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Assessment of Intra-Urban Passenger Transportation Means: Case Study of the City of Douala-Cameroon

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Abstract: **Efficient transport systems is pivotal for the success of urban areas. Hence, assessing the means of transport used in a city helps in bringing out their performance. This study centered around the city of Douala. The mode of transport used in the city is by land and the main means of transport used by passengers are taxis, motorcycle, and public buses. Passengers are often faced with a dilemma, regarding which means of transport to use as a result of traffic congestion during certain hours of the day. The criteria used in assessing the means of transport were; cost, distance, accessibility, reliability, and safety. Delphi method was used to weight the criteria and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) model was used to rank the means of transport.**

Keywords: **Delphi method, Intra-urban, Passenger, TOPSIS, transportation, transport means.**

I. INTRODUCTION

Transportation is a very invaluable tool that facilitates various movements in virtually every sector of today's world. It involves the movement of people, commodities as well as information from one point of origin to another specified destination. The availabilty and accessibility of transport infrastructures plays a huge role in ensuring growth and development which makes it very worthwhile not only in commerce but also in general every day lives of people. Furthermore, transportation plays a critical part in urban development by providing access for people to education, employments, market, recreation and other activities[1]. Ogundade (2013) stated that, the key transport issues are usually related to urban areas and they occur when transport systems cannot meet the numerous requirements of urban movement[2]. Therefore, urban productivity is heaviliy reliant on the efficient and effective transport system to move labour, consumers and freight between multiple origins and destinations[2].

Problems like congestion has greatly plagued developed cities like Rome[3] and this problem is similar to most underdeveloped cities to which Douala is not an exception. Other issues like state of transport infrastructure, availability of alternative transport mode and transport policies will influence the choice of a particular means of transport over another. Worthy of note is that, the dominant mode of transport used in the interior of Cameroon is road transport. It covers 80 to 99% of passenger transport and goods transportation[4]. The main means by which people can displace themselves from one place to another in the city of Douala are by taxis, buses, motocycles, bicycles and walking. Therefore, this paper seeks to assess and categorize the different means of transport available to passengers for movement within the city of Douala.

1.1 The study area:

The study area includes the entire territory of the region of Littoral. The capital of the Littoral region of Cameroon is Douala and it is the largest city in Cameroon. It is located in the southwestern part, besides the delta of the wouri. Its latitude is **4° 3' 41.5296'' N** and longitude **9° 47' 9.8592'' E.** It has a population of about 5 million people [5].

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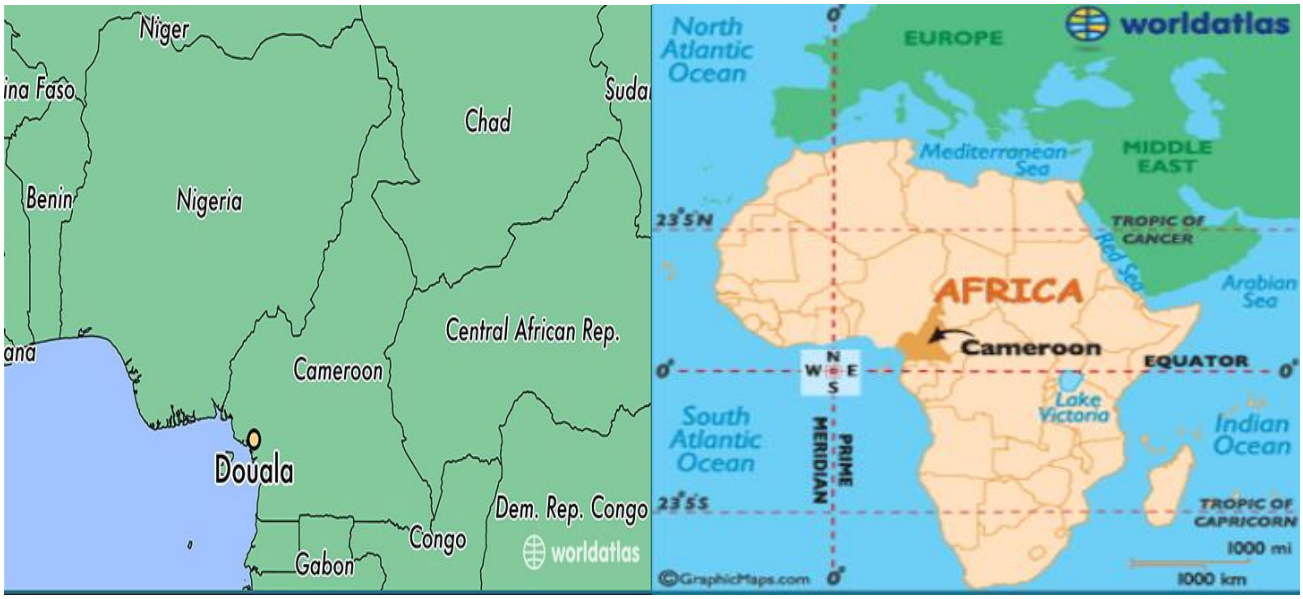
This study describes the means of transport used in the city and ranks them in terms of five criterias which are; cost, distance, accessibility, reliability and safety.

Location of Douala and Cameroon on the map



Source: world atlass

II. CONCEPT AND STATE OF INTRA-URBAN TRANSPORT MEANS IN DOUALA

Intra-urban passenger transportation is best explained when divided into two parts. "Intra-urban" and "passenger transportaton". Intra-urban transportation is refered to the movement within a particular urban area.[6] Passenger transportation on the other hand, is the movement of people via a means of transport such as buses, airoplanes, ships, bicycles and trains. The demand for transport by passengers arises from from the desire to access opportunities that are found at other locations.[7] In the city of Douala, the transport sector is not well orgarnized and the safety rate is low. The state of the means of transport used in the city is as follow:

The taxis have no fixed route and they move based on their passenger's destination. They are yellow and are shared with other passengers. Commercial motobikes on the other hand, are sometimes prefered by passengers because of their ability to go places where the other means of transport cannot go. The buses offer a fixed fare irrespective of the distance covered and they usually cover longer distances than the other means of transport. Other challeges like the poor nature of the road in some areas leads to high rate of accidents by certain means of transport like motorcycle because they are cheap.

III. METHOD FRAMEWORK

TOPSIS model:

Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), was presented by Hwang and Yoon (1981)[8]. It is a Multiple Criteria Decision Making (MCDM) method. The basic principle is that the chosen alternative should have the shortest distance from the ideal solution.

The TOPSIS procedure consist of the following 7 steps as stated by Srikrishna et. al. (2014)[9].

Step I: Establish a decision matrix

The initial phase of the Topsis model involves the construction of a decision matrix (DM)

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$$DM = \begin{array}{c} \\ L_1 \\ L2 \\ , \\ , \\ , \\ L_m \end{array} \begin{array}{c} C_1 \quad C_2 - - - Cn \\ \begin{pmatrix} X_{11} & X_{22} - - - X_{1n} \\ X_{21} & X_{22} - - - X_{2n} \\ , & , \quad , \\ , & , \quad , \\ , & , \quad , \end{pmatrix} \\ X_{m1} \; X_{m2} - - - X_{mn} \end{array} \quad \ldots\ldots\ldots [10]$$

Where 'i' is the criterion index (i = 1, ... m); m is the number of potential sites and 'j' is the alternative index (j = 1, ... n). The elements C_1, C_2, ... C_n refer to the criterion.

While L_1, L_2, ..., L_n refer to the alternative locations. The element of the matrix are related to the values of the criterion i with respect to alternative j.

Step II: Compute a normalised decision matrix

The normalised values represent the normalised decision matrix (NDM) which stands for the relative performance of the generated design alternatives.

$$NDM = R_{ij} = \frac{X_{ij}}{\sqrt{\Sigma_{i=1}^{m} x^2_{ij}}} \quad \ldots\ldots\ldots [11]$$

Step III: Determine the weighted decision matrix

The weighted decision matrix is constructed by multiplying each element of every column of the normalized decision matrix by the weights attributed.

$$V = V_{ij} = W_j \text{ x } R_{ij} \quad \ldots\ldots\ldots [12]$$

Step IV: Identify the positive ideal solution (PIS) and negative ideal solution (NIS)

The positive ideal (A^+) and negative ideal (A^-) solutions are defined according to the weighted decision matrix .

$PIS = A^+ = \{V^+_1, V^+_2, ..., V^+_n\}$, where: $V_j^+ = \{(\max i(V_{ij})\ j \in J); (\min V_{ij} \text{ if } j \in J')\}$ . . . . [13]

$NIS = A^- = \{V^-_1, V^-_2, ..., V^-_n\}$, where: $V_j^- = \{(\max i(V_{ij})\ j \in J); (\min V_{ij} \text{ if } j \in J')\}$ . . . . [14]

Where J is associated the beneficial attributes and J' is associated with the non beneficial attributes.

Step V: Calculate the separation distance of each competitive alternative for the ideal and non-ideal solution.

$$S^+ = \sqrt{\Sigma_{i=1}^{n} (V^+_j - V_{ij})^2} \qquad i = 1, ..., m \quad \ldots\ldots\ldots [15]$$

$$S^- = \sqrt{\Sigma_{i=1}^{n} (V^-_j - V_{ij})^2} \qquad i = 1, ..., m \quad \ldots\ldots\ldots [16]$$

Step VI: Measure the relative closeness of each location to the ideal solution. For each competitive alternative, the relative closeness of the potential location with respect to the ideal solution is computed.

$$C_i = S_i^- / (S_i^+ + S_i^-), \qquad 0 \le Ci \le 1 \quad \ldots\ldots\ldots [17]$$

Step VII: Rank the preference order

According to the value of Ci, the higher the value of the relative closeness, the higher the ranking order and hence the better the performance of the alternative. Ranking of the preference in descending order thus allows relatively better performances to be compared.

IV. DATA ANALYSIS AND PRESENTATION OF RESULTS

Evaluation criteria are; cost, distance, accessibility, reliability and safety.

The study is both quantitative and qualitative. The instrument used in collecting the data is by questionaires and interviews. The data was collected from 189 respondents from different background in the city and an average was taken

to form out the response table matrix. Weightings of the evaluation criteria was established by applying the Delphi methodology. Furthermore, the TOPSIS model is used to rank the means of transport to be used based on the evaluation criterias.

Ranking criteria

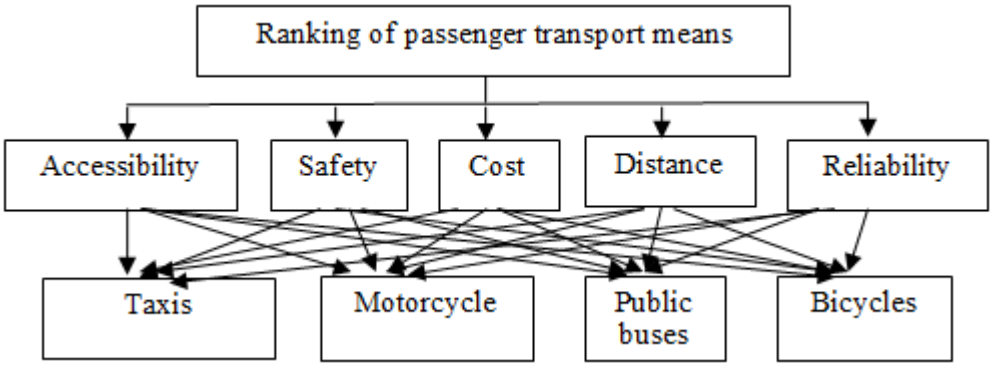

TABLE I: RESPONSE DATA

Attributes	Taxis	Public buses	Motorcycles	Bicycles
Average cost of transport per kilometer (km) within the city of Douala	250 frs	150 frs	100 frs	0
Average distance per kilometer (km) within the city of Douala	6 km	10 km	2 km	1km
Safety level (Low, Medium or High)	Medium	Medium	Low	Low
Accessibility (Low, Medium or High)	Medium	Low	High	Low
Reliability (Low, Medium or High)	Medium	Medium	Low	Medium

Source: Derived from questionnaire

TABLE II : DECISION TABLE

Attributes	Ranking criteria				
	Accessibility	Safety	Cost	Distance	Reliability
Public buses	5	6	5	9	6
Taxis	6	5	6	7	5
Motorcycles	3	2	3	6	3
Bicycles	2	3	2	1	5
Weight	0.34	0.27	0.20	0.13	0.06

Source: Derived from response table A

Result:

The spatial characteristics of the roads in the city of Douala are narrow and a high density of the human inhabitants in the city prefer a specific vehicle for transportation within the city.

The normalised decision matrix is shown in the table below:

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TABLE III: NORMALIZED DECISION TABLE

Attributes	Ranking criteria				
	Accessibility	Safety	Cost	Distance	Reliability
Public buses	0.58	0.70	0.58	0.69	0.62
Taxis	0.70	0.58	0.70	0.54	0.51
Motorcycles	0.35	0.23	0.35	0.46	0.31
Bicycles	0.23	0.35	0.23	0.07	0.51
Weight	0.34	0.27	0.20	0.13	0.06

Source: Researcher, (2017)

The normalised matrix is multiplied by the weight to get the weighted decision matrix.

TABLE IV: WEIGHTED NORMALISED TABLE

Attributes	Ranking criteria				
	Accessibility	Safety	Cost	Distance	Reliability
Public buses	0.12	0.19	0.12	0.09	0.04
Taxis	0.24	0.16	0.14	0.07	0.03
Motorcycles	0.12	0.06	0.07	0.06	0.02
Bicycles	0.08	0.09	0.05	0.01	0.03

Source: Researcher, (2017)

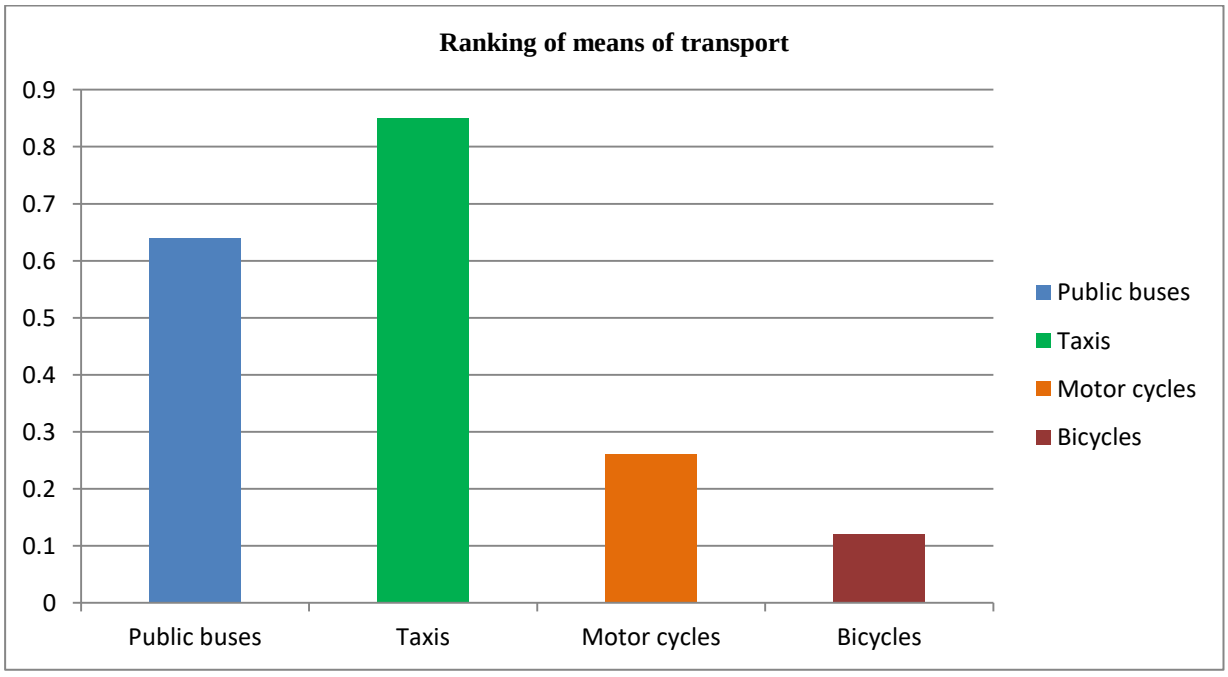
According to equation [10] and [11], the positive ideal solution(PIS) and the negetive ideal solution are(NIS);

PIS = { 0.24, 0.19, 0.14, 0.09, 0.02}

NIS = {0.08, 0.06, 0.05, 0.01, 0.04}

The seperation distance of each competitive alternative for the ideal and non-ideal solution.

Ci = {0.64; 0.85; 0.26; 0.12}



Source: Researcher, (2017)

FIGURE 1: RANKING OF MEANS OF TRANSPORT

V. CONCLUSION

Intra urban transportation means plays an important role by providing the channel through which people, goods and services are displaced in order to ensure economic vitality and quality of life. TOPSIS is used to rank the different means of transport used by passengers in city of Douala. From the findings, it is observed that the best means of transport to use for intra urban movement within the city of Douala is by taxis based on the factors considered. Bicycles should also be promoted within the city for passengers going on short distances in order reduce the number vehicles on the road hence reducing congestion and pollution.

This paper centered around an analysis and ranking of the individual transport means used in the city by passengers. Future research can be made to see the effects of intergration of these transports means.

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