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A STUDY ON TRAVEL BEHAVIOR OF INFORMAL WORKERS IN MAPUTO, MOZAMBIQUE

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Abstract —***Informal sector employs a significant proportion of the population in developing countries and the number is likely to continue increasing due to problems such as poverty and urban population growth. The nature of the activities in this sector creates complex travel patterns with implications in the temporal and spatial trip distribution, traffic congestion, and environmental concerns. Using person-trip data, this paper attempts to investigate the travel behavior of the people engaged in the informal sector or informal workers in Maputo by applying logistic regression model. Findings indicate car ownership, household size, age, gender, occupation status, and residence location as the main determinants influencing travel behavior of informal workers in Maputo. These findings are expected to contribute to understanding the daily mobility of informal workers not only in Maputo but also in other developing cities with the similar socio-economic background.***

Keywords: *Person Trip Data, Travel Demand, Chapas*

I. INTRODUCTION

The informal sector is growing more rapidly in Sub-Saharan African cities where more than 50% of working people have their employment in this sector. According to [1] the increasing importance of the informal sector as a source of income in developing countries is changing the travel patterns with trips overlaid in both space and time because of the movements associated with trading, hawking, and employment-seeking. Despite playing an important role in the economics of developing cities, studies on the travel behavior of people engaged in the informal sector are rare. However, this is critical for transport planners in developing cities because increased participation in this sector means more travel needs, complex travel patterns, increased traveled distance, and more traffic congestion. It is this gap in the literature that motivated the present research.

We begin by considering what is generally meant by informal workers. [2] defines the informal sector as a heterogeneous group of activities that share one common characteristic: lack of legal recognition or protection. On the other hand [3], defines the informal sector as consisting of private firms with ten or fewer employees. The characteristics of informal sector are as follows: easy of entry, family ownership of the firm, small scale operation, and skills acquired outside formal school. For the purpose of this study, the first definition was found to be more appropriate. That is, it is it is widely recognized that the informal sectors are neither taxed nor administered by any government. The definition of informal sector by [2] appears to be closer to the one used commonly as well as people's recognition.

1.1. Objectives

The objectives of this study are twofold: (1) to investigate the travel behavior of informal workers in Maputo, and (2) to identify the factors underlying travel behavior of informal workers.

1.2. Research structure

The paper is organized as follows. In section 2, previous studies on travel behavior in developing countries are reviewed. Section 3 describes the fundamental features of the study area. Section 4 is devoted to dataset analysis. In section 5 we investigate travel behavior in Maputo. Section 6 is devoted model estimation followed by discussion and conclusion in section 7.

II. LITERATURE REVIEW

To understand the travel behavior of the informal workers we review the existing literature in the context of developing countries. [5] investigated the travel behavior of slums dwellers in Nairobi City, Kenya. Their findings indicate that slum dwellers cannot afford any transport mode and they cope by reducing their travel to walking. [5] compared the travel patterns between poor and non-poor households and found the former to be systematically worse off. [1] also analyzed the mobility of low-income in two Sub-Saharan African cities, Harare in Zimbabwe, and Kampala, in Uganda. Their results show the livelihood of work to be the most frequent purpose of short-distance trips for all income groups. Additionally,[1] reveal that walking dominates modal share in both cities with households in Kampala also relying on bicycle and motorcycle taxi. Finally, Venter et al. (2007) examined relationships between residential location and travel behavior of low-income households in Durban, South Africa and they found residential location has a significant influence on gender travel behavior. According to Venter et al. (2007), gender differences are more pronounced in distant rural areas where households face the highest travel costs.

On the other hand, several studies have been conducted in other parts of the world. For example, [6] put forward a mechanism to describe motorization phenomena. Known as simple generic model of the urban transport and land use evolution in developing cities, the model is intended to describe the paths taken or potentially to be taken by cities in the developing world. Following [6], some cities in Asia have moved rapidly from transport systems in which walking, non-motorized vehicles, and rudimentary, low-cost, bus-based public transport systems catered for the majority of transport needs, to a situation where cars and motorcycles are beginning to dominate. [6] underlines that these outcomes are influenced not only by the decisions of individual consumers but also by governments policies towards motor vehicle ownership and use, road supply, urbanization and suburbanization, traffic restraint and relative investments in roads, public transport, and non-motorized modes.

In a study on the travel behavior of low-income groups in India [6] found travel behavior measures such as mode choice, travel time, cost and frequency to be affected by location. Similarly, [7] investigated travel behavior of low-income households in China. Their findings suggest that low-income households have lower mobility levels than non-low-income households. Low-income households not only make fewer trips but also short-distance trips. With respect to transport mode, [7] walking, motorcycles, and bicycles were identified as the main non-motorized transport, while for motorized trips bus is the most dominant mode. [6] states that the mobility of low-income is extremely limited primarily because many cannot afford any form of motorized private transport or public transport although in some cities low-income households may own motorcycles.

According to [9], misunderstandings have occurred in the studies on the demand for transport in developing countries. He argues that the economic view of the car as a "free consumer desire" is inadequate to understand the context of developing countries. Due to market failures, the majority of people in the developing countries have no choice than to use public transport. [9] states that in addition to its utility, the demand for private cars is influenced by urban, transport, and economic policies which shape the space and constraining transport choices. Finally, [10] analyzed the rise in car use and the decline in bus services in developing countries. He states that although empirical evidence at the country level may suggest a strong relationship between the rising income and car use, at the urban level, local characteristics, traffic congestion, and policies do affect travel decisions. He highlighted the positive feedback or relationships between traffic congestion and car use as leading to deterioration of bus services.

III. FUNDAMENTAL FEATURES OF THE CITY

Maputo, the capital of Mozambique is a city of 2.3 million people in southern Africa and has an area of 1228 km^2. The city was established was established as a main urban center in early 1884 with the development of transport infrastructures such as road and railway to connecting Mozambique and South Africa. The Greater Maputo metropolitan area (**Fig.1**) include 3 municipalities and 1 district: Maputo, Matola, Boane, and Marracuene. As the economic and political center of Mozambique, the metropolitan area accounts with a major industrial zone of the country and one of the most important ports in Southern Africa region

Urban transport services are mainly provided by public bus operators and individual paratransit operators. Urban transport modes include buses, with seating capacity for 50 passengers, minibuses *Chapas* with seating capacity ranging

from 15-to-25 passengers. According to [11], approximately 3.3 million trips were made in a day and 98% of total trips originated and terminated within the metropolitan area.

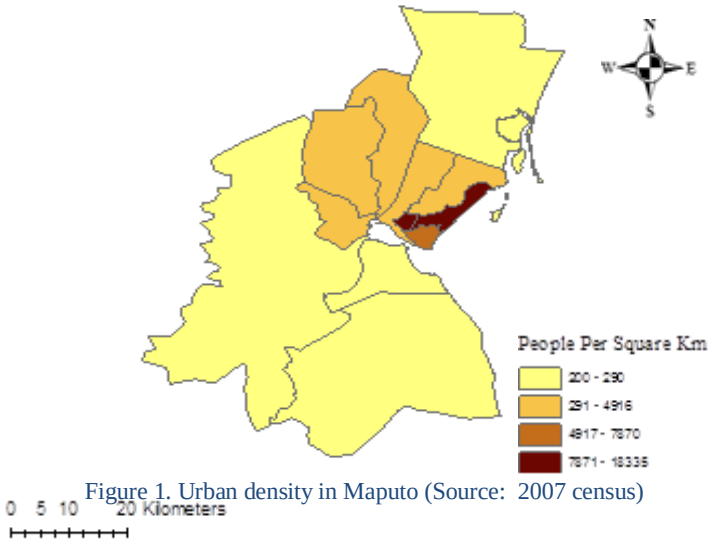

Figure 1. Urban density in Maputo (Source: 2007 census)

3.1. Public transportation background

Mozambique is an independent country since 1975. From the early age, urban transportation systems were nationalized yielding to a regulated public transport system. Transportation services were exclusively provided by a public bus company. Fares were regulated with a purpose to ensure affordability of the majority of the population. At the beginning of the 1980s, Maputo witnessed an increased immigration of people from rural to the capital city [10], while the Bus Company had difficulties to provide bus services. From the 1970s to 1980s, for example, less than half of the buses were available to service the demand (**Fig.2**). As a result, the number of passengers gradually declined from 60 million users in the 1970s to 40 million in the 1980s. [11] argue that in the beginning public bus companies were able to operate without subsidies in Sub-Saharan Africa, however, as deficits grew and subsidies did not grow commensurately, bus operators faced enormous difficulties either to maintain or to replace bus fleet. In 1985, public bus operators had a fleet of about 300 conventional buses, but less than 50% of buses were operated. A substantial proportion of buses was out of services due to delays in the acquisition of spare parts and mechanical problems. Some buses were "cannibalized" to provide parts for others, and very often the buses which are "cannibalized" were rarely returned to service.

According to [12], to meet the increasing demand in urban areas, individuals initiated the paratransit services and gradually their number increased. These new minibus operators or *chapas* were formally acknowledged at the end of the 1980s when the government gave them permission to operate urban transportation services. By the beginning of the 1990s, *chapas* operators had a higher market share. The majority of the operators of *chapas* are not the owners of the vehicles, but hired drivers. They are hired under 3 main conditions: (1) to pay a daily fixed amount of revenue to the owners; (2) to meet their own salary and (3) to provide for the daily operating costs. To operate *chapas*, minibus drivers usually hire a conductor who collects the fares from the passengers. There are no formal contracts either between the owners and the drivers of "chapas", or, between drivers and conductors.

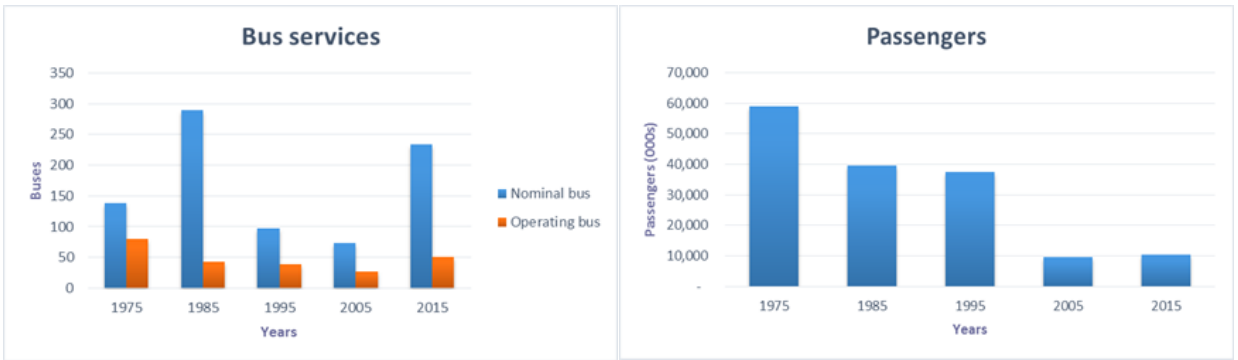

Figure 2. Public bus fleet and passengers (Source: Maputo municipality)

IV. METHODOLOGY

4.1. Data

This study uses the person trip survey conducted in Maputo City (as of 2012). Person trip survey or Household survey (HH survey) data consist of information about the characteristics of households, individuals and their transportation mode in the previous 24 hour period. The sample data include approximately 10,000 households were surveyed, out of which 10444 were reported as informal workers or informal vendors. Considering the purpose of the study, the remaining individuals were excluded from modeling.

4.2. Logistic regression model

According to [15] regression models that involve nominal scale variables are known as qualitative response regression model and they can be either binary or dummy variable, dependent models. Binary regression models are employed when the objective is to choose between two discrete alternatives. For more than two discrete alternatives multinomial regression models are used. Considering that urban transportation services in Maputo are mainly provided by formal operators (public buses) and paratransit services chapas, binary regression seems to be more appropriate.

V. TRAVEL BEHAVIOR ANALYSIS

At the present, little has changed as both bus and paratransit operators continue to be the main providers of the urban transport services. It is worthy to note that other transportation modes such as railway and ferry services are also available but their market share is insignificant. The modal share is as follows: walk (45.8%), chapas (32.9%), private car (10.2%), buses (9.2%), rail (0.6%), and others (1.3%). Buses and minibuses "chapa" share most of the routes. However, due to supply-side limitations, the number of the routes of the public buses (59 routes) is smaller than that of the minibuses (139). For example in 2012 road network coverage in Maputo city was at about 1001 km, of which only 359 km, that is, 38%, comprise paved roads whilst the remaining 642 km (64%) of the of the road are unpaved roads. Likewise, outlying areas have 714 km of total road network, but only 187 km constitute paved roads.

5.1. Profile of informal workers

To better understand the residence and workplace of informal workers we first describe the four zones constituting Maputo (see Fig.3). Zone 1 is an area of 8 square kilometers with a residential population of 45734. In terms of employment, zone 1 contains 15.4% of service workers, 0.9% of industry workers. It is the where Maputo port, one of the major ports in southern Africa. Zone 2 covers 10 square kilometers and contains 76863 residents. Employment distribution is as follows: service workers 27.1% and industry workers 16.6%. In these two zones, the proportion of agriculture workers is less than 1.0%. Zones 3 and 4 have populations of about 1 million residents each. Zone 4 comprises 2 municipalities (Matola and Boane) and 1 district. The proportions of service workers, industry, and agriculture are 42%, 42%, and 26% respectively in zone 3, 15%, 41%, and 74% for zone 4.

Fig.3 depicts a spatial location of residences and workplaces of the informal workers. Each zone is shaded equivalently by the number of residences and workplaces. As it can be seen, most informal workers appear to reside in zones 2, 3, and 4. This is consistent with our expectation for about 80% of urban population in Maputo live in suburban or slum areas. On the other hand, workplaces are mainly concentrated in the CBD (zone 1), Zone 2 and zone 3. This can be explained by the zonal characteristics mentioned above.

Fig.4 provides the characteristics of informal workers in Maputo. Informal workers were relatively young. The proportion of informal workers under 19 years of age old is 4 %, while approximately 63% of individuals are in age groups between 20 years and 39 years of age. This might indicate not only the difficulties faced by individuals to get a job in the formal sector but also the increasing migration from the rural areas to the capital city. Lastly, less than 16% of informal workers are over 50 years of age. Overall, these findings confirm why [1] considered East African cities as being "young cities" with a substantial proportion of the population being the first generation of the urban dwellers.

5.2. Commuting trips by informal workers

Fig.5 shows that temporal trip distribution between informal and formal workers. As it can be seen in Fig.5, temporal trip distribution of informal workers appears to be different from patterns exhibited by other groups. Specifically, trip patterns by informal workers are characterized by two peak-hour periods: morning peak at around 6:00 a.m., and evening peak at 17:00. It is worth to note that morning peak is relatively longer than the usual probably reflecting the nature of the informal activities. Temporal trip distribution of other groups is characterized by three peak-hour periods: morning peak at around 6:00 a.m., day peak at 12:00 and lastly evening peak at around 17:00. The factors behind the three peak-hour periods observed include trips to school and to work during the morning; trips to school and home at noon, and lastly trips to home and school in the evening.

Fig.6 indicates the reasons for transport mode choice. The common reason found to influence the use of public transportation among informal workers is the lack of alternatives. In a study on demand for transportation in developing countries [9] argues that most people in the developing world have no choice other than to use public transportation. This is true in the case of Maputo, where the number of the available alternatives is very limited. As it would be expected, there are three main reasons for private car usage: comfort, convenience, and travel time. Despite increased traffic congestion, private cars appear to be more comfortable and convenient than the crowded public buses and *chapas*. Similarly, lack of alternative by Informal workers is the main reason for selecting Non-motorized transport (NMT).

Fig.6 also indicates transport mode choice by residential location. Most informal workers highly depend on *chapas* and walking for their commuting purposes. This finding is consistent with the reasons for mode choice discussed previously.

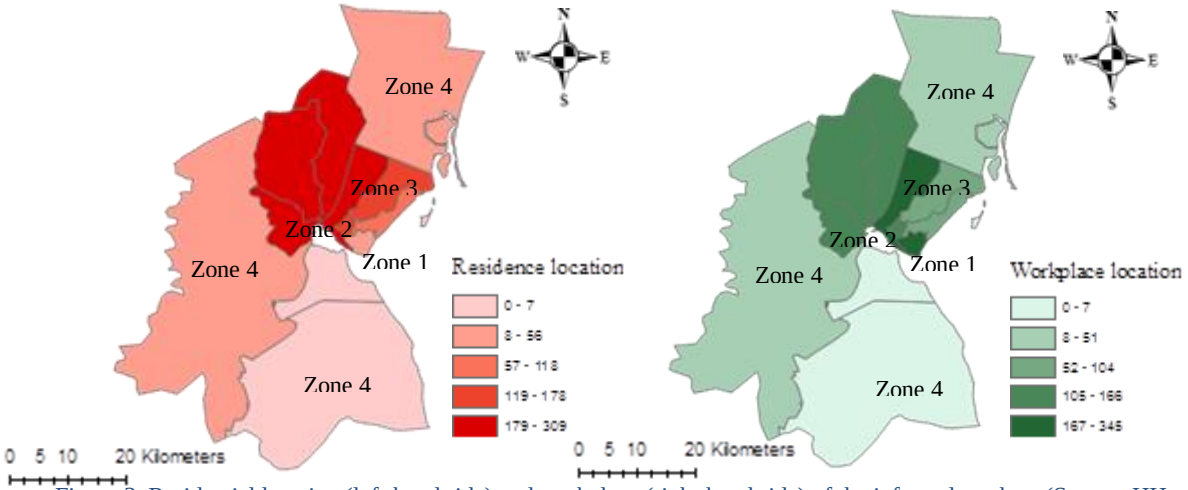

Figure 3. Residential location (left-hand side) and workplace (right-hand side) of the informal workers (Source: HH survey)

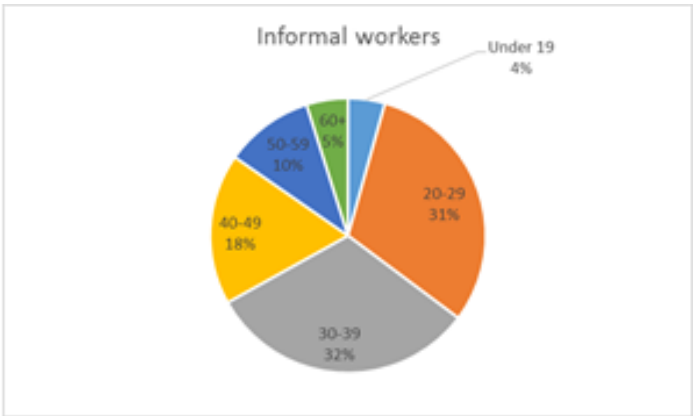

Figure 4. Age distribution of informal workers (Source: HH survey)

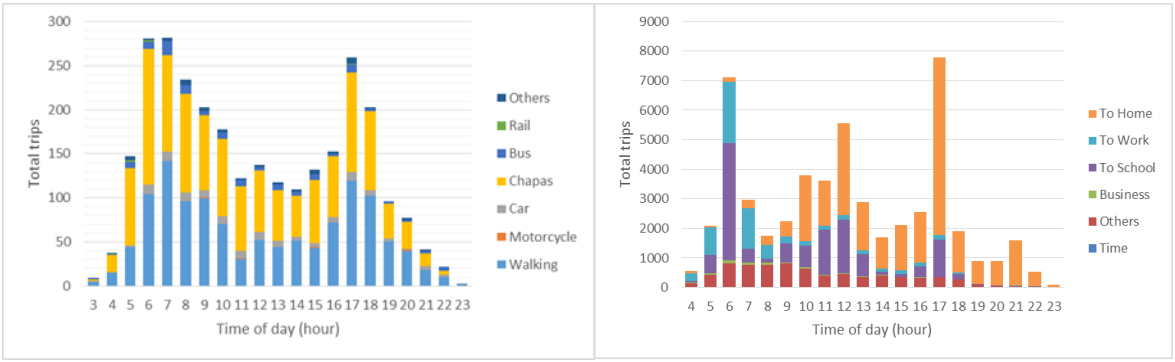

Figure 5. Temporal trip distribution by informal workers (left) and (right) formal workers (Source: HH survey)

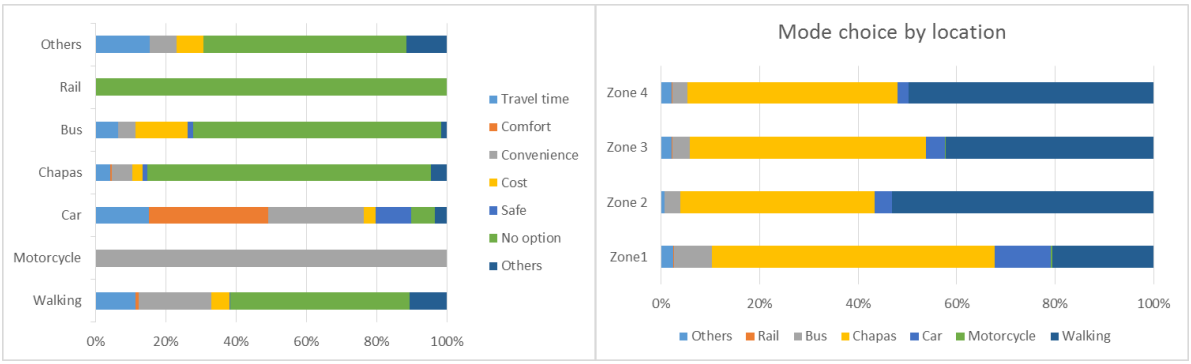

Figure 6. Reasons for transport mode choice and choice by location (Source: HH survey)

VI. MODEL ESTIMATION

In this section, a binary logistic regression is applied to investigate the factors affecting travel behavior by informal workers. The dependent variable is transportation mode: 0 for the private car and 1 public transport (bus, chapas, and rail). Informal workers who commute by walk, motorcycle, and other modes were excluded from the model. Gender, age, occupation status, ownership of motorcycle and private car, household size, and the location of residence were used as explanatory variables.

Overall, statistical indicators show that the model in **Table 1** is relatively appropriate and a good fit with the Pseudo R-square at 56% while the p-value (the exact level of significance level) is almost zero. **Table 1** shows the likelihood of the informal worker choosing public bus over private car. From **Table 1**, we observe that gender, age, occupation status, car ownership, household size and location of residence are statistically significant when selecting public transport as a transportation mode. Next, we proceed with the interpretation of the model estimates, followed by discussion and conclusion. From **Table 1** we can see that age and car ownership decrease the probability of selecting public transport (chapas, bus, and rail) over the private car, holding other variables constant. In contrast, gender, occupation status, household size, and residential location increase the probability of choosing public transport over private car. These findings are consistent with our expectations for many reasons. First, given that buses and chapas often run crowded and the standard their service quality is relative poor (based on the reasons for mode choice), we should expect private cars to be more attractive. Second, as the number of female engaged in the informal sector, the demand for public transportation also increases. This can be explained by the fact that informal activities are generally dominated by female individuals.

Table 1. Logistic regression results

Variables	Coefficient	P-value
(Intercept)	1.70	0.00***
Female	0.59	0.00***
Age	-0.02	0.00***
Worker	0.26	0.01*
Motorcycle owner	-0.04	0.61
Car owner	-1.63	0.00***
HH size	0.13	0.00***
Location	0.02	0.00***
Number of observations: 10444 Log likelihood: -2302.49 (8 df) Chi-square p-value: 0.00 Pseudo R-Square: 0.56 Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1		

VII. DISCUSSION AND CONCLUSION

As in many other developing cities, informal workers constitute a significant proportion of working population in Maputo. The findings of this study are expected to contribute to understanding the mobility of informal workers not only in Maputo but also in other developing cities with the similar socio-economic background.

First, findings suggest that car ownership and age decrease the odds of choosing public transport over private cars. This might indicate that as informal workers become car owners, public transportation is no longer a preferred travel mode. This is not surprising taking into account that both buses and *chapas* are always crowded during the morning and evening peak hours. This result raises concerns because the economics of Mozambique has been growing more rapidly over the recent years leading to a vehicle ownership of about 52 vehicles per 1000 people (as of 2012). The modal share of private cars is already greater (10.2%) compared to buses (9.2%) and this is likely to contribute to the vicious cycle between public transport and car usage according to [16].

In contrast, gender, occupation status, household size, and residence location were found to influence positively the likelihood of public transport over private transport. Specifically, the demand for transportation by commuters residing in zones 3 and 4 is such that during the evening peak-hour, along the main bus stops there are regularly long queues of people awaiting buses heading out of town. There are also many people waiting for buses heading into town, most of whom are intending to remain on the bus for the outward trip, in order to be sure of getting a seat. In a study on the travel behavior of informal workers by [17] distance was also found to influence the transport mode choice in Nairobi. Most informal workers were reported to travel long distance by public transportation. The findings of this study suggest that travel behavior of informal workers can be influenced by policies encouraging public transport while introducing travel demand management strategies.

Finally, as this paper only investigated travel behavior of informal workers based on their socio-economic characteristics, further analysis is needed to better understand the observed behavior. In addition to socio-economic characteristics of the decision maker, transportation behavior is influenced by other factors such as general transport costs, trip purpose, time of day and individual or group trip.

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