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Modelling of Active and Latent Attributes Based on Traveler Perspectives: Case of Port City of Douala

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Abstract

A growing stream of study stresses the relevance of subjective elements in understanding the hierarchy of preferences that underpin individual travel behavior. The purpose of this study is to evaluate the impact of various factors on mode choice. To achieve this, a multinomial logit model (MNL) was used to analyze the relationships between mode choice and three classes of attributes; Combined Active and Latent, Active only and Latent only attributes. The data used are derived from surveys in the port city of Douala, Cameroon as a case study. Results stipulated that, the combined attributes model performed better than both active only attributes and latent only attributes models. Likewise, latent only attributes model performed better than active only attributes model. The advantage of modelling all three groups is for better selection of the most relevant attributes, and this is very relevant in understanding travel behavior of individuals and mode choice decisions.

Keywords

Multinomial logit Model, Latent Attributes, Mode Choice, Individual Behavior, Active Attributes

1. Introduction

Mode choice is very significant in transport planning, and it closely deals with choice behavior which impacts policy making directly [1]. Customarily, transportation parameters and socioeconomic characteristics of service users have been used to model and analyze the choice of travel mode [2]. The costs, destinations, capacities, frequency, and other attributes of the modes, as well as the nature of the traveler (in the case of passenger transport) and their destinations, may influence mode selection [3]. Transportation modeling is used to assess the effects of behavioral changes as well as the consequences of infrastructure investments [4] [5]. The tools available are becoming more complicated, and there are an increasing number of criteria, aspects, and stakeholders to consider [6]. Traditional modeling techniques have been supplemented with activity based models, which are used to analyze traffic impacts and travel behavior, with the selection of the most relevant modeling parameters being a major challenge [7]. A growing stream of study stressed the relevance of subjective elements in understanding the hierarchy of preferences that underpin individual travel behavior throughout the last decade. It backs up the idea that attitudes and behaviors might play a role in mode selection. These subjective or latent elements, on the other hand, cannot be directly observed; they can be extracted from other observable variables, such as replies to survey questions regarding attitudes, perceptions, or decisions. Most of the existing study on mode choice dwells on active variables and their effects on choice behavior but these active variables are more tilted in the econometric analysis of utility and mode choice and due to their availability and predictive nature they are very easy to model especially in transport systems where the service level is high and well developed. Some recent studies have looked at the latent variables and their effects on mode choice behavior and expressed the challenges involved in acquiring data with this information. Notwithstanding, they also clearly showed the extent to which it is important to include these variables directly and not just assume them to be represented or included in the error term as unobserved attributes. The downside is that most of these existing works used the latent variables for single trip purposes and due to the fact that the determinants of mode choice are found to differ across trip purposes, it is not very valid to generalize the results from studies considering only single purpose. Therefore, this study presents a clear case, incorporating the important attributes as depicted by the respondents of the study area in a very unpredictive transport system which is still being developed keeping in mind the importance of including individual perceptions in transport planning and policy making decisions for better service provision. In their study [8], they investigated the idea of user perception of safety, comfort, and accessibility and how these may have effects on transport mode choice. The study [9], supports the idea that individual latent preferences do play a significant role in mode choice behavior in urban transport. They discovered that, in addition to standard cost and benefit factors, individual beliefs and qualities about some aspects of transportation, such as flexibility, comfort, safety, and symbolic-affective nature, influence urban travel behavior [9]. Their study was limited to work trips. Furthermore, age, gender, employment status, and the number of young children have all been found to be significant explanatory factors in the psychological profiles of respondents for both studies.

In this study, we plan to find out the factors that influence the travel behavior for the respondents in the city of Douala, Cameroon. Especially, at this period where the population is increasing rapidly with influx from neighboring cities dealing with civil unrest. According to recent knowledge, the traffic congestion is very great even with the opening and building of new transport infrastructures like that of the bridge of Bonaberi which has been known to be one of the biggest bottlenecks. It is believed that with the comprehensive implementation of various policies, laws, and regulations, as well as econometric modeling, traffic demand management aims to achieve a stable and healthy balance of the traffic system by providing guidance and limits of travel behavior, adjusting residents' trip distribution, and alleviating the contradiction between supply and demand of traffic in order to achieve the set target of traffic system operation efficiency improvement, congestion ease, and pollution reduction [10]. This study takes particular interest in understanding the influence and extent of latent and active attributes for the different choice of transport modes. That is, why some individuals prefer some modes over others. This study looks at attributes in three different categories; first, the active attributes which are characteristic of the individual's socioeconomic life and household; second, the latent attributes of the modes as perceived by the individual and third, a combination of both active and latent attributes. We belief that transport planners need this information to better incorporate traveler's choice behavior for a more accurate policy and public transport service provision. It is not always about building new infrastructures, sometimes, all it takes is to include user's perception on qualitative dimensions to improve performance of public transport services and the entire transport system [11].

The main objective of the study is to investigate the role of active and latent attributes of respondents based on the data collected using stated and revealed preference (SP/RP) survey. The data is analyzed using multinomial modelling and attribute fitting analysis in R. The reason for the attribute fitting analysis is to show the inferred impact of latent, active and a combination of both on traveler's behavior in mode choice for the respondents in this study area. We discovered that, sometimes even the poor will disregard cost in comparison to other attributes for better satisfaction. Due to the time in which this study was done, the data collected was very limited as the Covid-19 pandemic is still in action. Also, getting personal information from respondents was not very easy as there is a lot of crises in Cameroon. So, the data had a lot of missing information to be considered representative. In future, a more representative and complete analysis can be done with a larger sample size.

The next part of this paper describes the study area and collected data of the respondents. Section 3 gives the mode choice model specification, while section 4 gives the model estimations and the results. In the last section, we discuss and draw conclusions and make recommendations for future research developments.

2. Study Area and Data Analysis

2.1. Study Area

The area considered for this paper is Douala, the economic capital and chief port of Cameroon. It is situated on the southeastern shore of the Wouri River estuary, on the Atlantic Ocean coast about 130 miles (210 km) west of Yaoundé [12]. Douala, being a port and a natural gateway for the entry of imports and the exit of exports, is home to most Cameroon's industrial and service operations, accounting for more than half of the country's economic activity and industrial production. The geographical situation, on the other hand, is adverse. The city deals with a natural environment that is severely limited. In swampy places, as well as on the slopes of streams and natural drainage basins, several unplanned neighborhoods have sprung [13]. For purpose of this study, the area will be divided into 10 main zones (See **Figure 1**).

2.1.1. Institutional Framework of Urban Transport in Douala—Multiple Players and Minimal Coordination

Five urban and one rural arrondissement make up the city of Douala. A municipality that consists of an elected mayor and a municipal council oversees each arrondissement [13]. The Douala Urban Community is governed by an appointed government representative and is made up of multiple representatives chosen by the arrondissements. The municipal council of the Community is made up of several officials elected by the arrondissements. At the municipal level, the Urban Community has control over issues such as parking, main roads, signal maintenance, urban planning, and urban development. Even though the limits defining who is responsible for what are not often obvious, the Urban Community shares its authority with the central agencies and their local delegations. The Public Works Ministry oversees administering the renovation of the bridge over the Wouri River, and the City Ministry oversees the creation of the future Urban Development Master Plan, while the Transport Ministry gives licenses for transportation. The Urban Community has no authority to intervene in the arrondissements' issuance of several transport licenses.

2.1.2. Road System and Public Transport Supply

The road infrastructure struggles to keep up with urbanization in Douala, as it does in most Sub-Saharan cities. Paved roadways are primarily found in the city's center. The Wouri river, the Bessengué rail station, the Bassa industrial

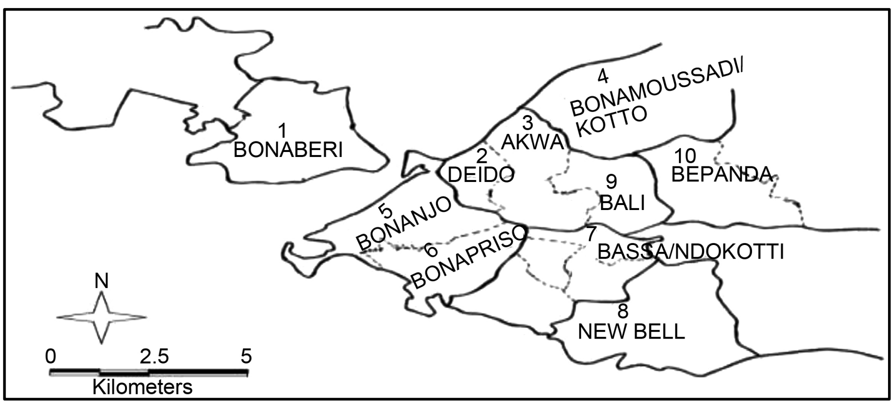

Figure 1. Map of survey locations for study area.

park, and the former airport serve as obstacles around the city's core. Access to the city's core for vehicles going from Bonaberi or the east side mostly follows four routes: the Wouri Bridge from north to south, the Ndokoti, North Akwa Road, and the main highway (Axe Lourd). Notwithstanding, the supply of public transport is very diversified ranging from taxis, bendskins (motorbike taxis), SOCATUR buses, cargos (minibuses and light trucks), and unregistered cabs. In this paper we refer to taxis (commercial cars), bendskins (commercial bikes), SOCATUR buses (Public bus) and every other fall in the "others" category. The commercial cars form part of the declining transport modes in this area as the cars are most often very old and not very convenient as they are often overloaded and carry several people going to different locations in same area, but their prices are relatively stable and determined by their union. The commercial bikes on the other hand are the booming transport mode in this area as they are easily accessible even though they are not very safe especially on main routes, their prices are also very expensive. The public buses are limited in supply, no definite schedule and not very accessible but it is the cheapest mode of transport in this area. Some individuals prefer walking, but that too is not very safe as there are no designated walkways. Residents of remote neighborhoods and the city's outermost regions have a harder time getting access to the transportation system. The access conditions for the poor in these locations are marginally worse than for the non-poor [13]. Figure 2 and Figure 3 present the Mode share of the study area for the respondents of this study based on their origin and destination respectively. The two figures for the origin and destination mode shares show that commercial bikes top the chart of usage followed by commercial cars then public bus and others. It is clearly seen that the commercial bikes access more locations than commercial cars and public bus. The major reason for this is the fact that accessible roads into streets are limited and some are in terrible conditions leaving the people with more of commercial bikes than commercial cars and public bus.

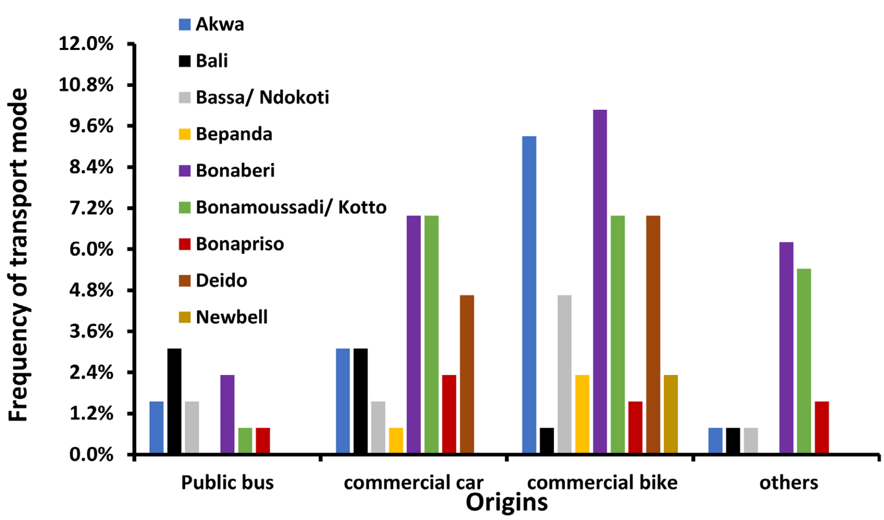

Figure 2. Mode share of study area based on origin of respondents.

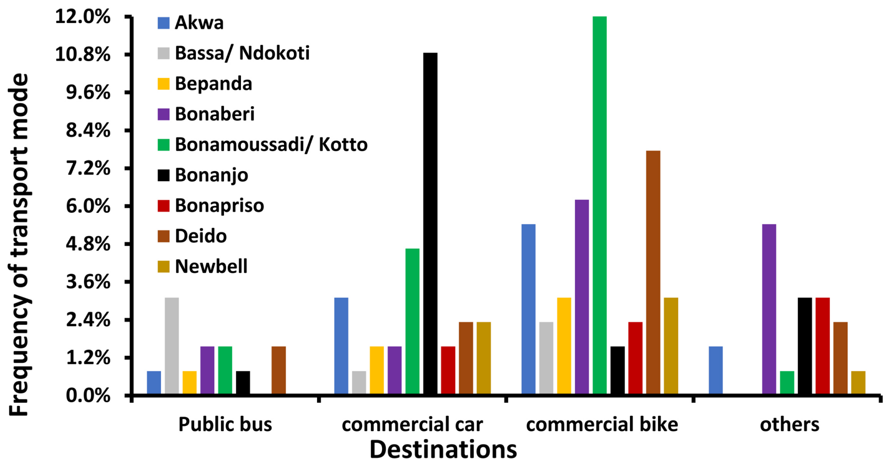

Figure 3. Mode share of study area based on destination of respondents.

2.2. Data Analysis

This study uses both quantitative and qualitative analysis methods as well as primary and secondary data obtained by use of Stated Preference/Revealed Preference survey techniques and interviews where necessary. The collected data has information on the individuals, their household characteristics, daily trip characteristics, their perceived perspective on the various mode of transport at their disposal, and so on.

2.2.1. Socio-Economic Characteristics

The socio-economic characteristics of the respondents in this study are presented in Table 1. Table 1 shows the characteristics of the respondents in the study area. From the table, it is possible to get the percentage of female respondents to male as 55% and 45% respectively.

2.2.2. Trip Distribution by Mode

Figure 4 presents the mode choice distribution for the respondents. It shows the % of each mode option based on the survey response. The commercial bike % stands at 44.96%, which is the highest and is followed by commercial cars, with 29.46%; the public bus % of 10.08% is the lowest of all the modes.

2.3. Household Characteristics

The key characteristics of households include household size, household income, the number of cars owned by each household, the number of workers, etc. these characteristics are those observed to impact mode choice behavior most.

2.3.1. Household Size

As the size of the household increases, so does the frequency of trips [5]. The breakdown of the household structure for the chosen dataset is provided in Figure 5. In the data acquired one household declared size as 6 and that was left out as an outlier. From the figure below, household size of 3 constitutes the largest share with a 36% as it is the densest including respondents from all study zones

Table 1. Socio-economic characteristics of respondents.

Socio-Econ. Variables	Categories	Frequency	% Frequency
	Female	71	55%
Gender	Male	58	45%
	Total	129	100%
	18 - 25	67	52%
Age	26 - 35	45	35%
	36 - 45	17	13%
	Total	129	100%
	1	5	4%
	2	34	26%
	3	47	36%
Household Size	4	38	29%
	other	5	4%
	Total	129	100%
	35,000	8	6%
	53,000	25	19%
	88,000	28	22%
Ave. Household Income (Fcfa)	128,000	32	25%
	150,000	36	28%
	Total	129	100%
	0	50	39%
	1	76	59%
Number of Cars	2	3	2%
	Total	129	100%

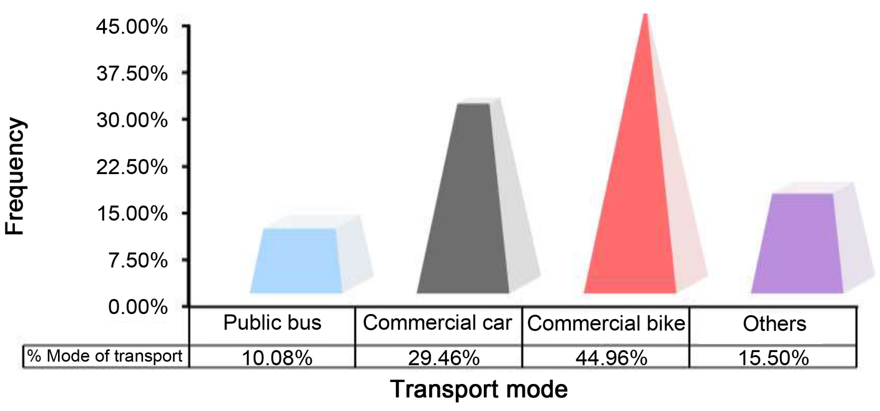

Figure 4. Mode choice distribution for respondents.

in the area. Similarly, household size of 4 with 29% followed by household size of 2 with 26%. The single individual households and those of 5 or more constitute less than 10%.

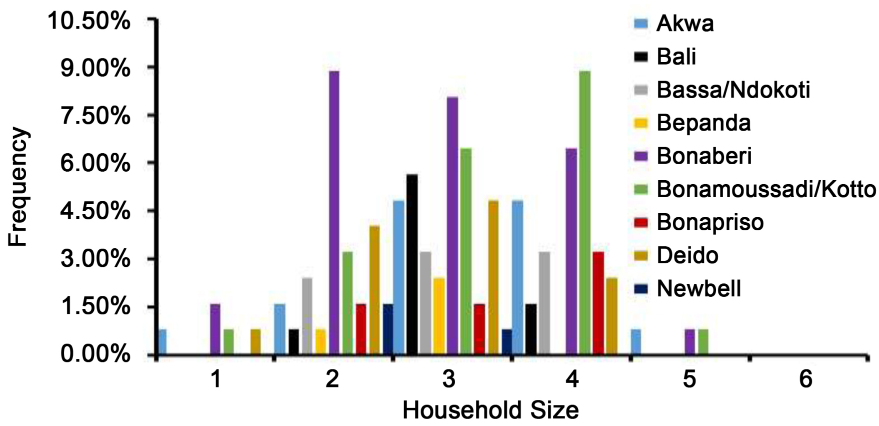

Figure 5. Household size distribution in study area.

2.3.2. Household Income

Due to the insecurity in the country, it was a bit difficult getting information about the household income of the respondents. So, it was easier getting the ranges for income and from the ranges average values were obtained to ease the process. According to [14], the legal minimum wage a person should earn in Cameroon is 36,270 CFA francs per month, but a lot of people still earn far less. Douala being the economic capital and the major port city in Cameroon makes it possible for most to be self-employed which enables them to earn more. From Table 2, it is seen that 25% of the respondents earn below 53,000 Fcfa average income while 75% earn from 88,000 Fcfa and above. This is clearly shown in Figure 6.

Table 3 gives the distribution of car ownership of respondents with regards to average household income. In the city center, houses are more expensive than in the outskirts [15]. Most people prefer to stay in cheaper areas to avoid the high pricing of houses and this weighs more on transportation mode and cost. The reason why in Douala there is no free ride, most car owners offer rides to individuals going their same direction at a cost to use their earnings for fuel and other car charges.

2.3.3. Individual Characteristics and Mode Choice

The individual characteristics such as age, gender and so on contribute also to mode choice behavior. The age group of respondents and mode choice distribution can be seen in Figure 7. The 18 - 25 years age group dominates the commercial bikes and commercial car, while the 36 - 45 years age group dominates other modes (own cars, walking, own bikes, etc.). The public bus mode is dominated by the 26 - 35 years group and avoided by the 36 - 45 years group.

In this study, the percentage of female and male respondents is 55% and 45% respectively. Mode choice with regards to gender of respondents is shown in Figure 8. It is seen that female respondents use commercial bikes, commercial cars, and other modes more than male respondents and the male respondents slightly use more of public bus than the female respondents.

Table 2. Average household income (Fcfa) for the respondents.

Ave. Household Income	Frequency	% Frequency
35,000	8	6%
53,000	25	19%
88,000	28	22%
128,000	32	25%
150,000	36	28%
Total	129	100%

Table 3. Car ownership with average household income (Fcfa) of respondents.

	Average Household Income (Fcfa)					
Number of Cars	35,000	53,000	88,000	128,000	150,000	**Total**
0	4	12	13	11	8	48
1	4	13	15	20	25	77
2	0	0	0	0	3	3
Total	8	25	28	31	36	128

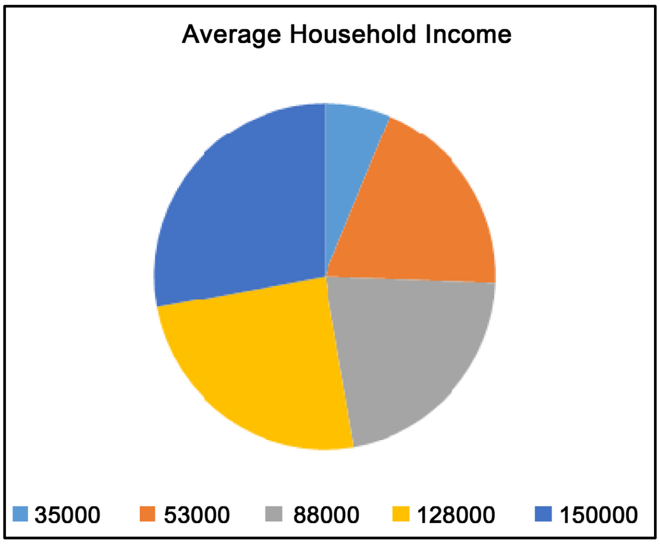

Figure 6. Average household income (Fcfa) for respondents in study area.

2.4. Latent Attributes of the Different Modes of Transport as Perceived by Respondents

For this study, we chose the Level of service (LOS), Availability (AV), Safety (S), Affordability (AF), Accessibility (AC), Flexibility (F) as the latent attributes for the model and the respondents gave their perceptions on the three main modes (commercial bike (CB), commercial car (CC), public bus (PB)) for this study. Figure 9 presents the visual perception of the respondents on a scale of 1 - 5

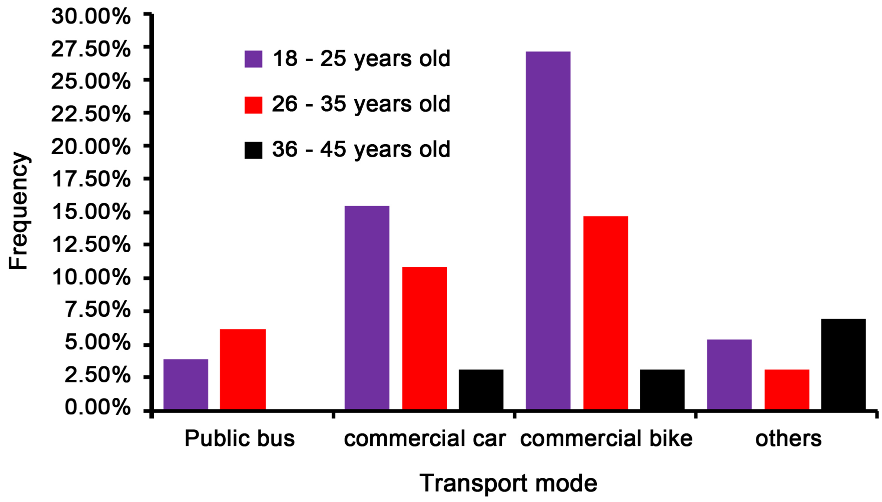

Figure 7. Age group of respondents and mode choice distribution.

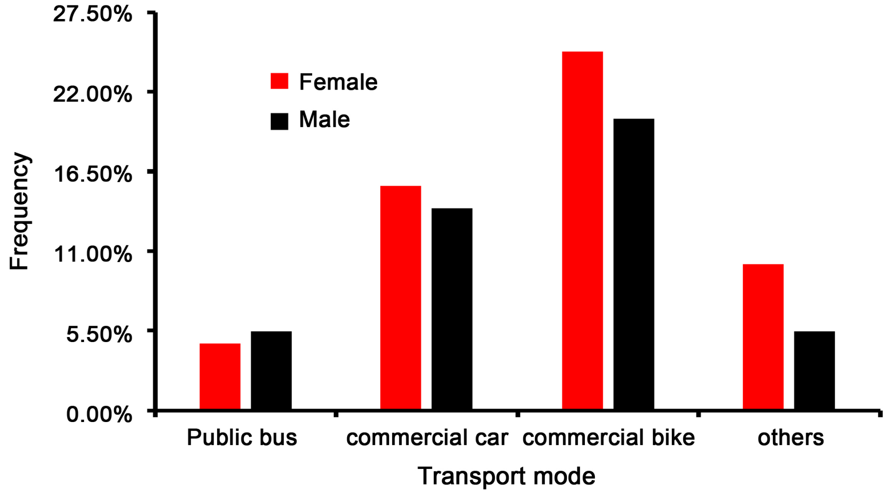

Figure 8. Gender of respondents and mode choice distribution.

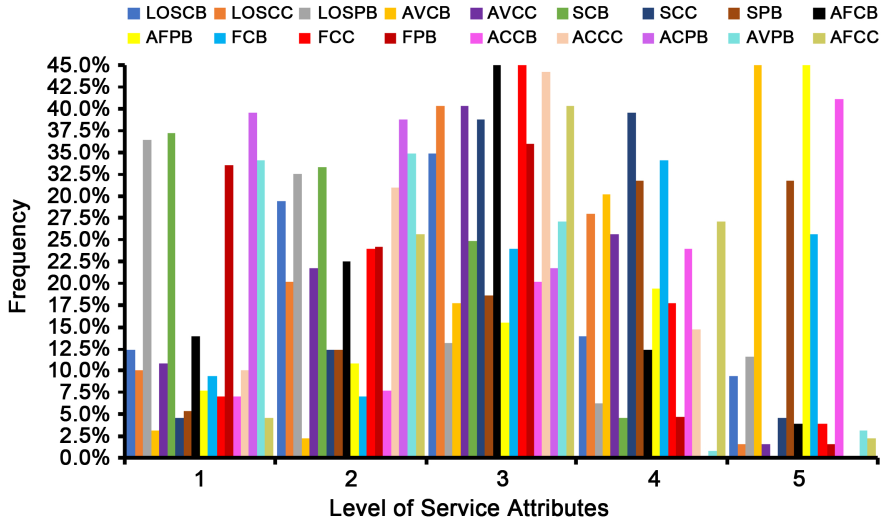

Figure 9. Respondents' perception on the selected latent attributes of the different modes.

with 5 being the highest and 1 the lowest of the latent attributes. The affordability of public bus (AFPB) and the safety of the public bus (SPB) tops the chart on the level 5, meaning the public bus is perceived by the respondents to be most affordable and safe but it is the least used mode as per **Figure 4**. The availability of commercial bike (AVCB) and accessibility of commercial bike (ACCB) tops the chart on the level 5, meaning the respondents perceive the commercial bikes to be the most available and accessible mode of transport and this is backed in **Figure 4**. Most of the respondents rate the level of the attributes with regards to commercial car as within level 3 and 4. Accessibility of public bus (ACPB) tops the chart on level 1. Seemingly, Safety of commercial bikes (SCB) is on the high side in level 1 and most of the respondents rated affordability of commercial bikes from level 3 down to level 1, but why is it that commercial bikes are still the most used mode is the reason we want to model these attributes to be able to answer that.

3. Multinomial Mode Choice Modelling

Mode choice modelling has been seen to be very significant in any transport system for many years now with changes either on the data being analyzed, the contributing attributes or the method used for analysis. This study aims to investigate the effects of both latent and active attributes in the mode choice behavior of the respondents in the study area considered. It models active attributes, latent attributes, and a combination of both active and latent attributes to see the degree of impact of these on mode choice decision making using the backward selection method.

3.1. Model Formulation

The basic assumption here is that not only traditional and objective attributes like travel time, travel cost, distance, income, or household size have effects on mode choice, but some subjective or latent attributes like safety, flexibility, comfort, and so on, also have effects on choice of mode. Since information about these latent attributes is difficult to get, they are most often left out or compensated for by person specific factors in traditional choice models. But, by including preference variables directly into choice models, these compensations can be improved [16]. The utility of the individual is typically expressed as a linear function of the trip's features weighted by coefficients that aim to capture the relative importance of those attributes as experienced by the individual. A possible representation of a utility function of a mode *m*, mathematically, can be shown in Equation (1).

$$U_{mi} = \beta_1 X_{mi1} + \beta_2 X_{mi2} + \cdots + \beta_k X_{mik} \tag{1}$$

where, U_{mi} is the net utility function of mode m for individual *i*; $X_{mi1}, \cdots, X_{mik}$ are *k* number of attributes of mode *m* for individual *i*; $\beta_1, \cdots, \beta_k$, are *k* number of coefficients or weights for each attribute. Since the behavior of the decision maker cannot be determined with certainty, an error component is included in the model to represent the unrepresented or unobserved components of utility. Therefore,

$$U_{mi} = V_{mi} + \varepsilon_{mi} \tag{2}$$

where, V_{mi} is the observed component of utility of mode *m* for individual *i*; ε_{mi} is the unobserved (error) component of utility of mode *m* for individual *i*. It is possible for the observed utility components to be viewed as a function of the characteristics for the available modes only if the decision maker's attributes are disregarded. Consequently, it might be possible to employ a single utility function for everyone. For the same reason, it is also possible to consider the error component of the utility to be independent of socioeconomic traits. If the error component has zero mean and an extreme value distribution, the net utility function can be given as:

$$U_m = V_m + \varepsilon_m \tag{3}$$

Therefore, if there are "*n*" alternative modes available, the probability of an individual selecting mode *m*, such that $m \in n$, is based on its associated utility function U_m, such that.

$$U_m \geq U_n \tag{4}$$

where, U_m represents utility of mode alternative *m*; and U_n represents utility of any mode alternative in the set of available modes. Briefly put, a person chooses the option that has the highest utility as shown in Equation (4). However, it is difficult to fully comprehend how different factors influence a person's decision-making. As seen in Equation (3), this is resolved by include the unobserved components in the error term and combining with the observed components. The mathematical structure of a discrete choice model is determined by the assumptions made for the error components of the utility function for each alternative. The Multinomial Logit Model (MNL) is based on the following specific assumptions:

- The error components are extreme value (or Gumbel) distributed;
- The error components are identically and independently distributed across alternatives;
- The error components are identically and independently distributed across individuals [17].

The MNL has a simple closed-form mathematical structure because of the three assumptions [17] described above. However, these assumptions leave the MNL model with the IIA property at the individual level, which is the model's worst flaw [18]. The MNL gives the choice probabilities of each alternative as a function of the systematic portion of the utility of all the alternatives. The general Equation (5) for the probability of choosing an alternative "*m*" ($m = 1, 2, \cdots, n$) from a set of *n* alternatives is:

$$Pr(mi) = \frac{\exp(V_{mi})}{\sum_{m=1}^{n} \exp(V_{mi})} \tag{5}$$

where, $Pr(mi)$ is probability of utility for a mode choice (m) by individual (i); V_{mi} is the utility of individual (i) choosing mode (m), V_n is the systematic component of the utility of the set alternative (n). The MNL describes the relationships between the independent and dependent variables and expresses these relationships in terms of utility.

3.2. Model Specification

Household information from the main data gathered from respondents in the study region is coded and used as variables in the model. Table 4 gives the description of the attributes/variables used in the model. Two broad classes of variables; active/objective and latent/subjective variables sub-divided into; trip characteristics, household characteristics and mode characteristics (gotten from individual perceptions using survey data). The model's chosen variables are derived from prior theoretical and empirical research on mode choice model analysis carried out by other scholars. As a result, the final variable definition based on statistical testing is reached here.

4. Model Estimation

The attributes described in Table 4 were considered for the formulation of the utility function of commercial bikes, commercial cars, and public bus. The total variables were used in the first case scenario and the backward selection approach was used to investigate the active only scenario and the latent only scenario for the study area being considered. Running the MNL model in R, the utilities are given as a logarithmic function of the reference level. In this case, 1 (commercial bikes) is used as the reference level. Table 5 and Table 6 show the coefficient and Standard errors of both active and latent variables in the model respectively.

Using the coefficients in Table 5, we can write the 2 utility equations following from Equation (1).

$$\ln\left(\frac{P(2)}{P(1)}\right) = 9.417239 + (-0.02287 * \text{ATT}) + 0.001521 * \text{ATC} + \cdots + 0.365315\text{AVPB} \tag{6}$$

$$\ln\left(\frac{P(3)}{P(1)}\right) = 11.504 + (-0.0708 * \text{ATT}) + 0.00o409 * \text{ATC} + \cdots + 0.304697\text{AVPB} \tag{7}$$

Equation (6) is logarithm of the probability that mode 2 (commercial car) is chosen versus the probability that mode 1 (commercial bike) is chosen. That is the log-odds of mode 2 chosen versus mode 1 chosen. While Equation (7) gives the logarithm of the probability that mode 3 (public bus) is chosen versus the probability that mode 1 (commercial bike) is chosen, literally, the log-odds of mode 3 chosen versus mode 1 chosen. Looking at the coefficients of the variable, those with positive values have positive impact on the log-odds and those with

Table 4. Description of attributes/variables used in model.

Active/Objective Attributes	Trip Characteristics	Scale
ATT (Average Travel Time)	Average time of travel using specific mode	number
ATC (Average Travel Cost)	Average cost of travel in Fcfa using specific mode	number
MOT (Mode of Transport)	Transport mode (1-commercial bike, 2-commercial car, 3-public bus)	factor
	Household Characteristics	
AHI (Average Household Income)	Average income of household in Fcfa	number
HS (Household Size)	Number of persons in household	number
NOC (Number of Cars)	Number of cars in household	number
Latent/subjective Attributes	**Individual Perceptions of the Different Modes**	
AVCB (Availability of Commercial Bike)	how available is the commercial bike on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
AVCC (Availability of Commercial Car)	how available is the commercial car on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
AVPB (Availability of Public Bus)	how available is the public bus on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
SCB (Safety of Commercial Bike)	how safe is the commercial bike on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
SCC (Safety of Commercial Car)	how safe is the commercial car on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
SPB (Safety of Public Bus)	how safe is the public bus on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
AFCB (Affordability of Commercial Bike)	how affordable is the commercial bike on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
AFCC (Affordability of Commercial Car)	how affordable is the commercial car on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
AFPB (Affordability of Public Bus)	how affordable is the public bus on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
FCB (Flexibility of Commercial Bike)	how flexible is the commercial bike on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
FCC (Flexibility of Commercial Car)	how flexible is the commercial car on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal
FPB (Flexibility of Public Bus)	how flexible is the public bus on a scale of 1 to 5 with 5 being the highest and 1 the lowest	ordinal

negative values have negative impacts on the log-odds. For example, ATT, AHI, SCC, AFCB, FCC, FPB, ACCB, ACPB, AVCB and AVCC have negative impacts on both log-odds; ACCC has negative impact on the log-odds of equation 6 and

Table 5. Coefficients of the variables in the combined model.

			Coefficients			
Intercept	**ATT**	**ATC**	**NOC**	**HS**	**AHI**	**SCB**
9.417239	−0.02287	0.0015216	1.517681	0.74283	−3.90E−05	0.084496
11.504	−0.0708	0.0004091	1.5853	0.629955	−4.60E−05	0.167198
SCC	**SPB**	**AFCB**	**AFCC**	**AFPB**	**FCB**	**FCC**
−0.45084	0.544052	−0.7561	2.144514	0.901466	1.10375	−0.93255
−0.54931	1.010095	−0.869541	2.073307	1.016476	1.058137	−0.68331
FPB	**ACCB**	**ACCC**	**ACPB**	**AVCB**	**AVCC**	**AVPB**
−1.33725	−1.24953	−0.292493	−1.10151	−0.47064	−1.02942	0.365315
−1.61651	−1.0055	0.2720018	−0.63452	−0.33259	−2.01547	0.304697

Table 6. Standard errors of the variables in the combined model.

				Standard Errors			
	Intercept	**ATT**	**ATC**	**NOC**	**HS**	**AHI**	**SCB**
2	3.39E−05	0.005112	0.0012067	1.41E−05	8.66E−05	7.68E−06	1.39E−05
3	3.04E−05	0.004445	0.0012343	1.17E−05	7.17E−05	7.62E−06	9.07E−06
	SCC	**SPB**	**AFCB**	**AFCC**	**AFPB**	**FCB**	**FCC**
2	8.80E−05	0.000185	0.0001537	0.00012	0.000208	0.0001639	0.000116
3	7.35E−05	0.000168	0.0001336	0.000103	0.000184	0.0001457	0.000101
	FPB	**ACCB**	**ACCC**	**ACPB**	**AVCB**	**AVCC**	**AVPB**
2	3.53E−05	0.00017	0.0001203	4.43E−05	0.000168	1.09E−04	4.75E−05
3	2.51E−05	0.00015	0.0001021	3.20E−05	0.000143	9.26E−05	4.16E−05

a positive impact on the log-odds in Equation (7). The remaining variables, ATC, NOC, HS, SCB, SPB, AFCC, AFPB, FCB and AVPB have positive impacts on both log-odds.

We can derive the probabilities from Equation (6) and Equation (7) as follows. Let Y_1 and Y_2 be the utility values obtained from Equation (6) and Equation (7) respectively.

$$Y_1 = \ln\left(\frac{P(2)}{P(1)}\right)\omega \rightarrow \frac{P(2)}{P(1)} = \mathrm{e}^{Y_1} \tag{8}$$

$$Y_2 = \ln\left(\frac{P(3)}{P(1)}\right) \rightarrow \frac{P(3)}{P(1)} = \mathrm{e}^{Y_2} \tag{9}$$

$$\frac{P(2)+P(3)}{P(1)} = \mathrm{e}^{Y_1} + \mathrm{e}^{Y_2} \tag{10}$$

$$\frac{P(1)}{P(1)} = \mathrm{e}^{Y_1} + \mathrm{e}^{Y_2} \tag{11}$$

Table 7. Probabilities of the observations in the combined model.

Mode	1	2	3
1	0.003719022	0.81710401	0.179176968
2	0.04798198	0.636533211	0.315484814
3	0.000261088	0.600789926	0.398948986
4	0.1971316	0.466301914	0.33656645
5	0.001706064	0.275174376	0.72311956
6	0.4850791	0.229753712	0.285167188
7	0.000104642	0.231675346	0.768220013
8	0.00035753	0.591812366	0.407830104
9	0.000155596	0.128154177	0.871690227
10	0.6729013	0.219010221	0.10808845
11	0.001543861	0.514836853	0.483619285
12	0.1469878	0.144807577	0.708204617
13	0.2208198	0.425703784	0.3534764
14	0.002556347	0.192986132	0.804457521
15	0.000182256	0.215954666	0.783863079
16	2.32732E−05	0.148568957	0.85140777
17	0.000140316	0.140785044	0.85907464
18	0.001155928	0.111971433	0.886872639
19	0.0131013	0.63697709	0.349921608
20	0.000142036	0.613370083	0.386487881
21	0.008104354	0.749216317	0.242679328
22	0.0154175	0.20846446	0.776118044
23	0.5796091	0.381880526	0.03851037
24	0.001511849	0.211473121	0.78701503
25	0.000384389	0.072047366	0.927568246
26	0.003079195	0.207807744	0.789113062
27	0.00141747	0.698166996	0.300415534
28	0.000158985	0.254660565	0.74518045
29	0.005900533	0.766616624	0.227482843
30	0.003306135	0.299238997	0.697454867
31	0.03571015	0.706111283	0.258178567
32	0.002456817	0.86198718	0.135556004
33	0.00239695	0.919028744	0.078574306
34	1.81777E−05	0.134479734	0.865502088
35	0.000129377	0.144301666	0.855568958
36	0.000146333	0.236521103	0.763332564

Continued

37	0.05803893	0.641911757	0.300049315
38	0.000586453	0.030814358	0.968599189
39	0.02248905	0.100369446	0.877141504
40	3.04877E−05	0.156685879	0.843283634
41	0.06823233	0.192355474	0.7394122
42	0.8902676	0.070338038	0.039394382
43	0.03017289	0.31357568	0.656251431
44	0.000442853	0.63458392	0.364973227
45	0.00013123	0.172450119	0.827418651
46	1.65868E−05	0.02960772	0.970375693
47	3.90888E−06	0.466841098	0.533154993
48	0.3651231	0.379942978	0.254933954
49	1.12517E−05	0.267400546	0.732588202
50	0.000256244	0.194980796	0.80476296
51	0.000228105	0.126413925	0.87335797
52	0.3108412	0.667323769	0.02183504
53	0.001193569	0.155526039	0.843280392
54	0.03004729	0.043826434	0.926126279
55	0.004275203	0.861878042	0.133846755
56	0.1678315	0.448144629	0.384023838
57	0.009011107	0.151099375	0.839889518
58	0.4449879	0.197131406	0.357880704
59	0.000494284	0.65006969	0.349436026
60	0.2226701	0.447607314	0.329722541
61	0.000850934	0.599486991	0.399662075
62	0.01157059	0.607486627	0.380942779
63	0.4027103	0.531313987	0.06597572
64	0.002033366	0.507980008	0.489986626
65	0.4555106	0.077134141	0.467355278
66	0.03715137	0.951713581	0.011135045
67	0.000154773	0.05989939	0.939945837
68	0.4647881	0.359044849	0.176167087
69	3.31584E−05	0.404407696	0.595559146
70	0.01233096	0.907204945	0.080464095
71	0.2399658	0.580523976	0.17951025
72	0.00035148	0.911346045	0.088302475
73	0.9992402	0.000601357	0.000158436

Continued

74	0.3640905	0.13112796	0.504781554
75	0.2007627	0.717713024	0.081524256
76	0.1337737	0.123906655	0.742319661
77	0.02660951	0.13836996	0.835020532
78	5.08473E−05	0.507467383	0.49248177
79	0.04311531	0.535693508	0.421191183
80	0.004892864	0.886547303	0.108559833
81	0.1474948	0.800501761	0.052003483
82	0.06269619	0.412315058	0.524988754
83	0.1917228	0.322377887	0.485899358
84	0.03625266	0.598339372	0.365407967
85	0.000754365	0.767063434	0.232182202
86	0.004104028	0.244818944	0.751077028
87	0.03656676	0.687103598	0.276329645
88	0.0346496	0.333895316	0.631455083
89	0.4622161	0.341223036	0.196560877
90	0.06982799	0.631760036	0.298411975
91	0.1951232	0.631483869	0.173392915
92	0.02178299	0.853192113	0.125024896
93	0.9806871	0.017984312	0.001328634
94	0.4369221	0.387671136	0.175406788
95	0.001991175	0.294790453	0.703218372
96	0.008089014	0.488189822	0.503721165
97	0.0701608	0.057355392	0.872483811
98	0.02328575	0.024358193	0.952356053
99	3.55517E−05	0.039408447	0.960556001
100	0.01826135	0.39008078	0.591657869
101	0.000134849	0.210632671	0.78923248
102	6.55574E−06	0.009368348	0.990625096
103	0.01067133	0.445520443	0.543808225
104	0.07060636	0.042748243	0.886645392
105	0.5647617	0.072429561	0.362808781
106	0.000639362	0.375972185	0.623388453
107	0.9592557	0.012515927	0.02822839
108	0.7377208	0.053730719	0.208548478
109	0.0258222	0.159927647	0.814250153
110	6.31355E−05	0.023748304	0.97618856

Continued

111	6.55574E−06	0.009368348	0.990625096
112	0.01067133	0.445520443	0.543808225
113	0.07060636	0.042748243	0.886645392
114	0.5647617	0.072429561	0.362808781
115	0.000639362	0.375972185	0.623388453
116	0.9592557	0.012515927	0.02822839
117	0.7377208	0.053730719	0.208548478
118	0.000871679	0.105084914	0.894043407
119	9.91398E−06	0.018163885	0.981826201

$$\frac{1}{P(1)} = 1 + e^{Y_1} + e^{Y_2} \tag{12}$$

Since $P(1)+P(2)+P(3)=1$, it implies that

$$P(1) = \frac{1}{1 + e^{Y_1} + e^{Y_2}} \tag{13}$$

$$P(2) = \frac{e^{Y_1}}{1 + e^{Y_1} + e^{Y_2}} \tag{14}$$

$$P(3) = \frac{e^{Y_2}}{1 + e^{Y_1} + e^{Y_2}} \tag{15}$$

4.1. Misclassification of the Combined Model

The probabilities of the combined model are given in Table 7. These probabilities are used to compare the model prediction to the data information, and the result is the misclassification matrix as seen in Table 8. The diagonals (14, 30, 49) gives the number of times the model classified correctly, and the rest of the value shows the misclassification.

The percentage in which there is misclassification between model and data is given by this formular.

$$C = \left(1 - \frac{\sum_{i=1}^{3} dm_i}{\sum_{j=1}^{9} m_j}\right) \times 100 \tag{16}$$

where, C is the percentage of misclassification between the model and data; dm_i is the diagonal values for the misclassification matrix; m_j is the misclassification matrix. For this model the value obtained was 21.85%. This means that the model was more right than wrong in predicting the data.

4.2. Two Tailed Z-Test to Check Model Fitting

A two tailed Z-test was performed to check for model fitting.

Looking at Table 9, with the P level set at 0.5, all the selected attributes fit for this data with only the second value for ATC (0.74021) exceeding the 0.5 level.

Table 8. Misclassification/confusion matrix table for the combined model.

Mode	1	2	3
1	14	1	1
2	1	30	11
3	1	11	49

Table 9. P-Values of both active and latent attributes in the combined model.

Attributes	P-Value 2	P-Value 3	Attributes	P-value 2	P-value 3
ATT	0.00000766	0	AFPB	0	0
ATC	0.2074	0.74021	FCB	0	0
NOC	0	0	FCC	0	0
HS	0	0	FPB	0	0
AHI	2.567E−07	1.114E−09	ACCB	0	0
SCB	0	0	ACCC	0	0
SCC	0	0	ACPB	0	0
SPB	0	0	AVCB	0	0
AFCB	0	0	AVCC	0	0
AFCC	0	0	AVPB	0	0

Table 10. Residual deviance and % misclassification for all three models.

Model	Residual Dev.	% Misclass.
Combined model	141.9737	21.85%
Active A. model	196.4175	39.50%
Latent A. model	174.0741	35.30%

The results of the Active Attributes Model and the Latent Attributes Model are shown in the appendix. Comparing the Residual Deviance and the percentage of misclassification of all three models shows that; the combined model has a lower misclassification percentage of 21.85% followed by the Latent attribute model with a percentage of 35.3% and lastly, the active attribute model of 39.5%. The combined model also has the lowest residual deviance of 141.9737 while the active attribute model has residual deviance of 196.4175, the latent attribute model has residual deviance of 174.0741; these are all seen in the Table 10.

5. Conclusion

The purpose of this study is to evaluate the impact of various factors on mode selection. To achieve this, we used a multinomial logit model (MNL) to analyze the relationships between mode choices of the individuals and three classes of attributes; Combined Active and Latent, Active only and Latent only attributes.

The information about the characteristics of the individual, household, the trip and perceptions on level of service of the modes by the individuals, derived from surveys conducted in the study area. Tests were conducted using modeling approaches to demonstrate that the models statistically fit the data. Additionally, review and interpretation of the variable estimations were done. From the results obtained, it was realized that some variables perform better when combined with others as the results of the combined model show a better fit than the Active only and latent only models. Though it is quite difficult to obtain information on latent variables, it is very important as they relate more information on individual perceptions and based on this case study data, the latent only model proved to be fitter than the active only and it predicted the data better with a misclassification % of 35.3% while the active only had a 39.5% of misclassification.

6. Recommendation

The result of this research goes a long way to explain why individuals in this study area prefer commercial bikes to public bus, which is cheaper and safer but least accessible, least available. It also gives insight to why many individuals prefer to own a car and even sometimes use the car for offering paid rides to others in this area as the cheap modes are not very accessible and the accessible modes are not very cheap and less safe. This information can aid traffic demand management in better improving public bus systems to reduce traffic congestion and achieve a stable and healthy balance in the traffic system. Building new transport infrastructures is not the answer to all traffic congestion problems.

The relevance of this study adds to the stress on the relevance of subjective/ latent attributes in understanding hierarchy of preferences that underpin individual travel behavior and further research can be done in identifying and selection of most relevant modelling parameters. The main limitation of this study was getting a representative dataset for the study since the process was disturbed by the civil unrest and Covid-19 pandemic. Future research will be helpful in further identifying numerous variables considering the effect on mode choice through expanded analysis of a big dataset. This will also allow for more recent techniques of modelling to be used. Finally, this research results in the creation of a mode demand model prototype that is based on microsimulation.

Acknowledgements

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Ethical Approval

The manuscript includes a survey study of inhabitants in the port city of Douala from 18 years and above of age. It, therefore, follows all ethical norms and no minors involved.

Conflicts of Interest

We state clearly that the paper titled "Modelling of active and latent attributes based on traveler perspectives: Case of port city of Douala" has no conflict of interest as it is not currently being considered anywhere else for publication.

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Appendices

Appendix A. Probabilities of the Observations for the Combined Model

Mode	1	2	3
1	0.003719022	0.81710401	0.179176968
2	0.04798198	0.636533211	0.315484814
3	0.000261088	0.600789926	0.398948986
4	0.1971316	0.466301914	0.33656645
5	0.001706064	0.275174376	0.72311956
6	0.4850791	0.229753712	0.285167188
7	0.000104642	0.231675346	0.768220013
8	0.00035753	0.591812366	0.407830104
9	0.000155596	0.128154177	0.871690227
10	0.6729013	0.219010221	0.10808845
11	0.001543861	0.514836853	0.483619285
12	0.1469878	0.144807577	0.708204617
13	0.2208198	0.425703784	0.3534764
14	0.002556347	0.192986132	0.804457521
15	0.000182256	0.215954666	0.783863079
16	2.32732E−05	0.148568957	0.85140777
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35	0.000129377	0.144301666	0.855568958

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40	3.04877E−05	0.156685879	0.843283634
41	0.06823233	0.192355474	0.7394122
42	0.8902676	0.070338038	0.039394382
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Continued

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84	0.03625266	0.598339372	0.365407967
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89	0.4622161	0.341223036	0.196560877
90	0.06982799	0.631760036	0.298411975
91	0.1951232	0.631483869	0.173392915
92	0.02178299	0.853192113	0.125024896
93	0.9806871	0.017984312	0.001328634
94	0.4369221	0.387671136	0.175406788
95	0.001991175	0.294790453	0.703218372
96	0.008089014	0.488189822	0.503721165
97	0.0701608	0.057355392	0.872483811
98	0.02328575	0.024358193	0.952356053
99	3.55517E−05	0.039408447	0.960556001
100	0.01826135	0.39008078	0.591657869
101	0.000134849	0.210632671	0.78923248
102	6.55574E−06	0.009368348	0.990625096
103	0.01067133	0.445520443	0.543808225
104	0.07060636	0.042748243	0.886645392
105	0.5647617	0.072429561	0.362808781
106	0.000639362	0.375972185	0.623388453
107	0.9592557	0.012515927	0.02822839
108	0.7377208	0.053730719	0.208548478
109	0.0258222	0.159927647	0.814250153

Continued

110	6.31355E−05	0.023748304	0.97618856
111	6.55574E−06	0.009368348	0.990625096
112	0.01067133	0.445520443	0.543808225
113	0.07060636	0.042748243	0.886645392
114	0.5647617	0.072429561	0.362808781
115	0.000639362	0.375972185	0.623388453
116	0.9592557	0.012515927	0.02822839
117	0.7377208	0.053730719	0.208548478
118	0.000871679	0.105084914	0.894043407
119	9.91398E−06	0.018163885	0.981826201

Appendix B. Coefficients of Active Attribute Model

	Coefficients					
	Intercept	ATT	ATC	NOC	HS	AHI
2	0.728291	5.29998E−06	0.000453	1.548406	0.6192083	−2.37275E−05
3	4.209319	−0.03435171	−0.00139	1.29507	0.6343305	−2.55555E−05

Appendix C. Standard Errors of Active Attribute Model

	Standard Errors					
	Intercept	ATT	ATC	NOC	HS	AHI
2	0.0000326	0.00482459	0.000916	0.00000479	0.0000859	0.00000608
3	0.0000302	0.00405661	0.000931	0.00000178	0.0000822	0.00000579

Appendix D. Misclassification/Confusion Matrix Table for the Active Attribute Model

Mode	1	2	3
1	3	4	0
2	3	16	8
3	10	22	53

Appendix E. P-Values of Active Attributes Model

Attributes	P-Value 2	P-Value 3
ATT	0.9991235	0
ATC	0.6209995	0.1367356
NOC	0	0
HS	0	0
AHI	0.00009532	0.00001012

Appendix F. Probabilities of the Observations for the Active Attributes Model

Mode	1	2	3
1	0.245265864	0.5670169	0.18771726
2	0.144880092	0.3348606	0.52025934
3	0.024195306	0.5278868	0.44791793
4	0.093384959	0.433134	0.47348106
5	0.01645815	0.1322132	0.85132864
6	0.313805195	0.2807543	0.40544054
7	0.0027925	0.1617471	0.83546044
8	0.03647846	0.3593155	0.60420601
9	0.010561238	0.1739432	0.81549553
10	0.211365962	0.2841243	0.50450976
11	0.127578595	0.4020314	0.47039004
12	0.013053489	0.2322687	0.75467786
13	0.070924677	0.1336925	0.79538284
14	0.246453207	0.2204785	0.53306833
15	0.058363797	0.204365	0.73727123
16	0.026395347	0.1854581	0.78814656
17	0.046061054	0.1992248	0.75471412
18	0.162846023	0.1309521	0.70620187
19	0.245658265	0.6135663	0.14077539
20	0.11995284	0.7022876	0.17775958
21	0.263194255	0.5964744	0.14033137
22	0.019679696	0.1744988	0.80582155
23	0.148811662	0.6903763	0.16081204
24	0.026395347	0.1854581	0.78814656
25	0.048504181	0.1834758	0.76802
26	0.070218518	0.2656353	0.66414614
27	0.037779513	0.7631296	0.19909087
28	0.039030672	0.3362293	0.62474001
29	0.148811662	0.6903763	0.16081204
30	0.070218518	0.2656353	0.66414614
31	0.148811662	0.6903763	0.16081204
32	0.037357158	0.815243	0.14739986
33	0.179566653	0.7560123	0.06442102
34	0.107264547	0.2479003	0.6448352
35	0.075569681	0.2593982	0.66503209
36	0.076302652	0.3210966	0.60260078

Continued

37	0.098483076	0.7122177	0.18929927
38	0.015369531	0.1683377	0.81629282
39	0.030529548	0.1320369	0.83743351
40	0.008230527	0.167443	0.82432646
41	0.019679696	0.1744988	0.80582155
42	0.122304601	0.6487347	0.22896073
43	0.296328674	0.2921828	0.41148851
44	0.030500475	0.7610185	0.20848099
45	0.03647846	0.3593155	0.60420601
46	0.036217617	0.1292591	0.83452324
47	0.005958721	0.4231964	0.57084489
48	0.197349311	0.6280092	0.17464153
49	0.014696255	0.2467442	0.73855956
50	0.056455171	0.4413194	0.50222541
51	0.093384959	0.433134	0.47348106
52	0.037779513	0.7631296	0.19909087
53	0.082885573	0.3558386	0.56127587
54	0.058363797	0.204365	0.73727123
55	0.082885573	0.3558386	0.56127587
56	0.093707575	0.139968	0.76632441
57	0.179622925	0.1823002	0.63807686
58	0.152693761	0.1674108	0.67989545
59	0.125031733	0.3121852	0.56278308
60	0.076302652	0.3210966	0.60260078
61	0.095090322	0.6193921	0.28551756
62	0.021777049	0.439782	0.53844099
63	0.458383354	0.3417237	0.19989293
64	0.072431172	0.4239615	0.50360737
65	0.380426884	0.1832248	0.43634836
66	0.069528143	0.6850207	0.24545116
67	0.347698255	0.4815064	0.17079534
68	0.579426088	0.2509301	0.16964383
69	0.016660761	0.2515271	0.73181209
70	0.238638612	0.5623576	0.19900375
71	0.133268649	0.4757814	0.39094991
72	0.038643063	0.7288806	0.23247631
73	0.614322033	0.2959696	0.08970834

Continued

74	0.461507939	0.2222934	0.31619862
75	0.245265864	0.5670169	0.18771726
76	0.50980314	0.1188324	0.37136446
77	0.055945943	0.1302642	0.81378991
78	0.009275455	0.4297729	0.56095163
79	0.103049573	0.609061	0.28788943
80	0.074974976	0.6163129	0.30871215
81	0.161662457	0.4036786	0.43465892
82	0.161662457	0.4036786	0.43465892
83	0.095090322	0.6193921	0.28551756
84	0.211365962	0.2841243	0.50450976
85	0.161662457	0.4036786	0.43465892
86	0.093805559	0.1733384	0.73285607
87	0.211365962	0.2841243	0.50450976
88	0.029567102	0.3214355	0.64899738
89	0.134164416	0.3039587	0.56187685
90	0.125031733	0.3121852	0.56278308
91	0.040025988	0.4351727	0.52480127
92	0.330950569	0.4158277	0.25322175
93	0.461507939	0.2222934	0.31619862
94	0.515600361	0.1473405	0.33705913
95	0.021104548	0.1372534	0.84164203
96	0.066284947	0.3515084	0.5822067
97	0.023310354	0.3130262	0.66366347
98	0.055945943	0.1302642	0.81378991
99	0.054075391	0.3164944	0.62943022
100	0.019679696	0.1744988	0.80582155
101	0.023310354	0.3130262	0.66366347
102	0.015369531	0.1683377	0.81629282
103	0.173389096	0.3928562	0.43375472
104	0.076302652	0.3210966	0.60260078
105	0.076302652	0.3210966	0.60260078
106	0.042177467	0.329682	0.6281405
107	0.313805195	0.2807543	0.40544054
108	0.313805195	0.2807543	0.40544054
109	0.313805195	0.2807543	0.40544054
110	0.283085181	0.1112036	0.60571119

Continued

111	0.015369531	0.1683377	0.81629282
112	0.173389096	0.3928562	0.43375472
113	0.076302652	0.3210966	0.60260078
114	0.076302652	0.3210966	0.60260078
115	0.042177467	0.329682	0.6281405
116	0.313805195	0.2807543	0.40544054
117	0.313805195	0.2807543	0.40544054
118	0.066284947	0.3515084	0.5822067
119	0.125600509	0.1274625	0.74693703

Appendix G. Coefficients of Latent Attribute Model

				Coefficients			
	Intercept	SCB	SCC	SPB	AFCB	AFCC	AFPB
2	3.804221	0.083555	−0.51599	0.3571186	−0.4814599	1.564801	0.891354
3	3.607433	0.317089	−0.55238	0.7260923	−0.7300499	1.540811	0.87951
	FCB	FCC	FPB	ACCB	ACCC	ACPB	AVCB
2	1.1556274	−0.53774	−0.86151	−0.981015	−0.6292959	−0.93889	−0.10107
3	0.8691507	−0.21387	−1.20387	−0.687919	−0.3634836	−0.51566	0.005411
	AVCC	AVPB					
2	−0.571227	0.272174					
3	−1.405064	0.263402					

Appendix H. Standard Errors of Latent Attribute Model

				Standard Errors			
	Intercept	SCB	SCC	SPB	AFCB	AFCC	AFPB
2	2.784766	0.6052918	0.567093	0.4085775	0.5766188	0.686129	0.351571
3	2.730042	0.592305	0.558901	0.4130272	0.5734553	0.666052	0.356202
	FCB	FCC	FPB	ACCB	ACCC	ACPB	AVCB
2	0.4912818	0.718285	0.543393	0.4302216	0.6078026	0.619659	0.439218
3	0.4535358	0.691122	0.519481	0.4026605	0.5998804	0.601275	0.431622
	AVCC	AVPB					
2	0.5514803	0.49463					
3	0.5549754	0.478606					

Appendix I. Probabilities of the Observations for the Latent Attributes Model

Mode	1	2	3
1	0.002612424	0.38844757	0.60894
2	0.192008474	0.447649	0.36034253
3	0.010317263	0.37504405	0.61463869
4	0.144425068	0.4945994	0.36097553
5	0.069387794	0.37067328	0.55993893
6	0.277031347	0.18329836	0.53967029
7	0.054137393	0.40017708	0.54568553
8	0.030099913	0.41695565	0.55294444
9	0.020938074	0.34887955	0.63018237
10	0.685850556	0.21431159	0.09983785
11	0.018523168	0.6095605	0.37191633
12	0.50372079	0.14215716	0.35412205
13	0.310853219	0.50832055	0.18082623
14	0.00524742	0.31365203	0.68110055
15	0.00436582	0.22200406	0.77363012
16	0.000724199	0.25778002	0.74149579
17	0.002625581	0.40468407	0.59269035
18	0.001579242	0.31081267	0.68760809
19	0.002425095	0.24589608	0.75167882
20	0.000281046	0.31495223	0.68476672
21	0.002130623	0.37488799	0.62298139
22	0.11567653	0.54565449	0.33866898
23	0.174729636	0.4284313	0.39683906
24	0.021286029	0.39119642	0.58751755
25	0.004145806	0.32916408	0.66669012
26	0.006585358	0.28299452	0.71042012
27	0.004724363	0.42270346	0.57257217
28	0.003471311	0.39220295	0.60432574
29	0.001929021	0.36671473	0.63135625
30	0.004056637	0.38394343	0.61199994
31	0.008116454	0.35994698	0.63193657
32	0.005571379	0.48939769	0.50503093
33	0.000600794	0.37554183	0.62385738
34	0.000443872	0.40298609	0.59657004
35	0.000573094	0.3268152	0.67261171
36	0.001896965	0.43626753	0.56183551

Continued

37	0.071652629	0.41666581	0.51168156
38	0.05652385	0.20483384	0.73864231
39	0.187646324	0.30022951	0.51212417
40	0.005321216	0.51846902	0.47620977
41	0.497735936	0.26358665	0.23867741
42	0.720066697	0.06220952	0.21772378
43	0.005045215	0.25860591	0.73634888
44	0.003087217	0.42296893	0.57394385
45	0.003778048	0.36749154	0.62873041
46	0.001131159	0.19982888	0.79903996
47	0.008339508	0.39861037	0.59305012
48	0.525018264	0.14471321	0.33026853
49	0.000488167	0.57977001	0.41974182
50	0.002290359	0.22239889	0.77531076
51	0.000544683	0.11530091	0.88415441
52	0.392415063	0.51143244	0.0961525
53	0.004843	0.1614845	0.8336725
54	0.070496003	0.05631499	0.87318901
55	0.016003005	0.86365985	0.12033714
56	0.096854832	0.65992627	0.2432189
57	0.012167238	0.13569998	0.85213278
58	0.4235968	0.26412689	0.31227631
59	0.00196815	0.59927711	0.39875474
60	0.258030458	0.45104264	0.29092691
61	0.012953365	0.49636492	0.49068171
62	0.220012034	0.41977348	0.36021448
63	0.249559642	0.49719799	0.25324237
64	0.00947125	0.58459109	0.40593766
65	0.407113708	0.17928628	0.41360001
66	0.066513193	0.82808953	0.10539728
67	0.000315995	0.01998092	0.97970309
68	0.027039277	0.32660285	0.64635788
69	0.005376589	0.67162384	0.32299957
70	0.009674723	0.7036616	0.28666367
71	0.271854057	0.2600842	0.46806174
72	0.025839506	0.83518032	0.13898018
73	0.884755093	0.02128131	0.0939636

Continued

74	0.120425359	0.16901651	0.71055813
75	0.041923977	0.47550653	0.4825695
76	0.025413427	0.26447718	0.71010939
77	0.138695163	0.34610064	0.51520419
78	0.004460145	0.66808654	0.32745331
79	0.324716841	0.32123102	0.35405214
80	0.024515945	0.83165018	0.14383387
81	0.039654193	0.80181478	0.15853103
82	0.067978722	0.30579663	0.62622465
83	0.311166286	0.15245769	0.53637602
84	0.013396931	0.6447718	0.34183127
85	0.000476588	0.66030558	0.33921783
86	0.002016772	0.50768617	0.49029706
87	0.038776392	0.7682206	0.19300301
88	0.194611533	0.4631858	0.34220266
89	0.343446704	0.29491382	0.36163948
90	0.081590973	0.4397502	0.47865883
91	0.385596279	0.47825616	0.13614756
92	0.043504044	0.69536949	0.26112647
93	0.626679673	0.31406884	0.05925149
94	0.112892257	0.53623504	0.3508727
95	0.019579524	0.34569785	0.63472262
96	0.047957798	0.49358243	0.45845977
97	0.400497049	0.06631977	0.53318318
98	0.120344969	0.06282196	0.81683307
99	0.001146843	0.06868927	0.93016389
100	0.104800015	0.38959538	0.50560461
101	0.028647163	0.35175293	0.61959991
102	0.001515095	0.06408181	0.9344031
103	0.008255167	0.40623186	0.58551297
104	0.175386861	0.03058769	0.79402545
105	0.605060058	0.11313355	0.28180639
106	0.005025374	0.47044092	0.52453371
107	0.75546893	0.03482064	0.20971043
108	0.486107854	0.0830784	0.43081374
109	0.006209682	0.09649667	0.89729364
110	0.000196794	0.09190672	0.90789648

Continued

111	0.001515095	0.06408181	0.9344031
112	0.008255167	0.40623186	0.58551297
113	0.175386861	0.03058769	0.79402545
114	0.605060058	0.11313355	0.28180639
115	0.005025374	0.47044092	0.52453371
116	0.75546893	0.03482064	0.20971043
117	0.486107854	0.0830784	0.43081374
118	0.006209682	0.09649667	0.89729364
119	0.000196794	0.09190672	0.90789648

Appendix J. Misclassification/Confusion Matrix Table for the Latent Attribute Model

Mode	1	2	3
1	11	0	3
2	3	19	11
3	2	23	47

Appendix K. P-Values of Latent Attributes Model

Attributes	P-value 2	P-value 3
SCB	0.8902084	0.5924095
SCC	0.3628778	0.322992
SPB	0.38208908	0.07875142
AFCB	0.4037341	0.2029924
AFCC	0.02257081	0.02070348
AFPB	0.01123364	0.013544
FCB	0.01865923	0.05531569
FCC	0.4540738	0.7569717
FPB	0.11286923	0.02047939
ACCB	0.02259259	0.08755591
ACCC	0.3004997	0.5445633
ACPB	0.1297274	0.3911108
AVCB	0.8179958	0.9899976
AVCC	0.30029232	0.01134922
AVPB	0.5821432	0.5820776