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Transport Choice of Spare Parts Dealers in Accra, Ghana

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Abstract This paper explores the determinants of the choice of mode of transport of intra-city spare parts dealers, and estimates the specific and overall predictions of the discriminant model. Two hundred spare parts dealers in Accra were sampled for this study. Discriminant model was employed to classify the spare parts dealers into their appropriate mode choice to ascertain factors determining their choice of mode of transport. The key findings from the study showed that individual characteristics and mode choice attributes determined the choice of mode of transport of spare parts dealers. In terms of prediction, the study showed that, more than two-third of the original private car users were predicted. The model also predicted over three-quarters of the original bus users. Moreover, the model over predicted the original trotro users, while almost all the original taxi users were predicted. Overall, the discriminant model was successful in correctly classifying about two-third of all original spare parts dealers in the study area. The study concludes with the recommendation that efforts should be made to encourage business private car owners to patronise public transport in their journey to work in Accra.

Keywords Transport, Choice, Intra-City, Spare Parts Dealers, Discriminant

1. Introduction

Transport is one of the most important catalysts for sustainable development. In developed countries, the transport sector contributes to the GDP by about 10 percent, and its services are a precondition for economic as well as leisure activities. In most developing countries, for example, the last 40 years have been characterised by a dramatic increase in urban populations and auto-centric lifestyle of the citizenry. Growing demands for passenger transport are visible manifestations of an increase in urban population. There is a high demand for motor vehicles, with ownership and use growing at a rate even faster than the population growth rate in most developing countries. Evidence suggests that motor vehicle ownership growth rates of 15 percent to 20 percent per year are common in developing countries (World Bank, 1996).

Over the years, transport experts in many developing economies, including Ghana, sought to adopt various innovative alternative strategies, such as car pooling, cycling and mass transport in an attempt to deal with the growing demand for private cars and their impact on road traffic, human health as well as urban transportation. Experts were of the view that a better demand management strategy could ensure efficient use of existing infrastructures. Prominent among these views is the modal diversion from private car to public transport by ensuring that the efficiency of the alternative substitutes is enhanced. Another option, experts maintained is the differential pricing system, whereby different toll rates for different types of vehicle at different times of the day are used. The objectives of all these are to help mitigate traffic congestion during the peak periods in metropolitan areas and to ensure efficiency and sustainability of the sector.

Studies suggest that there is an economic cost of choosing private cars over public transport as discussed extensively by Peirson, Skinner and Vickerman (1996). In their view, private cars are less efficient in bulk carriage of passengers and goods as compared to public transport. Research has also shown that on short distance journeys, the private car engine is cold and runs least efficiently (Potter & Hughes, 1990). Other evidence also indicates that most intra-city journeys are of short duration of about 5 minutes (Ullrich, 1990), and this implies that most private cars operate inefficiently in terms of their energy consumption.

It has been discovered that the number of private cars operating in Ghana increased from 20 564 to 22 523 between 2003 and 2005, whiles the number of public buses in operation within the same period increased from 914 to 2 192 (MoT, 2005). Evidence further shows that private car accounts for 34 percent of all average weekday daily traffic generated in Accra. The bus accounts for three percent, with the trotro (which is Ghanaian slag of large vans converted to seat 12-14 passengers and operated by a driver and mate and work along pre-defined routes), taxis and freight vehicles accounting for 25 percent, 20 percent and 18 percent respectively (DoUR, 2005). In the morning peak hour, the story is the same with public bus share decreasing compared to the share of private car.

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In terms of daily passenger flows in Accra, 56 percent of daily trips are made by trotro, 15 percent of daily trips are made by taxi, with 13 percent by bus and 11 percent of commuters use private car. The rest (5%) of the daily trips are accounted for by other modes (MoT, 2005). Several questions can be asked about why a commuter will prefer one mode to the other. It is difficult to tell whether the reasons relate to the individual making the choice decision or mode choice attributes. Several scholars and researchers have sought to answer the question. In the view of Verplanken, Aarts and Van (1994) making exactly the same journey to work under the same circumstances on the same way every morning, is not guided by deliberate decision, but is habitual. This means that the individuals who frequently travel by car in similar situations may develop a stronger car habit than individuals who sometimes travel by car and another time by public transport.

Whichever way one considers the issues, the need to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine factors that determine their choice of mode of transport becomes palpable. This study addresses the following questions: What makes people prefer private car to other modes of transport? What are the factors that will be important in discriminating between the choice of mode of transport of intra-city spare parts dealers? What is the probability of choosing a mode of transport given other modes and personal specific characteristics and mode choice attributes?

Literature indicates some factors that influence the choice of mode of transport. Hanson and Hanson (1980) noted that men travel on bus to lesser extent than women. Alpizar, Carlson and Martinsson (2001) discovered that travel time and travel cost are the most important determinants of choice of mode. Mathies, Kuhn and Klockner (2002) found in Germany, Switzerland and Australia that women use public transport more than men and reversibly use cars less frequently. Corpuz, McCabe and Ryszawa (2006) also found that, car users were concerned with speed, comfort and convenience associated with shorter travel time and the flexibility of the trip-making. Mintesnot and Takano (2007) posited that peripheral zone residents, who were public or private company employees and had a larger family size, had a higher probability of choosing bus over taxi. Eno (2007) maintained that women who had unrestricted access to private car persistently preferred the private car mode to public transport. Bill (2008) found no connection between affluence and car usage.

It is against this background that the study seeks to use a typical probabilistic model (discriminant function analysis) to classify and predict the choice of mode of transport of intra-city spare parts dealers and to examine the relevant personal specific characteristics and mode choice attributes that determine the choice of mode of transport. We chose Accra because it is the capital city and the main administrative and business centre of Ghana.

The rest of the paper is organised as follows: Section 2 presents the overview of the public road transport sector in Ghana. Section 3 deals with the methodology. This section outlines the survey method and describes the model and estimation techniques. Section 4 presents the results and discussion. Section 5 provides the conclusions and policy implications.

2. Overview of the Public Road Transport Sector in Ghana

Road transport is by far the leading carrier of freight and passengers in Ghana's land transport system. It carries over 95 percent of all passenger and freight traffic and gets to most communities in Ghana. Ghana's road network was about 38,000 kilometers in 2000. This has increased rapidly to 60,000 kilometers by the end of 2005. The road sub sector has seen gradual improvements. For example, the road condition in 2004 was 36 percent good, 36 percent fair, and 28 percent poor as compared to the desired condition of 70 percent good, 20 percent fair, and not more than 10 percent poor (MoT, 2009).

Road maintenance is critical to achieving desired accessibility, affordability, reliability and safety. However, since 1961 it increasingly became difficult to provide adequate funding from the consolidated fund to maintain the road network. A first generated road fund was established in 1985 to solve this problem. In 1997 the Road Fund Act (Act 536) was promulgated to offer a legal framework for road maintenance. This has resulted in great improvements in funding of road maintenance. The current level of the road fund is about 68% of the projected level of maintenance costs (MoT, 2005).

Public road transport services in Accra Metropolitan Assembly (AMA), as is the case for the entire country, are provided by the private sector, which operates a mix of fleets such as buses, trotro and taxis. In 1927, the Accra Town Council operated bus services in Accra, Kumasi, Sekondi-Takoradi and Obuasi. Prominent among the transport operators in this sector in the 1980s was King of Kings Ltd. Its bus operation, which was heavily patronised, was concentrated mainly on the Odorkor-Accra corridor. The company's operations could not survive the difficult and ruthless environmental conditions of the industry thus it wound up in the late 1980s.

Governments over the years have also established bus service companies such as the Omnibus Services Authority (OSA), State Transport Company (STC), City Express Services (CES) amid others. Similarly, operators like STC, CES and OSA in the formal sector have not fared well either, and this compelled the government to divest STC and CES and to liquidate OSA in the 1990s. The Government has quite recently established Metro Mass Transit (MMT) limited for various reasons including government social obligations, environmental factors, energy considerations and the promotion of efficient public transportation to increase productivity and economic growth. It is also in fulfillment of the government's promise to bus at least about 80 percent of passengers in Ghana, through mass transport (MoT, 2009). Other projects including Bus Rapid Transit (BRT) systems, School Busing Schemes and Rail Based Mass Transport Systems have also been given due consideration.

A number of buses have been imported and are operating in Accra and elsewhere under the management of Metro Mass Transit (MMT) Limited. The Company's bus Fleet as of December 2007 was 779. As of December 2007, MMT was operating in all 10 regions in the country. At the end of the year 2007, the number of buses that were in good condition for operation was 400 (51%) countrywide out of the total of 779 buses with 379 (49%) bus fleet at workshop (MoT, 2009).

The control over the operation of public transport by government is limited to an extent. The private operations are strictly controlled by trade unions of which the most powerful is the Ghana Private Road Transport Union (GPRTU). These unions charge membership fees and member drivers are obliged to register with and pay a daily fee to a local branch, which controls a terminal. The unons also collect user charges on behalf of the Metropolitan or District Assemblies, who own the terminals. As part of their rules, unions require a vehicle to be full before it can depart. This practice is inimical to the interest of passengers, who often cannot board vehicles between terminals and must wait for long periods until the vehicles are full.

Generally, quality of services provided by public road transport is poor. This is because most vehicles are old and maintenance standards are to the extreme very low. Sky-rocket vehicle maintenance costs arising from poor road surfaces and limitations imposed on earnings by the acute congestion on the urban roads constrain the operators to invest in new vehicles. The consequence is limited number of low-capacity vehicles and the resultant long queues during the morning and evening rush hours at most terminals in the country (MoT, 2005).

The public transport and freight terminals, known in the local parlance as lorry parks, serve all forms of vehicles from private commercial cars and taxis to multiple axle trucks. A few of these parks are paved and there is no clear demarcation between access roads, parking space, and passenger waiting areas. Overall, lorry parks have sprung up near markets and at major intersections. Lorry parks' development has been ad-hoc, with little account taken of the impact of the vehicle and pedestrian traffic they attract. Lack of their planning has also resulted in vehicles following long and meandering city routes and passengers having to change vehicles most time before reaching their destinations.

Problems of public road transport in Accra are eminent. The Department of Urban Roads (DoUR) in 2005 conducted a survey with public transport operators, who classified their concerns as terminal, route, operational or financial problems. According to DoUR, lack of toilets and poor sanitation is clearly the most common problem faced by transport operators at terminals in AMA. From the perspective of the operators, lack of shelters, congestion at access points and congestion within the terminal are also significant problems. Amongst the route problems, congestion (56%), with associated long travel time and high operating cost was the most common problem, the survey indicated. Along routes, insufficient provision of lay byes and bus stops was one of the most frequently identified problems cited by the operators. One third of the survey respondents mentioned conflict with hawkers and pedestrians, inadequate traffic control at junctions and police harassment among others as problems.

Furthermore, 28 percent of the operators interviewed claimed poor road signs and absent or faded road markings were problems for them. Driver indiscipline and old vehicles were the only two significant operational problems noted by the survey respondents. These two issues were listed by 50 percent and 44 percent of the survey sample respectively. Financially, high cost of maintenance was the major problem identified in the survey. This was closely followed by high taxes. Low fares and high vehicle replacement costs were the remaining financial problems identified by over 25 percent of respondents.

Accra, which is the capital city and main administrative and business centre of Ghana, had a population of approximately 1,659,000 in 2000. It was estimated that by 2013 the combined effect of growth and migration would increase the population of AMA to slightly less than 2 million. It was also expected that the population growth and increasing rates of car ownership would increase the number of cars in AMA from 181,000 in 2004 to over 1 million in 2023, and this is likely to aggravate the already chronic traffic congestion in the cities. Currently, the highest traffic volumes are found in the Winneba Road and Liberation Road corridors, which have volumes over 50,000 vehicles per day at certain points (DoUR, 2005).

About 10,000 vehicles also enter the central area of Accra within the Ring Road in the morning peak hour and on a typical weekday, 270,000 vehicle trips are made into, or out of, the Accra central area. In the morning peak hour, higher volumes of about 16,000 inbound vehicle trips and 300,000 daily vehicles trips in both directions cross into the area inside the motorway extension. These vehicle trips consist of 50,000 inbound passenger trips into the Accra central area and 85,000 trips into the area inside the motorway extension in the morning peak hour. Approximately 1.3 million passenger trips per day are estimated to enter or leave the area within the Accra Ring Road and 1.6 million passenger trips into or out of the area within the motorway extension (DoUR, 2005).

Eighty four percent of these passenger trips, according to Urban Road, are made by public transport. Over half (56%) of daily passengers are carried by trotros, and a further 15 percent by taxi. About 1 million passenger trips are made each day into and out of the central area of Accra using trotros and taxis. In Accra the average number of passengers carries by trotros and taxis per trip are 13 and 2.3 respectively. The implication of this is that these vehicles are inefficient in terms of congestion caused and the amount of road space used to transport each passenger. In a situation where the intra-urban journey is short, most of these vehicles also experience inefficiency in terms of high energy consumption per time as well as per passenger.

Congestion is a major problem on arterial routes in Accra, and this leads to 70 percent of major roads operating at unacceptable level of service at some time during the day (less than 20 km/h). Although considerable scope exists to improve the efficiency of people movement through a shift from low capacity public transport vehicles to large and double-decker or articulated buses with the potential to carry over 100 passengers, the concern is whether this will really work given the nature of roads and the volume of daily traffic congestion on all the corridors in the cities. Any attempt to shift from one mode to the other is also likely to face some challenges due to pervasive popularity of private cars in Accra and the country as a whole.

In summary, the discussion covers public road transport in Ghana and highlights some of the operational challenges pertaining to the public road transport sector in the Accra Metropolitan Area, and finally considers the effects of population growth and increasing demand for motor vehicles on urban transport in the study area. This paper aims at studying the transport choice of spare parts dealers in Accra and the literature is relevant since it reveals much information about the degree of transports that is used by travellers in Ghana.

3. Methodology

3.1. Study Area and Data

Abossey Okai is the study area for this research. It is situated in the Accra Metropolitan Area (AMA) of Ghana. The AMA is one of the largest assemblies in the country. The AMA is bordered in the North, West and East by other Municipal and District Assemblies, and South by the Gulf of Guinea. Accra is the capital as well as the largest urban centre in Ghana. It is located on the coast of the Greater Accra Region, and epitomises the level of socio-economic development in Ghana. Accra has a population of 1 848 614 according to 2 010 population and housing census.

For the purposes of this study, the study area was divided into two zones. These are inner zone and peripheral zone. The inner zone residents are spare parts dealers who live in and around the Central Business District (CBD) of Accra. The peripheral zone residents are those who live in the urban edges of the study area. These zones are largely inhabited by all manner of persons but the dominant languages spoken are Akan, Ga and English. Each zone is made up of settlements. The inhabitants, most of whom are spare parts dealers, engage in various activities such as banking, commerce and other administrative duties. Nonetheless, of all the activities engage in at Abossey Okai, spare parts dealing is the dominant one.

The data for this research was based on ex post facto survey design. Primary data were collected through survey of individual spare parts dealers in Accra. The study employed questionnaire instruments for data collection and in all, two hundred questionnaires were administered. The respondents were visited at their offices or shops during working hours. If the person at the office or shop could not make a choice decision, the person at the next office or shop next door was surveyed. All interviews were personal where the questions were read aloud to the respondents in English and vernacular (Akan & Ga).

3.2. Empirical Model of Mode of Transport

For empirical estimation purposes, the linear discriminant function for multiple groups was adopted to estimate the likelihood of an individual spare parts dealer choosing a particular transport modality with the grouping or dependent variable being the mode of transport, which was grouped into private car, public bus, public trotro and public taxi. This is of great importance because it will help policy makers to know which personal specific characteristics and mode choice attributes influence transport mode choice decision by spare part dealers in Accra.

The standard linear discriminant model is specified as follows:

$$F_K = \lambda_0 + \lambda_1 X_1 + \lambda_2 X_2 + \ldots \lambda_P X_P \qquad (3.2.1)$$

Where F_k is the score on the function K, the λ_is are the discriminant coefficients, and the X_is are the independent or response variables. The maximum number of functions K that can be derived is equal to the minimum number of predictors (p) or the number of groups less one (SPSS Inc., 2003). In this study, four groups were used. Therefore, four minus one maximum functions were used in the analysis.

Like other general linear model techniques, discriminant analysis has many of the same conditions. First of all, the predictor or independent variables must be measured either with interval or ratio scale. Ordinal variables measured on a likert scale must be treated as interval variables. Nominal variables may be included in the model if they are given dummy coding. Secondly, it is assumed that the data represent a sample from a multivariate normal distribution. One can examine whether or not variables are normally distributed with histograms of frequency distributions. However, note that violations of the normality assumption are not "fatal" and the resultant significance tests are still reliable as long as non-normality is caused by skewness and not outliers (Tabachnick & Fidell, 1996).

A third assumption of the discriminant analysis is that the variables that are used to discriminate between groups must not be completely redundant (Hurberty, 1994). If one of the independent variables is very highly correlated with another, or one is a function of other independents variables, then the tolerance value for that variable will approach 0 and the matrix will not have a unique discriminant solution. There must also be low multicollinearity of the independent variables. To the extent that independent variables are correlated, the standardized discriminant function coefficients will not reliably assess the relative importance of the predictor variables.The tolerance value is computed as 1 minus R-square of the respective variables with all other variables included in the current model (Hurberty & Olejinik, 2006). Thus, it is the proportion of variance that is unique to the respective variable.

Discriminant Analysis is highly sensitive to the inclusion of outliers. So it is important to run a test for univariate and multivariate outliers for each group, and transform or eliminate them. If one group in the study contains extreme outliers that impact the mean, they will also increase variability. Overall significance tests are based on pooled variances, that is, the average variance across all groups. Thus, the significance tests of the relatively larger means (with the large variances) would be based on the relatively smaller pooled variances, resulting erroneously in statistical significance.

Transport mode choice was discussed in relation to the following variables or characteristics: Sex of respondent, respondent's marital status, age of respondent, family size, average monthly income, risk specific issues (accident, missing appointment, robbery and breakdown), respondent's level of education, respondent's accessibility to transport, residential zone, in-vehicle travel time, average distance travel from home to work and habits. These variables were chosen because several studies have shown their effect on travel mode choice.

Habits represent the number of times the respondent used a particular mode from home to work in the last week preceding the survey. It is believed to have an effect on behaviour in this context. Triandis (1980) argued that habit could be measured by the frequency of occurrence of behaviour. A habit is a composite variable which was measured with likert scale. It received the value of 7 for the highest number of times respondents used a particular mode for the past week preceding the survey and 0 for minimum number of time.

Accessibility is how respondents perceived their access to a particular mode of transport. It was coded 1 = very easy, 2 = easy and 3= not easy at all. Because this variable has more than two response categories, it was contrast coded (also known as dummy coding) to represent and compare subgroups on the variables. This was very necessary because the process enabled the use of a single equation to represent multiple groups. It was also to fulfill one of the basic requirements for the discriminant model. In order to know how accessibility affects transport mode choice, response three or "not easy at all" was used as a reference category. The reference category was then used in the discriminant function modeling as a way of redefining categorical variables as a series of dichotomous variables.

For example, the covariate, accessibility, has three values and by assigning "not easy at all" as the reference category, each of the other three variables was treated as a dichotomous variable against "not easy at all". In other words, the three-way category became two simpler dichotomous variables – very easy (1) vs. not easy at all (0) and easy (1) vs. not easy at all (0). Therefore, for any independent categorical value with n categories, the use of contrast coding converts the independent variable to a series of n-1 dichotomous variables (see Borders, 2006 for more explanation on contrast coding). This approach was applied to all the categorical variables in the discriminant models.

In-vehicle travel time is the average time per minutes a commuter has to endure in a particular mode of transport. It is a generic variable (sometimes referred to as level-of-service attributes in mode choice analysis) and varied across alternative mode. In-vehicle travel time is a continuous variable that was measured in minutes per second. Family size is a continuous variable based on the number of children responsible to the respondent. It ranges between one to six children; age is also a continuous variable measured in terms of years (26 years above).

Average distance is the distance covered from home to work. It is a continuous variable. Distance was measured in kilometer per seconds; residential zone and gender are all categorical variables; income is a continuous variable in terms of monthly income. Risk specific issues are categorical and were measured on a scale of one to three, with the three being not risky at all and one representing very risky. Though the above variables are important in determining the choice of mode of transport, some of them could not pass the univariate F test and therefore did not enter the final discriminant model.

It is also not farfetched, that the Discriminant Function Analysis is unreliable, when testing for a large number of predictor variables. Therefore, only those variables that passed the tolerance test in the preliminary analysis were included in the model. The number of variables included in most discriminant analysis studies is limited to something on the order of 10 or 12 unless there are compelling reasons for including more (Hurberty & Olejinik, 2006).

3.3. Techniques of Data Analysis

The preliminary analysis and exploration of the data was done, employing Statistical Product and Service Solution (SPSS) version 17.0. This was done seeking patterns within responses, looking for casual pathways and connections and constant comparisons (Cohen, Manion & Morrison, 2000). By the nature of the measurement scales, two other statistical techniques, namely: Descriptive statistics of frequencies to determine whether distribution occurred evenly across categories or whether responses were skewed towards one end of the rating scales were employed. This enabled a meaningful description of the data with numerical indices and also checked for errors. Internal consistency methods or procedures were applied to ensure reliability of scores, since the interview schedules were administered only once.

The cross tabulation of frequencies and tables were used to analyse the demographic characteristics of respondents and other factors that influence the choice of mode of transport of the spare part dealers. The associations between personal and mode specific characteristics of respondents and their choice of mode of transport were analysed using the chi square test of independence.In addition, SPSS version 17.0 was used to analyse the data for the discriminant model. The discriminant analysis was used in the study to classify specific spare parts dealers into their appropriate mode choice groups based on a set of discriminating variables. The classification was based on the discriminant function and the discriminant score for each of the spare parts dealers in the sample.

The discriminant analysis was performed using two different steps. The first involved the computation of eigen values as well as the canonical correlation coefficients. The computed eigen values and the canonical correlation coefficients were tested for their significance using wilk's lambda (λ) and chi-square. The second step was the classification of the spare parts dealers into their appropriate mode choice group based on the canonical functions. Subjects are classified in the groups in which they had the highest classification scores. Linear discriminant function coefficients offered explanation on the effect of each of the variables on the mode choice behaviour of spare parts dealers in the study area.

4. Results and Discussion

The objective of this study was to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine their personal specific characteristics and mode choice attributes that are relevant in the choice of mode of transport. The coefficients of all the relevant personal specific and mode choice characteristic variables that provide the best discrimination were estimated. In all, 200 respondents were interviewed. Out of these 72 used private car; 18 used public bus; 83 used public trotro; 25 respondents used public taxi and the rest used other means. The main findings of the study are as follows:

4.1. Demographic Characteristics

Spare parts dealers with ages between 26 years and 60 years were sampled for the study. The average age of the male spare parts dealers was approximately 37 years and that for the female spare parts dealers was about 36 years. Average age of spare parts dealers significantly influenced the choice of mode of transport. Many of the spare parts dealers had more than three children. Family size also has significant influence on the choice of mode of transport of spare parts dealers. Majority of the male spare parts dealers had no formal education, whiles their female counterparts were in the minority. Most of the respondents sampled for this study were also in matrimonial relationship, with less than one-third single, separated or divorced. Majority of the spare parts dealers earned income far and above the national minimum wage in Ghana at the time of the study.

A lot more of the spare parts dealers used public trotro to work; over one-third used private car; about 13 percent used public taxi whilst the remaining 9.1 percent used public bus from home to work. A little over three-quarters of the spare parts dealers who used public bus were males whereas less than one-quarter were females. Less than half of the spare parts dealers who used private car were females with less than one-third being males. There were male dominant in the use of public bus, public trotro and public taxi at all levels of transport, apart from private car. It was discovered that sex has no significant influence on the choice of mode of transport of spare parts dealers.

Over half of the spare parts dealers lived within the peripheral zone of Accra whiles the remaining lived within the inner zone. Many of the peripheral zone spare parts dealers used private car and public bus as a means of transport to work. Less than three-quarters of the inner zone spare parts dealers used both private car and public trotro to work. A little below half of the spare parts dealers who lived in the peripheral zone used public trotro as means of transport to work. Over one-third of the inner zone spare parts dealers used public trotro from home to work.

In trying to answer the question about whether or not respondents' residential zone significantly influences their choice of mode of transport, the following hypothesis was made that: Residential zone has no influence on the choice of mode of transport of spare parts dealers. The results indicate that residential location of respondents, indeed, influenced their choice of mode of transport, as revealed by the χ^2 value of 8.089, with its associated p-value of 0.044. Pallant (2001) was of the view that for a test to be significant, the p-value must be equal to or smaller than 0.05. The test was therefore significant and we failed to accept the null hypothesis, implying that residential zone significantly influences the choice of mode of transport.

The analysis shows that the average in-vehicle time spent by private car users from home to work was 20.09 minutes but this has no significant influence on the choice of mode of transport by spare parts dealers. The average time spent by spare parts dealers in a public bus to work was nearly an hour and this also has no significant influence on the choice of mode of transport by spare parts dealers. The average time spent by spare parts dealers in a public trotro from home to work was 38.82 minutes. More than half of the taxi users spent between 15-25 minutes in traffic before getting to work. The average time spent by spare parts dealers in public taxi, however, has significant influence on the choice of mode of transport.

The study further shows that majority of private car users claimed it was very accessible to them. Most public bus users claimed it was easily accessible. Two-third of all those who used trotro from home to work, saw the trotro as easily accessible. Over half of all taxi users claimed that the taxi was very easily accessible. Majority of private car users perceived the car as the most non risky mode in terms of missing appointments. Spare parts dealers also perceived taxi as the most non risky in terms of missing appointments.

Some spare parts dealers, however, reported that public bus and public trotro were risky when it comes to missing appointments. Majority of the Spare parts dealers who used private car, public bus and public trotro believed they were not risky, given robberies. All public bus users did not rate it as risky in terms of accident. Some of the private car, trotro and taxi users, however, pointed out that these modes were risky in terms of accidents and majority of public bus and public trotro users perceived these modes to be risky in terms of break-down. Below half of all private car users and over one-third of all public taxi users did not rate these modes as risky in terms of break-down.

4.2. Results of the Discriminant Model

The previous analysis under the descriptive statistics results in relevant information about the factors that may affect the choice of mode of transport. However, explaining why people choose one mode over the other is much more complicated. Linear discriminant function model was employed to do the analysis. A number of tests were conducted to ascertain the importance of the personal specific and mode choice characteristic to the discriminant functions. The initial test results are shown in Table 1. In the table, the smaller the lambda for an independent variable, the more that variable contributes to the discriminant function. Lambda varies from 0 to 1, with 0 meaning group means differ (thus the more the variable differentiates the groups), and 1 meaning all group means are the same. The F test of Wilks' lambda shows which variables' contributions are significant.

From Table 1, the F test for wilk's lambda is statistically significant for all the predictive variables except average distance, sex, marital status, risk in terms of accident and risk in terms of breakdown. The implication of the results is that all those variables that are statistically significant at five percent and 10 percent levels are important to the discriminant functions.

One of the assumptions of the discriminant analysis is that the covariance matrices across groups are equal. The Box's M test tests the assumption of homogeneity of covariance matrices. This test is very sensitive to also meeting the assumption of multivariate normality. Table 2 presents the results on Box's test of equality of covariance matrices. From the Table, the results indicate that the Box's M test of homogeneity of covariances is very significant at five percent level of significance. Therefore, the hypothesis of equality of covariances at ($p <. 05$) is rejected, implying that the groups differ in their covariance matrices. While the log determinants were quite similar, Box's M indicated that the assumption of equality of covariance matrices was violated. Because the data violate the assumption of homogeneity of variance, this could lead to classification problems, meaning that the resulting predictions about transport modes may be less than optimal. This problem was therefore corrected by using separate group covariance matrices in the analysis (see Borders, 2006).

Table 1. Tests of equality of group means for predictive variables

Variable	Wilk's lambda (λ)	F	df1	df2	Sig
Accessibility*	.802	16.002	3	194	.000
Habit**	.964	2.402	3	194	.069
Average time*	.955	3.033	3	194	.030
Average distance***	.988	.807	3	194	.492
Average income*	.920	5.644	3	194	.001
Age of respondent**	.961	2.632	3	194	.051
Sex***	.981	1.252	3	194	.292
Marital status***	.988	.763	3	194	.516
Level of education*	.909	6.437	3	194	.000
Location of residence*	.957	2.913	3	194	.036
Family size**	.967	2.182	3	194	.091
Accident***	.971	1.944	3	194	.124
Missing appointment*	.958	2.869	3	194	.038
Petty robbery*	.957	2.900	3	194	.036
Breakdown***	.990	.656	3	194	.580

Note: *, ** denote variable statistical significance at 5% and 10% levels
*** denote variable that contributes "noise" (not significant) to the model

Table 2. Box's test of equality of covariance matrices

Box's M	F	df1	df2	sig
1200.461	6.629	156.000	16309.701	0.000

4.3. Summary of Canonical Discriminant Functions

The preliminary results of the discriminant analysis were promising. The canonical correlation, which is equivalent to the Pearson correlation coefficient, in the case of two-group discriminant analysis, measures the correlation between the discriminant scores and the grouping variable, in this case, choice of mode of transport. The canonical technique involves the computation of eigen values as well as the canonical correlation coefficients. A squared canonical correlation indicates the proportion of variation in the discriminant function that is explained by the grouping variable. The eigen values determine the variation in the grouping variable accounted for by the model.

The larger the eigen value, the more of the variance in the grouping variable is explained by that function. Since the grouping variable (dependent variable) in this analysis has four categories, there are three discriminant functions. This is because the number of discriminant function depends on number of groups minus one or number of characteristic or independent variables, whichever is less. The preliminary results of the discriminant analysis are shown in Table 3.

From Table 3, the computed eigen values for the three discriminant functions are 0.563, 0.217, and 0.103 and the canonical correlation coefficients are 0.600, 0.422 and 0.306. The squared of the correlation coefficients do point out that about 36 percent of the variation in the groupings is explained by the first function, 17.8 percent by the second and nine percent by the third function. This is an indication that, the discriminant functions have predictive utility or value.

The eigen values for each discriminant function were also tested for their significance using wilk's lambda (λ) and chi-square (Table 3). For each set of functions, wilk's lambda tests the hypothesis that the means of the functions listed are equal across groups. The test of the functions was found to be significant at a standard 5 percent for all the three functions. This implies that the discriminant functions will do better than chance at classifying the spare parts dealers into their appropriate mode choice groups. It is important to state that wilk's lambda and eigen values can also be used to assess how well the discriminant model as a whole fits the data.

4.4. Standardised Canonical Discriminant Function Coefficients

The standardised discriminant function coefficients serve the same purpose as beta weights in multiple regression models. Thus, they indicate the relative importance of the outcome or predictor variables in predicting the grouping variables or the dependent variables. The coefficients on the function indicate the partial contribution of each variable to the discriminant function(s), controlling for other independent variables entered in the model. The standardised canonical discriminant function coefficients are given in equations 4.4.2-4.4.4 for all the functions.

Table 3. Eigen value and wilk's lambda (λ) test of function

Functions	Eigen value	Canonical correlation	Wilk's lambda	Chi-squared	Degree of freedom	Sig
Function 1	0.563*	0.600	0.477	140.098	36	0.000
Function 2	0.217*	0.422	0.745	55.691	22	0.000
Function 3	0.103*	0.306	0.906	18.571	10	0.046

Note: * denote statistical significance at the 5% level

Table 4. The structure matrix

Predictor variable	Function 1	Function 2	Function 3
X_1	.657*	.033	-.194
X_2	-.274	-.480*	-.264
X_3	.063	-.378*	-.194
X_4	-.303	.391*	.157
X_5	.188	.330*	.122
X_6	-.174	-.236*	.093
X_7	-.041	-.304	.501*
X_8	.191	.116	.450*
X_9	.225	-.060	.387*
X_{10}	-.158	.140	.387*
X_{11}	-.222	.164	.265*
X_{12}	.092	-.209	.222*

Note: * denotes variable ordered by absolute size of correlation within functions
Source: Computed from Field Data, 2009

$$F_1 = X_1(.760) + X_2(-.171) + X_3(.093) + X_4(-.285) + X_5(-187) + X_6(.-.754) + X_7(-.098) + X_8(.030) + X_9(.699) + X_{10}(.-.017) + X_{11}(-.095) + X_{12}(.041) \quad (4.4.2)$$

$$F_2 = X_1(.190) + X_2(.554) + X_3(-.403) + X_4(.379) + X_5(.273) + X_6(-.531) + X_7(-.243) + X_8(.395) + X_9(-.014) + X_{10}(.203) + X_{11}(-.001) + X_{12}(-.302) \quad (4.4.3)$$

$$F_3 = X_1(-.257) + X_2(-.135) + X_3(-.169) + X_4(.000) + X_5(.232) + X_6(-.161) + X_7(.570) + X_8(.361) + X_9(.483) + X_{10}(.471) + X_{11}(.092) + X_{12}(.122) \quad (4.4.4)$$

4.5. Structure Matrix

The characteristic or independent variables measured on different scales were correlated with the output of the standardised canonical coefficients and were accordingly re-arranged in their order of importance based on the absolute size of the correlation coefficients to give the structure matrix. The structure matrix Table 4 shows the correlations of each outcome variable with each discriminant function. The correlations coefficients serve like factor loading in factor analysis. That is, the matrix helps us identify the largest absolute correlations associated with each discriminant function so that we can know how to assign a meaningful label to each function.

From Table 4, it can be observed that accessibility of transport (X_1) has the largest absolute correlation coefficient within the function 1, suggesting that it is the most useful outcome or predictor variable in predicting the choice of private car. In terms of public bus, the results indicate that the level of education (X_2), habits (X_3), average monthly income (X_4), respondent's residential zone (X_5) and risk in terms of accident (X_6) are the useful discriminating outcome variables, because they are absolutely highly correlated with public bus.

However, in order of absolute size of correlation coefficients within the public bus function 2, it was observed that the respondents' levels of education (X_2) was likely to be the best determinant of the choice of public bus followed by respondents' average monthly income (X_4) in that order. The reason is that, the absolute size of correlation coefficient of X_2 within function two was highest than the other variables. In terms of direction, the result implies that the higher the level of education for spares parts dealers, the less likely they will be to choose public bus as a means of transport.

The results in Table 19 also showed that, majority of the characteristic variables was useful in determining choice of public trotro. It was also observed from the table that in-vehicle travel time (X_7), risk in terms of missing appointment (X_8), risk in terms of robbery (X_9), number of children (X_{10}), respondent's age (X_{11}), sex (x_{12}), were absolutely highly correlated with the choice of public trotro. It was also observed that among these variables, in- vehicle average travel time was the most useful outcome variables because it was absolutely highly correlated with public trotro. This is followed by risk in terms of appointment and the rest followed in that order (see Table 19).

4.6. Unstandardised Canonical Discriminant Function Coefficients

The set of ensuing equations contain the unstandardised discriminant function coefficients. These coefficients could be used like the unstandardised beta coefficients in multiple regressions to construct actual predictive equation to classify new cases, the choice of transport. The unstandardised canonical discriminant function coefficients are given in Equations 4.6.5-4.6.7

$$G_1 = (-3.822) + X_1(2.618) + X_2(-.375) + X_3(.667) + X_4(-.061) + X_5(.379) + X_6(-2.166) + X_7(-.456) + X_8(.093) + X_9(1.866) + X_{10}(-.014) + X_{11}(-.011) + X_{12}(.083) \quad (4.6.5)$$

$$G_2 = (6.069) + X_1(.656) + X_2(1.215) + X_3(-2.884) + X_4(.081) + X_5(.554) + X_6(-1.526) + X_7(-1.136) + X_8(1.216) + X_9(-.036) + X_{10}(.170) + X_{11}(.000) + X_{12}(-.612) \quad (4.6.6)$$

$$G_3 = (-5.629) + X_1(-.886) + X_2(-.296) + X_3(-1.213) + X_4(.000) + X_5(.470) + X_6(-.461) + X_7(2.663) + X_8(1.111) + X_9(1.290) + X_{10}(.394) + X_{11}(.010) + X_{12}(.247) \quad (4.6.7)$$

4.7. Linear Discriminant Functions

The second step of the discriminant analysis was the computation of linear discriminant function coefficients for the classification of spare parts dealers into their appropriate mode choice groups. In combination with the data from the group centroids, the direction of the relative impact of the predictor or characteristic variables could be determined. In Table 5, the results on classification coefficients are presented.

From Table 5, the variable accessibility to mode of transport (X_1) was positively heavily loaded on public taxi function. This means that spare parts dealers who reported having very easy or unrestricted access to public taxi within their immediate locality are most likely to be taxi users. A similar conclusion was reached by Eno (2007) that respondents who had unrestricted access to private cars at home persistently preferred the private car mode to public bus. Spare parts dealers who expressed their risk perception in term of missing appointment (X_8) will less likely use any other modes of transport except public taxi. The justification is that risk in terms of missing appointment was positively heavily loaded on the public taxi mode.

The analysis, furthermore, indicated that the residential zone of spare parts dealers discriminates in their choice of mode of transport. The variable X_5 (respondent's zone of residence) was heavily loaded on public taxi with positive sign and this means that spare parts dealers who lived within the inner zone will most likely choose the public taxi for their trips to work. The reason being that, inner-city trips tend to be short, so using a taxi could be seen as a reasonable option. This outcome confirms the findings of Mintesnot and Takano (2007) that peripheral zone residents had higher tendency to choose bus over taxi. Another variable that was positively heavily loaded on the public taxi function was the perception of spare parts dealers in terms of robbery (X_9). The implication of this outcome is that, spare parts dealers who perceived risk of transport in terms of robbery will most likely use public taxi as their mode of transport.

On the other hand, average monthly income (X_4) had some impact on the choice of mode of transport. The results in Table 5 revealed that average monthly income (X_4) of spare parts dealers was positively heavily loaded on private mode. This is an indicative of the fact that when the average monthly earnings of spare parts dealers increase the tendency of using other modes of transport, such as public bus, public trotro and public taxi decreases. This is in line with the normally accepted understanding that, in most transport situations there is a positive correlation between increasing affluence and car usage. This is so because rich people tend to look for more convenient, although more costly, mode like private car as their level of affordability grows. These results reinforce the findings of Mintesnot and Takano (2007) and Davidov et al. (2003) that higher income groups tend to prefer private car to any other modes of transport.

Another variable that impacted the private mode of transport was the level of education (X_2) of the spare parts dealers. The level of education of respondents (X_2) was positively heavily loaded on the private transport mode. The explanation to this is that spare parts dealers who are highly educated will most likely prefer private car to either public bus or public trotro or public taxi. These results is not entirely different from the argument by Davidov et al. (2003) that higher education often relates to higher status or higher income and this might lead to a lower preference for public transport.

In connection with perceived risk in terms of accident, the results show that people who perceived risk in terms of accident (X_6) will less likely use public bus, public trotro or public taxi. This is so because perception of risk in terms of accident (X_6) was positively heavily loaded on private mode of transport. From Table 5, it was again observed that age was positively heavily loaded on the private mode of transport. This also shows that people who are older will most likely patronise the private mode of transport. Again, this result is consistent with the assertion made by Mintesnot and Takano (2007) that the probability of choosing a bus decreases when age increases. This is to be expected because the physical predisposition of the elderly people may not permit them to struggle for public trotro and public bus. Many of them may also want to use private car as a status symbol in the society. Another reason could be that, the bus was overcrowded and was not convenient to the elderly.

The results in Table 5 revealed that habit (X_3), which is measured in terms of the number of times a particular mode was used in the last week preceding the survey, also had a significant impact on group membership as well. Habit (X_3) was positively heavily loaded on public bus mode of transport, implying that spare parts dealers who reportedly used the public bus from home to work routinely will most likely continue to use public bus. This result confirms the findings of Verplanken et al. (1994) who argued that making exactly the same journey to work under the same circumstances on the same way every morning, is not guided by deliberate decision, but is habitual.

Table 5. Classification function coefficients

Discriminating Variables	Car	Bus	Taxi
X_{11}	1.406*	1.402	1.381
X_2	22.732*	20.637	22.269
X_5	5.703	5.763	6.796*
X_{10}	1.989	2.033*	2.017
X_8	27.772	27.145	28.425*
X_9	16.541	19.511	20.942*
X_7	26.675	29.369*	25.223
X_3	197.680	201.107*	198.237
X_1	30.658	32.132	37.059*
X_4	.167*	.002	.052
X_{12}	4.663	5.670*	4.648
X_6	31.909*	31.077	26.261
Constant	-439.466	-456.668	-448.605

Note: * denotes figures have higher values
Source: Computed from Field Data, 2009

Table 6. Discriminant model classification result

	Predicted Group Membership				
Original count	Private car	Public bus	Public trotro	Public taxi	Total
Private car	45	3	21	3	72
Public bus	4	9	5	0	18
Public trotro	18	3	59	3	83
Public taxi	1	1	5	18	25
Total	68	16	90	24	198

66.2% of original grouped cases correctly classified
Source: Computed from Field Data, 2009

In terms of average in-vehicle travel time (X_7), the results revealed that spare parts dealers who spend longer time from home to work will most likely prefer public bus to other transport, for example, private car or public taxi. The reason is that as average time increases, it makes it difficult for spare parts dealers to afford longer trips by private car, taxi or any other forms of transport. This conclusion is at variance with the findings of Alpizar, Carlsson and Martinsson (2001) that a reduction in travel time was significant in attracting commuters towards public transport. Other variables that were positively heavily loaded on the public bus were sex of respondents (X_{12}) and number of children in respondents' family (X_{10}). These results imply that, male spare parts dealers with large family size will most likely be bus users.

4.8. Classification Results

While the interpretation of the usefulness of the characteristic variables and the impact of the coefficients on the choice of mode of transport is informative, the primary objective of this study was to correctly classify spare parts dealers into appropriate mode choice groups and, to predict their choice of modes of transport. The classification table shows the practical results of using the discriminant model.

Each of the twelve variables in the discriminant model had a few cases of exclusion. Table 6 shows the classification of spare parts dealers into their appropriate mode choice groups. Of the 200 cases, only 2 (1%) were excluded from the final model because those cases relate to other forms of mode other than those under consideration.

The empirical results indicated that out of 72 original private car users, 45 (62.5%) were classified correctly. The remaining 27 were, however, re-assigned to other modes of transport. Out of the 27 that were re-assigned, 3 were re-assigned to public bus; 21 were re-assigned to public trotro with 3 re-assigned to public taxi. Of the 18 spare parts dealers who originally used the public bus, the results in Table 6 indicated that the model classified 9 (50%) correctly. Four were re-assigned to private car, while 5 were re-assigned to public trotro. No user was re-assigned to public taxi. Again, the results showed that 59 (71.1%) out of the original 83 trotro users were correctly classified. Three and 3 were re-assigned to public bus and public taxi, respectively.

The analysis further revealed that out of the 25 original taxi users, the model correctly classified 18 (72%). One respondent was re-assigned to the private car; another one was re-assigned to public bus, while 5 were re-assigned to public trotro. In predictive terms, the model predicted 68 out of the 72 original private car users. It also predicted 16 out of the 18 original bus users. Although 83 original trotro users were used to create the model, the model suggested that 90 should have gone to work on trotro, while 24 instead of 25 taxi users should have gone to work on taxi. Overall, the discriminant model was successful in correctly classifying 66.2% of original group cases (See Table 6). The results suggest that the discriminant model did relatively good job at classifying spare parts dealers into their appropriate modes. In fact, the model is correct about two out of three times.

5. Conclusions and Policy Recommendations

The objective of this study was to employ discriminant model to classify intra-city spare parts dealers into their appropriate mode choice groups and to examine their personal specific characteristics and mode choice attributes that are relevant in the choice of mode of transport. It was expected that all the personal specific and mode choice characteristics included in the model would have the rightful impact on the choice of mode of transport. For example, we expected that respondents' age, level of education and income would load heavily on private car, while time and family size were expected to load heavily on bus.

It came to light from the study that, spare parts dealers' choice of mode of transport was determined by their sex, age, income, family size and level of education. Factors such as time, residential zone, risk (missing appointment, robbery, accident and break-down), accessibility and habit also determined the choice of mode of transport. This means that higher education and higher income increase the chance of choosing private car. It was also realised that the older some people become the more predisposed they become to private car. Again, when an individual perceives a particular mode to be risky in terms of accident, the individual is likely to shy away from that mode. Male spare parts dealers with large family size will patronise public bus. If Individuals expressed risk in term of missing appointment for a particular mode, the individual will sacrifice that mode. When individual has unrestricted access to any transport within their locality, they will continue to use that transport.

The longer time an individual expect to spend from home to work in traffic, the more likely they are to choose bus.

In terms of best predictors for each mode, accessibility of transport (X_1) was the most useful predictor variable for private car. Though the level of education (X_2), habits (X_3), average monthly income (X_4), respondent's residential zone (X_5) and risk in terms of accident (X_6) were useful discriminating variables in favour of public bus, in terms of absolute size of correlation within the public bus function, respondents' levels of education (X_2) was the best predictor of the choice of public bus because it has the highest absolute size of correlation, followed by respondents' average monthly income (X_4) in that order. In-vehicle travel time (X_7), risk in terms of missing appointment (X_8), risk in terms of robbery (X_9), number of children (X_{10}), respondents' age (X_{11}) and sex (x_{12}) were all useful discriminators in favour of public trotro. However, average travel time was the most useful one, followed by risk in terms of appointment and the rest followed in that order.

The classification results from the discriminant analysis showed that, more than half of the original private car users should have gone to work on private car. The remainder should have used other modes of transport. In terms of the original public bus users, the results showed that half should have used other modes of transport. Again, less than two-third of the original trotro users should have used other means to work. Furthermore, more than two-third original taxi users were correctly classified, meaning that the rest will shift to other modes.

In terms of accuracy of the discriminant model to predict spare parts dealers, the model predicted more than two-third of the original private car users. The model also predicted over three-quarters of the original bus users. In addition to that, however, the model over predicted the original trotro users, while almost all the original taxi users were predicted by the model. Overall, the discriminant model was successful in correctly classifying about two-third of original spare parts dealers in the study area.

It is informative to note that the approach adopted in this study yielded conclusions that are consistent with the results from studies which used more complex modeling techniques. The key findings from the discriminant model showed that individual characteristics and mode choice attributes, in particular, sex, age, income, family size, level of education, time, residential zone, risk (missing appointment, robbery, accident and break-down), accessibility and habit determined the choice of mode of transport of spare parts dealers [Alpizar, Carlsson and Martinsson (2001); Bill (2008); Mintesnot & Takano (2007); Corpuz, McCabe & Ryszawa (2006); and Eno (2007)]

Based on the findings, the following policy conclusions were drawn: As noted earlier in the background to this work, the government of Ghana through the Department of Urban Road is currently redesigning BRT system. These findings shed light on the most important features required by the system if it is to attract commuters from private mode of transport. If the object is to encourage the patronage of mass transit system, as envisaged in the National Transport Policy document, then the Ministry of Transport should ensure that the mass transit buses are in good conditions, convenient and must not be risky in terms of accident to attract older spare parts dealers who own private cars.

In addition to that, efforts should also be made by the Ministry of Road to provide exclusive bus lanes and traffic priorities for public buses to ensure free flow of buses to avoid the risk of missing appointment. It is also recommended that efforts should be made by the Ministry of Water Resources, Works and Housing, together with Town and Country Planning Departments (TCPD), to provide residential accommodations to workers on the periphery of cities, and buses provided to increase accessibility to ensure patronage of buses.

Evidence emerging from the study further suggests that, there is a connection between family size of male spare parts dealers and their tendency to choose public bus. Ministry of Information should intensify education on the connection between family size and the choice of transport to encourage male spare parts dealers to accord patronage. In addition to the information campaigns to increase this awareness, it is also recommended that efforts should be made by the transport service providers to encourage spare parts dealers with large family size to patronise public bus. This could be done by offering free public bus tickets on selected days to spare parts dealers with large family size and also distributing free public bus tickets to frequent users with large family size among others.

The study also suggests that people will stick stubbornly to the use of particular modes of transport if they have unrestricted access to them. One real strategy that could be employed by government as a policy instrument to restrict access and cause modal shift on the road is the introduction or enhancement of taxes and charges. The tax in question could be in the form of toll tax. The proceeds from such taxes or toll could be used to provide standard mass transit facilities. This recommendation is in line with the famous Robin Hood principle. The major tenet of the principle is to tax private car users heavily and with the proceeds, support mass transit delivery and making it much more accessible to them.

It is important to note that the issue of transport mode choice is a debatable subject. This is partly because it is seemingly absolutely fallacious that private car users would abandon their private cars and travel by mass transport. The satisfactions of a private car are copious and one would least expect private car users to easily park their cars and opt for a public transport, especially, in a situation where the level of service rendered by mass transport is sub-optimal. Some of the utilities of a private car include comfort, convenience, flexibility and the fact that it is seen as a symbol of esteem. In advanced economies where public transport is well organised and adept, private car users find it convenient to park their cars at home and commute by public transport to their work places. This is a paradigm worthy of emulation by all stakeholders in Ghana.

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