EXPLORING FACTORS AFFECTING THE POTENTIAL OF BICYCLE COMMUTING IN DAR-ES-SALAAM

Alphonse Nkurunziza
Mark Zuidgeest
Mark Brussel
Martin Van Maarseveen

Conference CODATU XV
The role of urban mobility in (re)shaping cities
22 to 25 October 2012- Addis Ababa (Ethiopia)

CODATU

Conference CODATU XV
« The role of urban mobility in (re)shaping cities »
22 to 25 October 2012- Addis Ababa (Ethiopia)

Exploring factors affecting the potential of bicycle commuting in Dar-es-Salaam

Alphonse Nkurunziza, Mark Zuidgeest, Mark Brussel, Martin Van Maarseveen

Department of Urban and Regional Planning and Geo-information Management, Faculty of Geo-information Science and Earth Observation, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands**Abstract**

Abstract

Developing policies to promote and increase levels of cycling requires proper understanding of the determinants of bicycle use. The objective of this study is to investigate the potential factors that can influence bicycle commuting in the city of Dar-es-Salaam. The study is designed to explore the relationships between bicycle commuting and potential motivators, barriers and interventions in the different stages of change of cycling behaviour. Results show that the top rated potential cycling motivators consistent among all stages of change of cycling behaviour are: provision of bicycle lanes, low bicycle prices and direct routes; top barriers are: car driver attitude and behaviour, social (in) security and lack of safety on the road; whereas top interventions are no bicycle import tax. From logistic regression modelling, the following factors had the most influence on the likelihood of bicycle commuting regardless of the stage of change of cycling behaviour: *motivators*; low bicycle price, safe parking at home and work, quality of bicycle and cycling training. *Barriers* include; weather, social status, social (in) security and no cycling skills. *Interventions* include: no bicycle import tax. These results contribute to an improved understanding of the factors that can influence bicycle commuting in Dar-es-Salaam and may provide a stronger empirical basis for designing policy and programs to promote cycling.

Keywords: Bicycle commuting; Potential factors; Stages of change; Dar-es-Salaam

1. Introduction

Bicycling as a daily commute mode is currently gaining more recognition in many world cities due to its environmental and health benefits, especially when compared to motorised vehicles. With the increasing pressures of climate change, severe health consequences and strained capital budgets, there is a growing interest in shifting from over-reliance on motorised transport towards sustainable urban transport modes (Xing et al., 2010). Bicycling is a low-cost alternative to personal car use, requiring no more than the purchase of a bicycle. For individuals who do not have the option of motorised vehicle, whether for financial or other reasons, bicycling can be an important means to get to destinations, particularly for trips that are too long to walk or not served by public transit (Handy and Xing, 2011). In this respect, bicycling can be a potentially useful travel mode in most developing world cities where financing of travel tends to add significantly to urban household's economic difficulties (Bryceson et al., 2003).

The potential benefits of the bicycle in an African city context in particular are: first, it may provide better access to urban services that society considers vital for survival such as medical, education, employment and shopping (Bryceson et al., 2003). Second, cycling may enhance creation of more employment opportunities, which is crucial in maintaining incomes for the most vulnerable urban population (DFID, 2002). Third, cycling may enhance the maintenance of social networks and community-based solidarities, which are even more essential at times of economic crisis. While cycling can contribute to all the above mentioned benefits, it has most often been the target of policy efforts in many world cities (Pucher and Buehler, 2008, Pucher and Buehler, 2006). In most large African cities specifically, cycling has remained unrecognized and an inferior urban transport mode (Olvera et al., 2008, Sambali et al., 1998), and does not represent an attractive alternative for many of the urban population (Pochet and Cusset, 1999).

Although cycling has always been given little attention in most African large cities irrespective of its potential, the city of Dar-es-Salaam recently started to recognize cycling and has initiated policies to integrate cycling into the urban transport planning. The congestion problems and the issue of climate change have resulted to sustainable initiatives such as the introduction of the Bus Rapid Transit (BRT) system that will incorporate cycling feeder networks (Nkurunziza et al., 2012a, Nkurunziza et al., 2012b, JICA, 2008). Also, the need to make Dar-es-Salaam a touristic destination in the region has raised the need to design a bicycle network for the whole city (DART, 2009). While provision of improved cycling infrastructure will undoubtedly bring the possibility of cycling closer to more people, earlier research has shown that these facilities will not alone guarantee that more people will cycle (Parkin et al., 2008, Gatersleben and Appleton, 2007). Moreover, by using only such a supply oriented policy, it may not be practical to expect increases in bicycle use that can justify such a large investment. In order to develop better policies to promote bicycle commuting that are appropriate to the local context, knowledge on the determinants of bicycle use is required. The objective of this paper is, therefore, to provide a better understanding of the potential factors that can influence bicycle commuting. This information may serve as an empirical basis for development of cycling policies and programs aimed at promoting bicycle commuting in the city of Dar-es-Salaam.

2. Theoretical background and earlier related work

Theoretically, this study borrows from the stages of change model applied widely in many domains of health promotion (Prochaska and DiClemente, 1983, Prochaska and Velicer, 1997), especially in physical activity research (Marttila et al., 1998, Miilunpalo et al., 2000). Cycling being a means of transport to destinations as well as a form of physical activity, the stage of change model provides a useful conceptual framework for understanding cycling behaviour. The stage of change model has previously been used in cycling research (Gatersleben and Appleton, 2007, Rose and Marfurt, 2005, Shannon et al., 2006) and more recently (Nkurunziza et al., 2012c, Winters et al., 2011, Nkurunziza et al., in press). The model views behaviour change as a process rather than an event which occurs in six distinct successive stages that is; pre-contemplation, contemplation, preparation, action, maintenance and Relapse. It is shown that people go through a series of stages of change in their mindset and take a relatively long time before they choose to cycle (Gatersleben and Appleton, 2007, Nkurunziza et al., 2012c). In addition, these studies suggest that different strategies are necessary to move people in different stages of change of cycling behaviour till when they reach stage of maintaining their cycling behaviour. In this context, it is important to determine the factors that can influence modal change, so as to design effective policies to increase the share of commuter-cyclists. Our analysis thus explores different sets of variables that would potentially influence bicycle commuting behaviour.

Conventional analysis of bicycle commuting behaviour is often based on utility theory, assuming people decide on the best available transport mode by considering costs, time and effort. These studies offer insight into the modal choice and its determinants, taking hard factors such as socio-economics into account. This, however, fail to explain why individuals in similar situations and with corresponding socio-economic characteristics make different decisions about whether to cycle (Heinen et al., 2011). Moreover, development and implementation of hard transport policy measures (e.g. provision of bicycle infrastructure) alone appears not enough to create higher levels of cycling (Parkin et al., 2008, Bamberg et al., 2011, Moudon et al., 2005). Further, current transport policies often tend to tackle the symptoms (e.g., providing cycling facilities) but fail to tackle the underlying constraints such as attitudes, perceptions, and preferences (Dickinson et al., 2003, Heinen et al., 2011). Whereas infrastructure improvements are necessary (McClintock and Cleary, 1996), these measures may not alone be effective in achieving travel behaviour change suggesting that other factors clearly need to be addressed as well. This identifies the need for evidence on the types of initiatives that can create a supportive environment for cycling and induce positive, long term changes in travel behaviour.

Although there has been much work on bicycle commuting, for example; (Handy and Xing, 2011, Xing et al., 2010, Heinen et al., 2011, Noland and Kunreuther, 1995, Parkin et al., 2008, Wardman et al., 2007, Dill and Carr, 2003), few studies have examined factors that would potentially influence modal change towards cycling. There has been little work that looks directly at the differences between the different stages of change of cycling behaviour, and this point to some differences in the factors that affect cycling behaviour. Specifically there is very limited work on bicycle commuting behaviour in the developing world cities especially in an African city context where bicycle commuting is uncommon. There is lack of empirical knowledge on the factors that might be the most likely to influence bicycle commuting in a rarely cycling city context, whereas this information is essential for effective cycling promotion.

3. Methods and data

3.1. Sampling approach and data collection

The study investigates a wide range of factors that can potentially influence bicycle commuting in the city of Dar-es-Salaam, Tanzania. Data used in the analysis come from an individual travel survey conducted in March 2009 among individual daily commuters. Details of the survey development and administration have been published elsewhere (Nkurunziza et al., 2012c). The survey instrument is available from the corresponding author. In belief, the survey samples were collected from the pre-selected zones of the city based on whether the zones are located where the bus rapid transit lines and bicycle paths are proposed, zones that are densely populated and with high trip generation levels, and zones that have some commuter cyclists. In addition, the survey respondents were only those commuters whose daily journeys were within 15 km distance to key activity locations, since experience from many scientific cycling literature shows that a distance beyond that threshold makes cycling less attractive (Rietveld and Daniel, 2004, Heinen et al., 2011). The data was collected through a survey questionnaire which was presented as an individual travel survey to individual commuter respondents without the specific mention on bicycle use at the start to avoid any bias or strategic responses. The questionnaire involved four parts. The first part collected information about socio-demographics. The second part asked about commuters' travel patterns and transport 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 potential cycling market segments based on the stages of change model (see Nkurunziza et al., 2012 c). The final part collected information about potential motivators, barriers and interventions that would influence cycling in relation to the stages of change of cycling behaviour (the subject of this paper). In total 620 commuter respondents were interviewed resulting to 598 well completed questionnaires. The high response rate was a result of the interviewing technique employed and the mini-pilot survey conducted prior the main survey.

3.2 Measures

To explore which factors might be the most likely to influence bicycle commuting, we investigated an extensive list of potential motivators, barriers and interventions in relation to the stages of change of cycling behaviour. The stages of change of cycling behaviour are categories of commuter respondents (cyclists and non-cyclists) identified and defined in an earlier related study (see, Nkurunziza et al., 2012 c) based on the Prochaska and DiClemente (1983, 1984) theory of stages of behaviour change. The categories were: *pre-contemplation (PC),* defined as 'someone who never really think about and not even considering cycling to daily activity'; *contemplation(C)* 'someone who never used a bicycle but sometimes think about cycling to daily activity'; *prepared for action (PA)* 'someone who rarely or sometimes cycle to daily activity'; *action (A)* 'someone who have fairly often cycled to daily activity'; *maintenance (M)* 'someone who cycles regularly to daily activity' and *Relapse(R)* 'someone who no longer cycle to daily activity'.

The list of potential factors was compiled from cycling scientific studies done elsewhere. The list was revised 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 cycling advocacy groups such as 'UWABA'. A number of different items were grouped under motivational

factors, barriers and interventions and were analysed for their potential influence on bicycle commuting (see Table 1). The respondents were asked to rate the importance of each of the motivators, barriers and intervention items to the use of bicycles for daily commutes. Respondents could value the items on a rating scale ranging from 1 to 7 as shown in Table1.

Table 1 – Description of the variables in the models

Variable name	**Range**	**Description**
Dependent variables		
Bicycle commuting (whole data samples considered in the models)	0,1	0 = Pre-contemplation stage (non-cyclists), 1 = all other stages of change of cycling behaviour: PC,C,PA A,M, R (cyclists and potential cyclists) *PC: Pre-contemplation; C: Contemplation; PA: Prepared for action; A: Action; M: Maintenance; R: Relapse*
Explanatory variables		
Motivators	1-7	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
Barriers	1-7	
Policy interventions	1-7	

3.3 Analysis

The survey data were entered to an electronic database and anlysed using the Statistical Package for Social Sciences (SPSS version 18 for windows) by Field (2009). Data from rating the importance of motivators, barriers and intervention items were analysed using analysis of variance (ANOVA) to determine differences between the non-cyclists and cyclists in the different stages of change of cycling behaviour. Binary logistic regression models were also employed to identify the relationships between the different factors and bicycle commuting. This enabled examining factors that would potentially influence modal change towards bicycle commuting. In interpreting the binary logistic models, odds ratios were used since they are easy to understand and explain.

4. Bicycle commuting influences and stages of change

To explore the elements that can influence bicycle commuting, respondents were asked to what extent they feel a range of different motivators, barriers and intervention variables are important. Respondents were asked to rate the importance of these factors on a scale from 1 to 7 with 1 being "extremely not at all important" and 7 being " extremely very important".

Table 2 shows the mean scores of each motivator items for non-cyclists and cyclists in the different stages of change of cycling behaviour. In order of importance, provision of bicycle lanes, reduction of bicycle prices and direct routes are the most important cycling motivational factors regardless of stage of change of cycling behaviour. The results however show that there are clear and significant

differences among the non-cyclists and cyclists in the different stages of cycling behaviour. This difference may be appearing due to the lower scores given to the motivator items among the non-cyclist stages of behaviour change compared to the cyclist stages.

Table 2 – Mean motivator item scores for non-cyclists and cyclists by stages of change of cycling behaviour

	Non-cyclists				**Cyclists**			
	PC	**C**	**R**	**p-value**	**PA**	**A**	**M**	**p-value**
	N =79	N = 40	N =287		N = 51	N =34	N = 107	
Bicycle lanes	3.94	5.08	5.25	***	6.16	6.35	6.16	
Street lights	2.37	2.80	2.54		2.73	2.56	2.92	
Low bike price	2.14	4.18	3.48	***	4.76	4.94	5.53	**
Shades	2.11	2.65	2.36		2.61	2.68	2.41	
Safe parking	1.90	3.00	2.84	***	2.75	3.32	2.84	
Type of bicycle	1.81	3.10	2.60	***	3.10	3.09	2.91	
Cycling training	2.39	3.75	1.91	***	2.39	1.82	1.95	**
Water facilities	2.01	2.35	2.11		2.57	2.32	2.23	
Direct routes	2.99	3.98	3.66	**	4.04	3.82	4.58	*

One way ANOVA tests showing significant differences at ***$(p \leq 0.01)$, **$(p \leq 0.05)$, *$(p \leq 0.1)$ between non-cyclists (Pre-contemplation (PC), Contemplation (C), Relapse (R)) and between cyclists (Prepared for action (PA), Action (A), Maintenance (M))

Table 3 – Mean barrier item scores for non-cyclists and cyclists by stages of change of cycling behaviour

	Non- cyclists				**Cyclists**			
	PC	**C**	**R**	**p-value**	**PA**	**A**	**M**	**p-value**
	N =79	N = 40	N =287		N = 51	N = 34	N = 107	
Environmental barriers								
Hillness	3.86	4.28	3.51	*	3.43	2.38	2.79	
Weather	4.01	4.10	3.15	***	2.61	1.94	2.56	
Far distance	3.87	2.90	3.61	*	2.41	2.12	1.92	
No work parking	2.86	2.50	2.65		1.71	2.00	1.64	
No home parking	2.16	1.75	1.94		1.45	2.74	1.20	
No shower at work	2.52	1.60	1.95	***	1.49	1.29	1.14	
No cycle crossing	2.72	2.68	2.72		2.35	1.82	1.44	***
Driver attitude & behaviour	3.87	4.78	4.03	*	3.53	2.35	3.27	*
No cycling lanes	3.14	3.93	3.39		2.84	2.03	1.85	**
Personal barriers								
Social (in)security	5.03	4.83	5.00		5.14	5.06	4.01	**
Expensive to afford	1.27	2.18	1.87	***	1.94	2.24	1.99	
Not comfortable	3.47	1.98	2.31	***	1.43	1.32	1.14	

Not fit to ride	1.96	1.63	1.81		1.84	1.79	2.08	
Commitments after work	2.47	1.88	2.34		1.51	1.47	1.15	
Social status	3.37	2.20	2.28	***	1.39	1.35	1.17	
Not safe on the road	4.34	4.55	4.71		3.45	2.76	2.32	**
Not confident in cycling	4.41	4.93	2.36	***	2.06	1.53	1.24	**

One way ANOVA tests showing significant differences at ***$(p \leq 0.01)$, **$(p \leq 0.05)$, *$(p \leq 0.1)$ between non-cyclists (Pre-contemplation (PC), Contemplation (C), Relapse (R)) and between cyclists (Prepared for action (PA), Action (A), Maintenance (M))

Table 3 shows the mean scores of each environmental and personal barrier items for both non-cyclists and cyclists in the different stages of change of cycling behaviour. For environmental barriers, driver attitude and behaviour was perceived as the most important barrier among both the cyclists and non-cyclists stages. Although clear differences are shown among the different stages of cycling behavior, there are no environmental barriers that were considered "important" among both the non-cyclists and cyclists. With regard to personal barriers, social (in) security and lack of safety on the road were perceived as the most important barriers among the cyclists and non-cyclists in different stages of change. There were also clear and significant differences among the cyclist and non-cyclist stages of cycling behaviour. Importantly, the non-cyclists attach more importance to barriers, particularly: not comfortable on bicycle, social status, commitments before and after work, not safe on the road and not confident in cycling than do the cyclist stages of behaviour change.

Table 4 – Mean policy intervention item scores for non-cyclists and cyclists by stages of change of cycling behaviour

	Non-Cyclists				**Cyclists**			
	PC	**C**	**R**	**p-Value**	**PA**	**A**	**M**	**p-Value**
	N =79	N = 40	N =287		N = 51	N =34	N =107	
Interventions								
Car free zone	2.72	2.85	2.87		3.04	2.71	3.14	
Cycle parking stations	3.43	3.25	3.27		3.29	3.74	3.40	
Park and ride	3.06	3.03	2.72		2.27	2.03	2.21	
Car parking charges	2.27	2.40	2.33		2.65	2.18	1.93	***
Guarding bicycles	3.53	3.50	3.52		3.59	4.74	4.01	**
Congestion charges	2.52	1.88	2.19		2.24	1.85	1.89	
No import tax	4.06	4.93	4.66	**	5.04	5.00	5.58	

One way ANOVA tests showing significant differences at ***$(p \leq 0.01)$, **$(p \leq 0.05)$, *$(p \leq 0.1)$ between non-cyclists (Pre-contemplation (PC), Contemplation (C), Relapse (R)) and between cyclists (Prepared for action (PA), Action (A), Maintenance (M))

Table 4 shows the mean scores of each policy intervention item for both the non-cyclists and cyclists in the different stages of behaviour change. Exemption of importation tax on bicycles was perceived as the most important policy intervention in both the cyclist and non-cyclist stages of change. The mean scores for policy intervention items between stages of cycling behaviour were significantly different in very few instances (see Table 4).

After accounting for the differences between cyclists and non-cyclists in the different stages of change of cycling behaviour, it was thought important to also look at the effect of the perceived motivators, barriers and interventions on bicycle commuting by only comparing the *pre-contemplation* stage to the rest of the sample. The 'pre-contemplation stage'[1] was compared to 'all other stages of change of cycling behaviour (i.e. *contemplation, prepared for action, action, maintenance, and relapse*)'[2]. The dependent variable, bicycle commuting is thus based on comparing the 'all other stages of cycling behaviour' to the 'pre-contemplation stage' (see Tables, 5-8). This is purposely meant to identify sets of factors common to all stages of change of cycling behaviour that would potentially influence bicycle commuting.

Table 5 reports the odds ratio results on perceived motivators and shows that low bicycle price, quality of bicycle and cycling training positively increase the likelihood of bicycle commuting. On the other hand, provision of water facilities along cycle ways is associated with lower likelihood of bicycle commuting. These results support earlier findings discussed in (Nkurunziza et al., in press). It is also shown that direct routes were not significant in the model although they appeared important in earlier related studies (Nkurunziza et al., in press) . This apparent discrepancy may be explained by estimating a model with combination of stages which may have underestimated the influence of some explanatory variables.

Table 5– Odds ratios for perceived motivators on bicycle commuting

		Combined stages of cycling behaviour (n = 519) versus Pre-contemplation stage (n =79)
Variable	**Coefficient**	**Odds Ratio (95% CI)**
Low bike price	0.414	1.52 (1.30 - 1.77)***
Cycling training	0.282	1.33 (1.072 – 1.64)***
Quality of bicycle	0.297	1.35 (1.10 – 1.64)***
Water facilities	-0.201	0.82 (0.65 – 1. 03)*
n		598
Pseudo R^2		0.26
-2LL initial		466.886
-2LL final		377.582
Model χ^2		$\chi^2(3)$= 89.304***

* 10% significance level, ** 5% significance level, *** 1% significance level

With regard to perceived physical environmental factors (see Table 6), weather, lack of safe parking at home and work place, lack of shower at place of work and lack of street lights on cycling routes are strongly associated with lower likelihood of bicycle commuting. These results seem reasonable in the Dar-es-Salaam context. Surprisingly on the other hand, the model does not show an influence of such deterrents as: lack of bicycle paths and lack of bicycle crossing signals at road intersections on bicycle commuting, which appeared significant in some earlier results. The suggested reason could be that the influence of these variables may have been underestimated by using the whole sample of combined stages of change of cycling behaviour.

[1] Segment of non-cyclists with a negative cycling attitude characterized by high car ownership and high education

[2] Segments of commuter cyclists and potential cyclists with a positive attitude on cycling (see Nkurunziza et al, 2012 for more details)

Table 6– Odds ratios for perceived physical environmental barriers on bicycle commuting

		Combined stages of cycling behaviour (n = 519) versus Pre-contemplation stage (n =79)
Variable	**Coefficient**	**Odds Ratio (95% CI)**
Weather	-0.156	0.86 (0.76 - 0.96)***
No safe parking at home and work	-0.231	0.79 (0.67 – 0.94)***
No shower at work	-0.245	0.78 (0.68 – 0.90)***
No street lights on routes	-0.202	0.82 (0.68– 0.98)**
n		598
Pseudo R^2		0.12
-2LL initial		466.886
-2LL final		428.126
Model χ^2		$\chi^2(4)$= 38.760***

* 10% significance level, ** 5% significance level, *** 1% significance level

With regard to personal factors (Table 7), the perceived barriers such as: social (in) security, social status, not feeling comfortable to cycle on bicycle, having many commitments before and after work and not having confidence in cycling are more likely to discourage bicycle commuting. These results suggest that measures that are only working on the physical barriers are less likely to have major impact on bicycle commuting.

Table 7– Odds ratios for perceived personal barriers on bicycle commuting

		combined stages of cycling behaviour (n = 519) versus Pre-contemplation stage (n =79)
Variable	**Coefficient**	**Odds Ratio (95% CI)**
Social(in)security	-0.276	0.76 (0.64 – 0.90)***
Not comfortable	-0.270	0.76 (0. 66– 0.89)***
Many commitments	-0.143	0.87 (0.74 – 1. 02)*
Social status	-0.216	0.81 (0.70 – 0. 93)***
No cycling skills	-0.487	0.614 (0.53 – 0.71)***
n		598
Pseudo R^2		0.370
-2LL initial		466.886
-2LL final		333.234
Model χ^2		$\chi^2(5)$= 133.651***

* 10% significance level, ** 5% significance level, *** 1% significance level

The model results summarised in Table 8 show that exemption of bicycle import tax is positively associated with bicycle commuting. This finding emphasizes the importance of an earlier result on lowering bicycle prices which demonstrates its significance in promoting bicycle commuting. While congestion charging is negatively associated with bicycle commuting, other *'push'* intervention factors like car free zones, park and ride policies, car parking charges were insignificant and excluded from the model.

Table 8– Odds ratios for perceived policy interventions on bicycle commuting

		Combined stages of cycling behaviour (n = 519) versus Pre-contemplation stage (n =79)
Variable name	**Coefficient**	**Odds Ratio (95% CI)**
Congestion charges	-0.184	0.83 (0.72 - 0.96)**
No import tax	0.200	1.22 (1.09 -1.36)***
-2LL initial		466.886
-2LL final		449.418
Model χ^2		$\chi^2(2)$= 17.467***

* 10% significance level, ** 5% significance level, *** 1% significance level

5. Discussion and conclusion

The study has examined the relationship between the various perceived motivators, barriers and interventions and bicycle commuting among regular commuters (non-cyclists and cyclists) in the different stages of change of cycling behaviour. The results indicate that there are clear differences in the influences of those factors among the different stages of change of cycling behaviour. These results corroborate earlier findings of the other part of this bicycle commuting behaviour study (Nkurunziza et al., 2012c, Nkurunziza et al., in press), where potential cycling market segments are identified. Motivation measures related to reducing the cost of bicycles, providing good quality bicycles and providing cycling training centres may encourage bicycle commuting. These measures are likely be more effective when targeting commuters in their early stages of change of cycling behaviour especially those in the *contemplation* stage to think about trying cycling. Such motivational measures, however, would not only require individual efforts but most importantly government support. For example, implementing a measure related to reduction of cost of bicycles, would allow many people to afford bicycles.

The results share some similarities with previous work on bicycle commuting elsewhere. For instance, non-cyclists in early stages of change of cycling behaviour (*pre-contemplation, contemplation, prepared for action*) perceive more barriers than cyclists (*action, maintenance*) (e.g., Gatersleben and Appleton, 2007, Shannon et al., 2006). Although not in the same context, there do appear to be some consistencies with results of (Davies et al., 2001, Gatersleben and Appleton, 2007, McClintock and Cleary, 1996, Wardman et al., 1997) that show barriers, such as weather, lack of bicycle facilities, distance, unsafe on the road, bad driver attitude and behaviour, social (in) security, and not feeling comfortable to be on bicycle. The study also revealed some new insights which can be important when promoting bicycle commuting especially among non-cyclists in early stages of change, for instance; reduction of bicycle prices, quality of bicycle and exemption of bicycle import tax, which are specific to Dar-es-Salaam context.

Most important, the results suggest that working on the physical barriers alone is likely to have little impact. This finding supports prior findings by Parkin (2008) where provision of infrastructure alone appears insufficient to achieve modal change towards bicycle use. Giving more attention to personal barriers may be even more important, though what would matter most are the attitudes towards bicycle use particularly social status, not feeling comfortable on bicycle and social (in) security. At the moment many of those who have never contemplated cycling (non-cyclists) believe they would feel strange on bicycle. Other people would also perceive it as a transport mode for the poor and consider

it an urban fringe mode of travel. Similar findings have also been seen elsewhere where the car is the dominant travel mode (Pucher et al., 1999, Vandenbulcke et al., 2011, Pucher et al., 2010).

While changes in attitudes and favourable cycling environments are important, some commuters would still encounter such barriers as having many commitments before and after work and not having confidence in cycling which may discourage bicycle commuting. This gives support to previous research where it is shown that the need to run errands on the way to or from work discourages cycling (Handy and Xing, 2011). The results, however, do not show a big influence of barriers such as lack of bicycle paths and lack of bicycle crossing signals at road intersections on bicycle commuting. A possible explanation could be that although these facilities may be good to have, they do not seem to be very important barriers for cycling especially among those currently cycling as they can still find their way to activities. Also in this respect according to Pucher et al (2010), some specific elements might appear to have negligible impact when examined in isolation but have significant impact when implemented comprehensively. The importance of '*pull'* interventions such as exemption of bicycle import tax and guarding bicycles at public places on bicycle commuting is revealed, although most *'push'* interventions like car free zones, park and ride policies, car parking charges have shown no influence on bicycle use. Their insignificance may be tied to limited experience with such measures in the study area. Some studies on acceptability of various transport policy measures have revealed that people are more likely to accept positive (pull) measures than negative (push) measures (Anable, 2005).

6. Conclusions

In conclusion, although a comprehensive approach offers much greater impact on cycling than individual measures, this study provides evidence on which factors to focus efforts to maximise modal change towards cycling. Factors including reduction of bicycle prices, quality of bicycle and cycling training are the most influencing perceived motivators likely to have dramatic impact on bicycle commuting especially among the non-cyclists in early stages of change of cycling behaviour. Physical factors like weather, absence of safe parking at home and work place, lack of water showers at work places as well as personal factors such as social status, social (in) security and not feeling comfortable on the bicycle have the most negative influence on bicycle commuting. Measures like exemption of bicycle import tax and car congestion charges are the most important perceived policy interventions. These findings may be useful in providing richer information to increase the effectiveness of future cycling campaigns aiming to provide an indication to the aspects such campaigns may want to address in order to promote cycling. The study results are likely to be even more informative in a developing world city context where bicycle commuting is uncommon and the reported cycling influential factors have not yet been addressed.

Acknowledgements

This study is part of the scientific output of the Cycling Academic Network (CAN) and is partly based on a financial contribution by the Dutch Ministry of Development Cooperation through the Bicycle Partnership Program (BPP) of the Interface for Cycling Expertise (I-CE), co-funded by the University of Twente, The Netherlands. The authors would like to acknowledge the support of the University of Cape Town, South Africa and the field work assistance by the DART Agency, Dar-es-Salaam City Council staff, Ardhi University and University of Dar-es-Salaam, Tanzania.

References

Anable, J. 2005. 'Complacent car addicts' or 'Aspiring environmentalists'? identifying travel behaviour segments using attitude theory. *Transport Policy,* 12**,** 65-78.

Bamberg, S., Fujii, S., Friman, M., Gärling, T. 2011. Behaviour theory and soft transport policy measures. *Transport Policy,* 18**,** 228-235.

Bryceson, D. F., Mbara, T. C., Maunder, D. 2003. Livelihoods, daily mobility and poverty in sub-saharan africa. *Transport Reviews,* 23**,** 177-196.

DART 2009. The preliminary design of a bicycle network in Dar-es-Salaam including a bicycle path/Beach prominade from old post office to Sea Cliff hotel. Tender document. Dar-es-Salaam, Tanzania: Dar-es-Salaam Rapid Transit (DART) Agency.

Davies, D. G., Gray, S., Gardner, G., Harland, G. 2001. A quantitative study of the attitudes of individuals to cycling. *TRL report.TRL,*. Crowthorne.

DFID 2002. Transport role in achieving the millenium development goals. Un published report. UK Department for International Development(DFID), Transport Resource Center.

Dickinson, E. J., Kingham, S., Copsey, S., Hougie, J. P. 2003. Employer travel plans,cycling and gender: Will travel plan measures improve the outlook for cycling to work in the UK? *Transportation Research Part D,* 8**,** 53-67.

Dill, J., Carr, T. 2003. Bicycle commuting and facilities in major U.S.cties: if you build them, commuters will use them. *Transportation Research Record,* 1828**,** 116-123.

Field, A. 2009. *Discovering statistics using SPSS: Third edition,* London, SAGE Publications Ltd.

Gatersleben, B., Appleton, M. K. 2007. Contemplating cycling to work: Attitudes and perceptions in different stages of change. *Transportation Research Part A,* 41**,** 302-312.

Handy, S. L., Xing, Y. 2011. Factors correlated with bicycle commuting : A study in six small U.S. cities. *International Journal of Sustainable Transportation,* 5**,** 91-110.

Heinen, E., Maat, K., Wee, B. V. 2011. The role of attitudes toward characteristics of bicycle commuting on the choice to cycle to work over various distances. *Transportation Research Part D: Transport and Environment,* 16**,** 102-109.

JICA 2008. Dar es Salaam transport policy and system development master plan. Final report. Dar es Salaam, Tanzania: Dar es Salaam City Council.

Marttila, J., Laitakari, J., Nupponen, R., Miilunpalo, S., Paronen, O. 1998. The versatile nature of physical activity - on the psychological, behavioural and contextual characteristics of health-related physical activity *Patient Education and Counseling,* 33**,** 29-38.

Mcclintock, H., Cleary, J. 1996. Cycle facilities and Cyclist's safety. *Transport Policy,* 3**,** 67-77.

Miilunpalo, S., Nupponen, R., Laitakari, J., Marttila, J., Paronen, O. 2000. Stages of change in two modes of health-enhancing physical activity: methodological aspects and promotional implications. *Health Education Research: Theory and Practice,* 15**,** 435-448.

Moudon, A. V., Lee, C., Cheadle, A. D., Collier, C. W., Johnson, D., Schmid, T. L., Weather, R. D. 2005. Cycling and the Built environment: US perspective. *Transportation Research Part D,* 10**,** 245-

261.

Nkurunziza, A., Zuidgeest, M., Brussel, M., Maarseveen, M. in press. Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dar-es-Salaam. *Transport Policy*.

Nkurunziza, A., Zuidgeest, M., Brussel, M., Van Den Bosch, F. 2012a. Spatial variation of transit service quality preferences in Dar-es-Salaam. *Journal of Transport Geography,* 24**,** 12-21.

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

Nkurunziza, A., Zuidgeest, M.,Van Maarseveen, M. 2012c. Identifying potential cycling market segments in Dar-es-Salaam, Tanzania. *Habitat International,* 36**,** 78-84.

Noland, B. R., Kunreuther, H. 1995. Short - run and Long-run policies for increasing bicycle transportation for daily commuter trips. *Transport Policy,* 2**,** 67-79.

Olvera, L. D., Plat, L., Pochet, P. 2008. Household transport expenditure in sub-saharan african cities: measurement and analysis *Journal of Transport Geography,* 16**,** 1-13.

Parkin, J., Wardman, M., Page, M. 2008. Estimation of the determinants of bicycle mode share for the journey to work using Census data. *Transportation,* 35**,** 93 -109.

Pochet, P., Cusset, J. M. 1999. Cultural barriers to bicycle use in western african cities: the case of Bamako and Ouagadougou. *IATSS Research,* 23**,** 43-50.

Prochaska, J. O., Diclemente, C. C. 1983. Stages and processes of self-change in smoking: toward an integrative model of change. *Journal of Consulting and Clinical Psychology,* 51**,** 390-395.

Prochaska, J. O., Diclemente, C. C. 1984. *The transtheoretical approach: crossing traditional boundaries of therapy,* illinois, USA, Dow Jones-Irwin.

Prochaska, J. O., Velicer, F. W. 1997. The transtheoretical model of health behaviour change. *American Journal of Health Promotion,* 12**,** 38-48.

Pucher, J., Buehler, R. 2006. Why Canadians cycle more than Americans: A comparative analysis of bicycling trends and policies. *Transport Policy,* 13**,** 265-279.

Pucher, J., Buehler, R. 2008. Making cycling irresistable: Lessons from the Netherlands,Denmark and Germany. *Transport Review,* 8**,** 31-46.

Pucher, J., Dill, J., Handy, S. L. 2010. Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine,* 50**,** S106 - S125.

Pucher, J., Komanoff, C., Schimek, P. 1999. Bicycling rennaissance in North America? Recent trends and Alternative policies to promote bicycling. *Transportation Research Part A,* 33**,** 625-654.

Rietveld, P., Daniel, V. 2004. Determinants of bicycle use: do municipal policies matter? *Transportation Research Part A,* 38**,** 531-550.

Rose, G., Marfurt, H. 2005. Travel behaviour change impacts of a major ride to work day event. *Transportation Research Part A,* 41**,** 351-364.

Sambali, G., Zuidgeest, M., De Langen, M. 1998. Determinants of cycling in medium and large cities

in sub - Saharan Africa. . *In:* H. MEERSMAN, E. V. D. V. W. W. (ed.) *8th WCTR conference proceedings : World Conference on Transportation Research.* Antwerp, Belgium: Pergamon.

Shannon, T., Giles-Corti, B., Terri., P., Bulsara, M., Shilton, T., Fiona, B. 2006. Active commuting in a university setting: Assessing commuting habits and potential for modal change. *Transport Policy,* 13**,** 240-253.

Vandenbulcke, G., Dujardin, C., Thomas, I., Geus, B. D., Degraeuwe, B., Meeusen, R., Panis, L. I. 2011. Cycle commuting in Belgium: Spatial determinants and 're-cycling' strategies. *Transportation Research Part A: Policy and Practice,* 45**,** 118-137.

Wardman, M., Hatfield, R., Page, M. 1997. The UK national cycling strategy: can improved facilities meet the targets? *Transport Policy,* 4**,** 123-133.

Wardman, M., Tight, M., Page, M. 2007. Factors influencing the propensity to cycle to work. *Transportation Research Part A,* 41**,** 339-350.

Winters, M., Davidson, G., Kao, D.,Teschke, K. 2011. Motivators and deterrents of bicycling: comparing influences on decisions to ride. *Transportation,* 38**,** 153-168.

Xing, Y., Handy, S. L., Mokhtarian, P. L. 2010. Factors associated with proportions and miles of bicycling for transportation and recreation in six small US cities. *Transportation Research Part D: Transport and Environment,* 15**,** 73-81.