mahali vinavyoathiri matumizi yake, halikadhalika kwa upande wa BRT sababu hizi zinaweza kutumika kufanya mfumo wa BRT uwe mbadala kwa usafirishaji wa vyombo vya moto vya binafsi, na muhimu

kwa ajili ya kupata maendeleo endelevu ya usafirishaji mijini. Utafiti huu unachunguza sababu muhimu za ki-mahali na mambo ya mitizamo ambavyo iinaweza kuelezea upendeleo wa watu kwa mifumo endelevu ya usafiri. Zaidi ya hayo, utafiti huu unachunguza jinsi mambo hayo yanavyoweza kutofautiana ki-mahali na kwa makundi binafsi yanavyoweza kutambulika, na jinsi gani mabadiliko katika tabia yanaendana na matukio ya maisha. Utafiti unaonyesha kwa vipimo jinsi mambo haya yanavyoweza kutumika kupata sera ya usafiri mijini endelevu katika muktadha wa Dar es Salaam.

Kuhusiana na ubora wa huduma ya BRT uliopendekezwa, utafiti unaonyesha kwamba mfumo wa BRT una uwezekano wa kuwa wa kuvutia zaidi kuliko mfumo uliopo wa usafiri wa umma (daladala). Matokeo ya utafiti yanaonyesha kwamba ili kuvutia watumiaji tarajiwa, lazima BRT itoe huduma ya usafiri bora zaidi, muda mfupi wa usafiri na nauli ya chini zaidi. Matokeo haya yanaashiria kwamba wataalamu wa mipango na watunga sera wanapaswa kutoa kipaumbele zaidi na kuzingatia sifa hizi tatu muhimu wakati wa kutoa huduma ya BRT. Muhimu zaidi, matokeo yanaonyesha kwamba faida ya BRT inatofautiana ki-mahali, hasa kutegemea umbali kutoka mjini kati (CBD). Kwa wasafirishaji, maarifa kuhusu ubora wa huduma unaohitajika yanatoa jibu kwa maswali yao ya uwekezaji na kuazisha msingi kwa ajili ya kubuni sera za kuhamasisha matumizi makubwa ya usafiri wa umma kwa kuzingatia mahitaji na matarajio ya wateja.

Kwa upande wa baiskeli, utafiti unaonyesha kwamba njia ya hatua ya mabadiliko ni muhimu katika kukusanya wasafiri mbalimbali na kutambua wasafiri wanaoweza kutumia usafiri wa baiskeli. Utafiti unaonyesha wazi kwamba sio makundi ya wasafiri wa baiskeli (tayari kwa hatua, hatua na matengenezo) wala makundi yasiyo ya wasafiri wa baiskeli (kabla ya kutafakari, kutafakari, na kupita) katika hatua ya mchakato wa mabadiliko yako sawa, ambayo ina maana kubwa katika kuainisha mikakati ya matumizi ya baiskeli kwa kila kundi. Matokeo ya tafiti yanaonesha kwamba sera za miji na mikakati ya masoko yenye lengo la kukuza matumizi ya baiskeli inaweza kwanza kulenga *wanaotafakari*, *waliotayari* na *hatua* kwa kuwa watu katika makundi hayo wamevutiwa zaidi na mabadiliko na wako tayari kusafiri kwa baiskeli. Utafiti unaonyesha pia kwamba athari ya motisha, vikwazo, na sera mbalimbali (yaani kibinafsi, kijamii na kimazingira) inatofautiana kati ya watu katika hatua tofauti za mabadiliko ya tabia kuelekea matumizi ya baiskeli. Kwamba, madhara hutofautiana baina ya watu katika hatua za mwanzo za mabadiliko ya tabia kuelekea matumizi ya baiskeli (kabla ya kutafakari, kutafakari) na wale walio katika hatua za mwisho za mabadiliko (hatua, matengenezo). Utafiti pia unaonyesha kwamba kuondoa vikwazo ardhini peke yake kuna uwezekano wa kuwa na athari kidogo juu ya kubatilisha matumizi ya baiskeli.

Utafiti huu umetoa ithibati ya kwamba kuna makundi mbalimbali ya wasafiri waendao kazini na kurudi, na kwamba maamuzi ya uchaguzi wa mfumo wa matumizi kwa mtu binafsi na uwezekano wa mabadiliko ya ndani ya makundi haya hutegemea sababu mbalimbali. Utafiti huu unasaidia katika kubuni miradi tofauti kwa watu wenye sifa tofauti.

Kwa kifupi, utafiti unachunguza iwapo mradi wa BRT utatoa huduma bora inayotarajiwa na watumiaji waliolengwa. Utafiti pia umejaribu kutambua kina nani wana uwezekano wa kuanza kusafiri kwa baiskeli na kueleza jinsi na kwa nini watu hutofautiana katika kuamua kutumia au kutotumia baiskeli. Elimu hii itawezesha utungaji wa sera zitakazoboresha na kukuza matumizi ya mifumo endelevu ya kusafirishaji, hivyo kujenga jamii endelevu na yenye afya zaidi.



## Samenvatting

Verkeer – en vervoersbeleid in ontwikkelingslanden wordt gedomineerd door plannen voor, en investeringen in, gemotoriseerd verkeer. Dit ondanks het vaak grote aandeel van openbaar vervoer (OV) en niet-gemotoriseerd verkeer in stedelijke gebieden en het feit dat deze in veel gevallen een geschikt alternatief bieden voor gemotoriseerde ritten. Pas in de laatste twee decennia hebben onderzoekers en verkeerskundigen, het belang en de voordelen van OV en niet-gemotoriseerd verkeer onderkend. Wetenschappelijk onderzoek heeft bijgedragen aan het identificeren, zelfs terugdringen, van een aantal urgente problemen in stedelijk verkeer en vervoer. Echter, het meeste onderzoek naar duurzaam verkeer en vervoer zijn slechts uitgevoerd op enkele onderdelen en in isolatie van de rest van het verkeer – en vervoerssysteem. Ook is het onderzoek vooral gericht op ontwikkelde landen, voornamelijk Europa en Noord Amerika. Een beter inzicht is nodig hoe duurzame vervoersmiddelen effectief ingezet kunnen worden om mobiliteitsproblemen in ontwikkelingssteden zoals Dar-es-Salaam in Tanzania, terug te dringen.

Daarnaast kan duurzaam verkeer-en vervoersbeleid een bijdrage leveren aan het terugdringen van armoede, het reduceren van CO<sub>2</sub> emissies en tegelijkertijd economische groei stimuleren. Wil een dergelijk beleid effectief en efficiënt en zijn dan is het essentieel de sleutelfactoren te kennen die bepalend zijn voor de keuze van de vervoerswijze. Met die kennis kan specifiek beleid, voor specifieke groepen gebruikers - gericht op het reduceren van sociale ongelijkheid - ontwikkeld worden.

Gedragfactoren spelen een belangrijke rol bij de keuze voor vervoerswijze. Deze factoren hangen bijvoorbeeld sterk af van locatiekarakteristieken (als ruimtelijke factor) en reizigerskarakteristieken (als in sociaal-demografische kenmerken en percepties). Het doel van deze studie is het onderzoeken van de percepties van reizigers met betrekking tot fietsen en mogelijk gebruik van hoogwaardig openbaar vervoer (*Bus Rapid Transit* – BRT) in Dar-es-Salaam, de grootste stad in Tanzania, en het gebruik hiervan in het formuleren van beter en specifiek beleid voor de marketing en promotie van duurzame vervoermiddelen.

Deze studie bespreekt de individuele percepties en voorkeuren die een sleutelrol spelen bij het begrip van keuzes voor duurzame vervoermiddelen zoals fietsen en BRT. Voor fietsen bijvoorbeeld, kan begrip van deze factoren bijdragen aan het identificeren en wegnemen van belangrijke sociale en ruimtelijke barrières voor fietsgebruik, terwijl kennis van de belangrijkste factoren voor BRT gebruik kan helpen bij het ontwikkelen betere systemen en zo een waardiger alternatief voor privaat gemotoriseerde vervoermiddelen te

creëren, cruciaal in het verduurzamen van stedelijke verkeer – en vervoersontwikkeling.

Dit proefschrift beoogt dus de belangrijkste ruimtelijke en gedragsfactoren (in termen van attitudes en percepties) te bepalen die de voorkeuren van gebruikers van duurzame vervoermiddelen in een stad als Dar-es-Salaam kunnen beschrijven en verklaren. Daarnaast kijkt het onderzoek naar hoe deze factoren variëren naar locatie en gebruikersgroep, en hoe deze weer afhankelijk kunnen zijn van belangrijke gebeurtenissen in het leven van de gebruiker, zoals verhuizing of huwelijk. De studie laat zien hoe deze empirisch bepaalde factoren kunnen worden gebruikt om duurzaam stedelijk vervoersbeleid in de context van een stad als Dar-es-Salaam te formuleren.

Met het oog op het serviceniveau van de in ontwikkeling zijnde BRT van Dar-es-Salaam (DART), laat de studie zien dat het BRT systeem beduidend aantrekkelijker zal zijn voor de gebruikers dan het huidige informele OV systeem (*daladala*). De studie laat zien dat specifieke serviceniveaus in termen van comfort, lagere reistijden en – tarieven aantrekkelijk zijn voor potentiële gebruikers. Planners en beleidsmakers moeten derhalve alle drie aspecten tegelijkertijd in beschouwing nemen bij het formuleren van BRT serviceniveaus. Belangrijker nog, de studie laat zien dat de BRT nutsparameters ruimtelijk variëren en afhangen van de afstand tot aan het stadscentrum van Dar-es-Salaam. Voor het DART vervoerbedrijf kan deze kennis over het gewenste serviceniveau door gebruikers leidend zijn bij investeringsvragen en een basis vormen voor het formuleren van toekomstig beleid. Beleid dat bijvoorbeeld tot doel heeft om – met oog voor de potentiële gebruikers – een groter aandeel van OV in de stad te creëren.

Op het gebied van fietsen laat de studie zien dat de fasen van gedragsverandering (gemodelleerd in het transtheoretische van verandering - *Stages of Change Model* - van Prochaska en DiClemente) zeer bruikbaar zijn bij het aantonen van de heterogeniteit van de groep forenzen in de stad en bij het identificeren van potentiële fietsers. Duidelijk wordt bijvoorbeeld dat noch fietsers (als in Preparatie, Actie en Behoud) noch niet-fietsers (als in Precontemplatie, Contemplatie en Terugval) zich hetzelfde gedragen in hun fasen van gedragsverandering. Dit heeft belangrijke gevolgen voor het formuleren van groep specifiek fietsbeleid – en promotie. Het onderzoek in dit proefschrift laat dan ook zien dat stedelijk beleid en promotionele activiteiten gericht op het stimuleren van fietsgebruik het beste de groepen Contemplatie, Preparatie en Actie kunnen bedienen omdat de reizigers in deze segmenten het meest bereid zijn om fietsen voor hun dagelijkse ritten serieus te overwegen.

Daarnaast laat de studie zien dat het effect van motivatie, barrières, en beleid gerelateerde acties (in termen van persoonlijke, sociale en fysieke factoren van de bebouwde omgeving) varieert tussen groepen gebruikers in verschillende fasen van gedragsverandering voor wat betreft fietsen. Vooral in de vroege fasen van gedragsverandering (Precontemplatie en Contemplatie) en in de latere stages (Actie en Behoud) blijken deze effecten sterk te zijn. De studie laat bijvoorbeeld zien dat alleen het wegnemen van fysieke barrières weinig tot geen invloed heeft op het aandeel fietsen.

Ook het potentieel voor wijziging van het gedrag in de keuze van vervoerswijze blijkt sterk af te hangen van het type forens en de factoren die de verschillende groepen gebruikers typeren. Dit wetende stelt het onderzoek voor om beleidsinterventies sterk af te laten hangen van deze verschillende gebruikersgroepen en de factoren die hun specifieke gedrag beïnvloeden.

Doordat het onderzoek laat zien dat het voorgestelde BRT systeem in staat zal zijn het de door de gebruiker gewenste serviceniveau te leveren, en dat het daarnaast ook mogelijk is om specifieke groepen potentiële fietsers te identificeren en te weten hoe en waarom zij verschillen in hun keuzes om wel of niet te fietsen, stelt dit proefschrift lokale beleidsmakers in Dar-es-Salaam in staat duurzaam verkeer – en vervoersbeleid te formuleren dat uiteindelijk kan bijdragen aan een duurzamere, sociaal gelijkwaardigere en gezonde samenleving.



## Biography



Alphonse Nkurunziza was born September 15th, 1978 in Kiboga, Uganda. He is currently an assistant lecturer of transportation planning and engineering in the department of civil engineering at Kigali Institute of Science and Technology (KIST), Rwanda. In 1992 he completed primary school among the top best pupils in the country and was admitted at Ntare School in Mbarara, western Uganda on government of Uganda scholarship. He continued and completed his high school at Lycee de Kigali in Rwanda taking Physics, Economics and Mathematics. From 1999, he studied in the faculty of Engineering at Kigali Institute of Science and Technology (KIST), where he received a Bachelor of Science degree with Distinction in Civil Engineering & Environmental Technology in 2005. After his BSc studies, he was retained at KIST and joined the department of civil engineering as a Tutorial Assistant for Transportation and Geo-technical engineering. He was later in the same year appointed by the KIST Rector as an academic officer and first year convener in the office of the Vice-Rector academics, a work he did in liaison with his teaching assistantship.

In 2006 he was granted a scholarship by the Netherlands organisation for international cooperation in higher education (Nuffic) to enrol in the Urban Planning and Management Master of Science program at the University of Twente, Faculty of Geo-Information Science and Earth Observation (ITC), The Netherlands. His MSc thesis was completed with distinction in 2008. In the same year he was awarded a PhD research scholarship co-funded by the Cycling Academic Network (CAN) and ITC. The research was conducted in collaboration with the University of Cape Town in South Africa. He has successfully published most of his PhD thesis work with important publications in scientific journals, book chapters and participation in international conferences. His areas of research interest are in transportation planning, travel demand analysis, travel behaviour, sustainable transport analysis and urban planning.

## **Scientific output**

### *Journal articles*

Nkurunziza, A., Zuidgeest, M., Brussel, M. & Van Maarseveen, M. 2012. Modeling Commuter Preferences for the Proposed Bus Rapid Transit in Dar-es-Salaam. *Journal of public transportation*, 15 (2), 95-116.

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### *Book Chapter*

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### *Conference Proceedings*

Nkurunziza, A., Van Maarseveen, M.F.A.M, & Zuidgeest, M.H.P (2010). Cycling potential demand and travel behaviour change in Dar-es-Salaam, Tanzania. In: 12th WCTR: World Conference on Transport Research, 11-15 July 2010, Lisbon, Portugal: General Proceedings/ J.M. Viegas, R. Macario. - [s.l.] : WCTR society, 2010. ISBN 978-989-96986-0-4. Nr. 03235, 21 p. Full text. [http://www.civil.ist.utl.pt/wctr12\\_lisboa/proceedings.htm](http://www.civil.ist.utl.pt/wctr12_lisboa/proceedings.htm)

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Nkurunziza, A., Zuidgeest, M., Brussel, M., Van Maarseveen, M., Vanderschuren, M. (2012). Exploring factors affecting bicycle commuting in Dar-es-Salaam, Tanzania. CODATUXV: The role of urban mobility in (re)shaping cities. Addis Ababa, Ethiopia 22-25 october, 2012.  
<http://www.codatu.org/news/codatu-xv-the-role-of-urban-mobility-in-reshaping-cities/>

*Conference Presentations*

Nkurunziza, A., Zuidgeest, M., Brussel, M. & Van Maarseveen, M. (2012). Key events and their effects on travel behaviour change in Dar-es-Salaam. The 5th International Conference on Traffic and Transport Psychology (ICTTP). Groningen, The Netherlands, August 29-31,2012.

Nkurunziza, A., Zuidgeest, M., Brussel, M., Van Maarseveen, M., Vanderschuren, M. (2012). Exploring factors affecting bicycle commuting in Dar-es-Salaam, Tanzania. CODATU-XV: The role of urban mobility in (re)shaping cities. Addis Ababa, Ethiopia, October 22-25, 2012.

## **ITC Dissertation List**

[http://www.itc.nl/research/phd/phd\\_graduates.aspx](http://www.itc.nl/research/phd/phd_graduates.aspx)

# ITC PhD Education Certificate

With the educational activities listed below the PhD candidate has complied with the educational requirements set by the ITC Graduate School which comprises of a minimum total of 20 ECTS.



## UNIVERSITY OF TWENTE.

### Review of Literature (4.2 ECTS)

- Sustainable transport in Dar-es-Salaam: the potential of BRT and Cycling from a user perspective

### Writing of Project Proposal (3.5 ECTS)

- Sustainable transport in Dar-es-Salaam: the potential of BRT and Cycling from a user perspective

### Graduate / doctoral courses (7.4 ECTS)

- A short course on **Cycling Inclusive Transport Planning** (Bicycle travel demand modeling, evaluation and monitoring) at ITC, **University of Twente, Enschede**, The Netherlands, April, May and June, 2008
- A short course on **Transportation Planning and Road Safety** from **Indian Institute of Technology, Delhi (IIT, Delhi)**, India, awarded a *certificate* of course completion, November, 2008
- A short course on **Discrete Choice Modeling** from the Netherlands Research School for Transport, Infrastructure and Logistics (TRAIL), **Delft University of Technology (TU Delft)**, The Netherlands, awarded a *certificate* of course completion, May, 2009
- A short course on **Travel Demand Modeling: Predicting travel demand and market shares** at **Massachusetts Institute of Technology (MIT)**, Cambridge, USA, awarded a *certificate* of course completion, June, 2009
- A short course on **Design of Road Intersections & Roundabouts: Promoting cycling for everyone as a daily transport mode** from PRESTO, **European Cyclist's Federation (ECF) Brussels, Belgium**, awarded a *certificate* of successful course completion, December, 2011
- A TransportNET short course on **Transport Economics and Regulation** at **Karlsruhe Institute of Technology (KIT)**, *Institute for Economic Policy Analysis (IWW)*, Karlsruhe, Germany, a *certificate of course completion*, March 26-30, 2012

### Competence Strengthening / Skills Courses (6 ECTS)

- Course on Presentation skills; ITC (2009)
- Barmiento, H. (2012) Public transport rationalisation in Kigali, Rwanda, CTS, Department of civil engineering and management and ITC, University of Twente, Enschede, The Netherlands. MSc Thesis (**MSc Advisor**)
- Woldesmayat, E.M. (2009) Developing geo-spatial method for strategic bicycle network design. Enschede, ITC, University of Twente, The Netherlands. MSc Thesis (**MSc Advisor**)
- Nyaki, P.S. (2009) Development of geo-information based public transport assessment model. Enschede, ITC, University of Twente, Enschede, The Netherlands. MSc Thesis (**MSc Advisor**)
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- Fikse, K. (2008). Public transport quality?: assessing local public transport in Dar es Salaam, Tanzania. Dar Rapid Transit (DART). Department of Civil Engineering and Management, and ITC, University of Twente, Enschede, The Netherlands. BSc Thesis (**BSc Advisor**)

**Discussion Groups / Local Seminars and Other Scientific Meetings (3.7 ECTS)**

- Cycling Academic Network (CAN) central meetings Netherlands, India, Brazil, South Africa (2008-2010)
- PGM PhD meetings (2008-2009)
- Irregular meetings and discussions with visiting scientists (2008-2012)

**In-house symposia / guest speaker seminars (2.8 ECTS)**

- Participation in ITC PhD day
- ITC PhD weekend
- Beta Postdoc Retreat

**International Symposia, Workshops and Conferences (10.8 ECTS)**

- Participated in a US/Africa Regional Workshop on “Developing sustainable urban transport systems in African cities” in Arusha, Tanzania organized by the East African community secretariat together with the United States embassy in Tanzania in (2009)
- PhD Researchers’ symposium on “Innovation and entrepreneurship in new technologies”, University of Twente, The Netherlands (2009)
- 7<sup>th</sup> Cycling and Society symposium at the Transport Studies Unit (TSU), University of Oxford, Oxford, UK (2010)
- Participated in the World Urban Forum 2010 (WUF 2010) organized by UN- Habitat, Rio de Janeiro, Brazil
- YES-DC Congress- Sustainable Mobility in developing countries, Academieggebouw, Utrecht, The Netherlands (2012)
- World Conference for Transport Research (WCTR 2010), Lisbon, Portugal
- International Conference on Traffic and Transport Psychology (ICTTP 2012), Groningen, The Netherlands
- Co-operation for urban mobility in the developing countries ( CODATU XV), Addis Ababa, Ethiopia