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I. Introduction

Researchers have approached location problems with a variety of quantitative models. Limbourg and Jourquin (2008) use integer programming to locate facilities with the goal of minimizing total transportation costs. This method not only uses aggregated supply and demand points but also accounts for commodity flows and their geographic location to determine the optimal position of intermodal terminals on a given network. Melkote (2001) also uses integer programming but identifies changes to the network topology along with identifying potential facility locations. Arnold et al. (2004) formulates the location problem as a binary linear program but solves it using a heuristic approach. Racunica and Wynter (2005) also use heuristics in their model and allow for non-linear and concave cost functions.

Existing tools including location theory and other quantitative location decision models guide freights but do not provide qualitative information regarding livability and sustainability vital for determining community readiness. To obtain a holistic view of the location decision, rather than a purely quantitative view, Murthy (2001) suggests good performance criteria should include both quantitative and qualitative measures as applicable to the project. And, Bontekoning et al. (2004) extensively reviewed current intermodal research and recognized that a more multidisciplinary approach is used in modeling intermodal terminal location decisions. Management and policy theory were two areas they identified that required to be considered more thoroughly. Multi-criteria decision analysis (MDCA) serves as a tool for modeling freight-related movement decisions because of its flexibility to combine various types of data and different viewpoints from experts. Macharis (2005) and Vreeker (2002) have both implemented the Analytic Hierarchy Process (AHP) as a decision support tool for MDCA. Piantanakulchai (2003) uses the AHP in conjunction with a Geographical Information System (GIS) to aid in location and alignment decisions.

The AHP was used as a way to gather input from different stakeholders of potential transportation movement projects (Macharis, 2005; Dooms & Macharis, 2003). Sirikijpanichkul (2007) shows a decision model that specifically addresses the location issue and attempts to select the optimum location based on the needs of stakeholders. Dooms (2003) presents a similar model that takes into account the short and long-term objectives of multiple stakeholders, but it does not address the location decision. This model identifies the key stakeholders in the port's long-term strategy and a way to include these parties in the decision making. Henesey et al. (2003) also uses this approach and incorporates Multi Agent-Based Simulation to provide a foundation for inland port decision makers.

The needs of all the stakeholders involved in a multimodal terminal location project can be enormous. Quantitative modeling tends to maximize the benefits of the users and operators of terminals without consideration for community impacts. Community concerns often include environmental, economic, and quality of life effects of the project. Environmental and land use impacts have been identified (Litman, 1995; McCalla, Slack, & Comtois, 2001), but quantifying the effects of these impacts is difficult. The economic significance of transportation facilities are often unclear due to the complexities of these impacts. Although a more efficient freight network would be beneficial for any nation, the possible side effects of multimodal terminals, such as noise pollution, decreased land values, and stimulation of urban sprawl can outweigh these benefits (Litman, 1995). Likewise, if jobs are created as a result

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of increased multimodal transport, but traffic congestion increases, the net effect of the movement itself could be disheartening.

Finding the balance point between all of the relevant criteria can be difficult and, often, a partnering opportunity can enhance a good location's potential or even supersede a deficient location's disadvantages. Lipscomb and Long (2008) suggest that inland freight movement decisions should take advantage of the synergies created through strategic partnerships. Because of the range of factors that affect the choice to either provide new inland freight or further develop existing inland freights, Multi-Criteria Decision Analysis is an effective way to consider all of the relevant criteria as well as all of the relevant stakeholders. Recent models describe the methodology for analysing and locating inland freights, but they do not describe how to develop the important criteria and how to measure alternatives based on these criteria. The importance of quantifiable criteria for sustainable transport systems is covered in Litman (2007). This paper developed relevant variables for complementary indices for inland freight movement in Nigeria.

II. Methodology

The method of analysis utilized in this study are derived from an analysis of the concept of cargo traffic flows and traffic forecasts. The analysis is based on the concepts of gravity model, which serves as the theoretical framework. The method to be used is the multiple regression analysis, which is used to obtain the coefficients associated with population and distance. The regression line is expressed as follows; $Y = a_o + a_1X_1 + a2X_2 + u$, Where: Y = Cargo volume, X_1 = population, X_2 = distance, U = stochastic/error term; $a_{0,}$ a_1, and a_2 are respective parameters to be estimated.

For accurate analysis of the flow model from the selected ports (i.e., Port Harcourt and Calabar Port complexes). Some service towns have been chosen and arranged as follows: Aba, Benin, Enugu, Jos, Kano, Makurdi, Nnewi, Owerri, Sokoto, and Uyo. The volume of cargo bound for the respective towns the ports was obtained by combining the flows from both Port Harcourt and Calabar ports. The estimated population size of these towns and their distances from both Calabar and Port Harcourt ports were calculated for in-depth analysis and model formulation.

Table 1 shows the actual volume and direction of flow of import goods discharged at the ports within the years in view. It also shows the annual average volume of cargo distributed (combined values of Port Harcourt and Calabar port) from the port complexes to the hinterland from 2010-2015.Table 1also shows the distance from the port complexes at Port Harcourt and Calabar respectively. It also indicates the average separating distances of the towns from two Ports in Kilometers. The table for example, shows that the distance between Calabar Port to Kano is 1183km and that of Port-Harcourt to Kano is 1179kkm. These two figures now give rise to an average of 1181km from Kano to both ports. The other service towns and their distances from the ports are set out as shown.

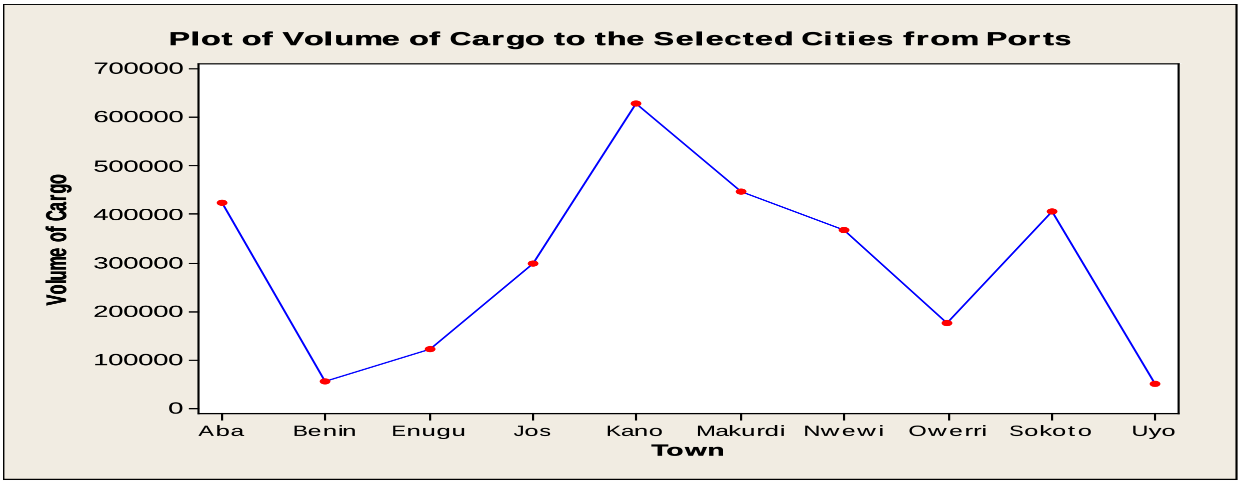
Table 1: Study Data (2010 – 2015)

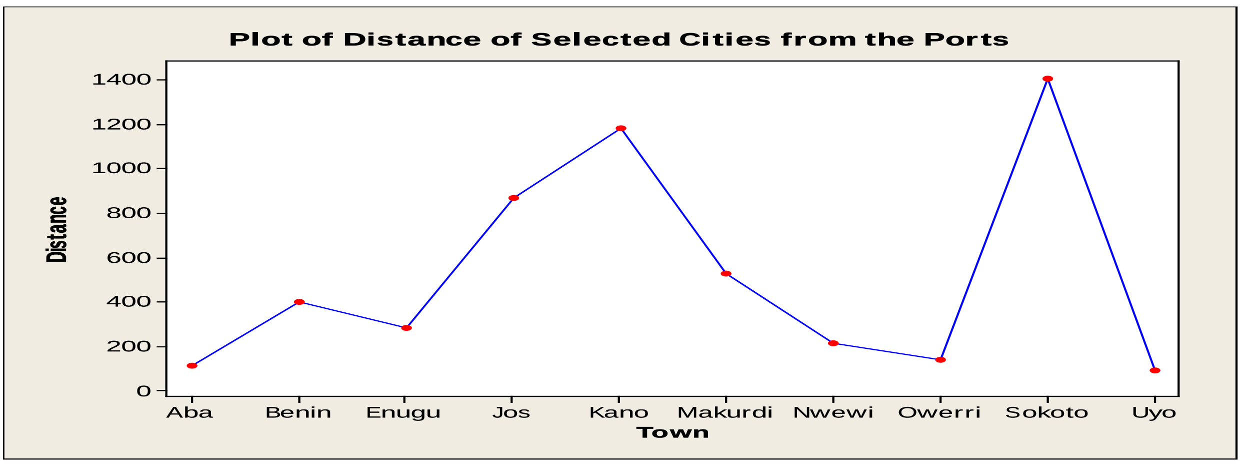
S/N	Towns	Average Annual flow of cargo from ports (in metric tonnes)	Average Population ('000)	Average Distances from Port Harcourt and Calabar (in km)
1	Aba	425640	491432	110
2	Benin	54485	2785619	400
3	Enugu	122967	21306	282
4	Jos	299824	4248204	865
5	Kano	628664	7451991	1181
6	Makurdi	447739	3530849	527
7	Nnewi	366780	159158	215
8	Owerri	176154	197743	141
9	Sokoto	407374	5733050	1406
10	Uyo	50808	124671	92

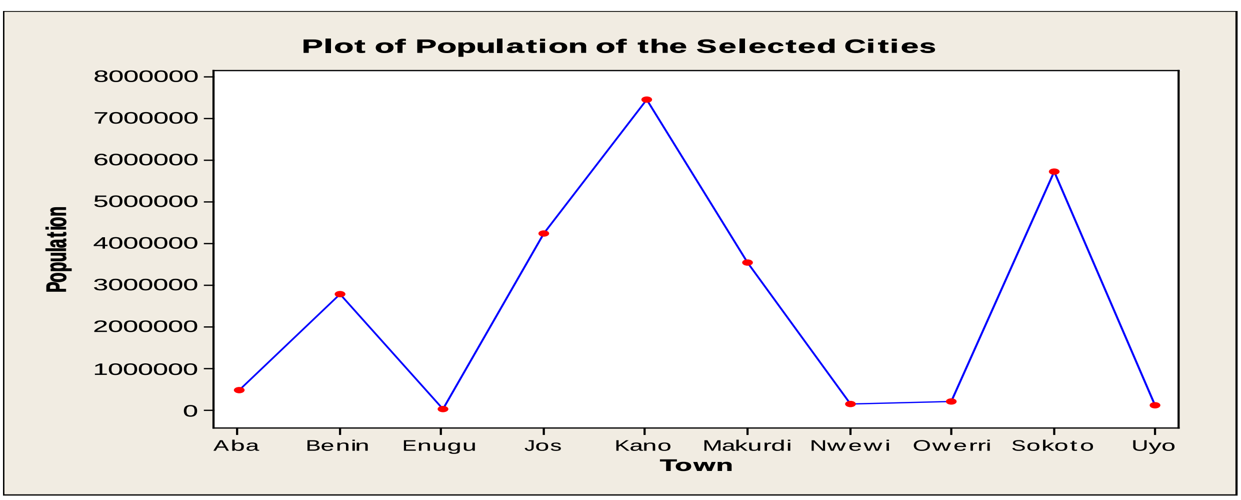
Source: National Population Commission, Lagos, Nigeria Ports Authority Abonemma, Wharf P/H and Calabar Ports and Federal Office of Statistics, Lagos.

III. Results

The figure below shows the trend of inland freight variables in the ten selected cities under study from the Port nodes- Port Harcourt and Calabar.







Categorical regression quantifies categorical data by assigning numerical values to the categories, resulting in an optimal linear regression equation for the transformed variables. Standard linear regression analysis involves minimizing the sum of squared differences between a response (dependent) variable and a weighted combination of predictor (independent) variables. Variables are typically quantitative, with (nominal) categorical data converted to binary or contrast variables. As a result, categorical variables serve to separate groups of cases, and the technique estimates separate sets of parameters for each group. The estimated coefficients reflect how changes in the predictors affect the outcome. Prediction of the response is possible for any combination of predictor values. In this case, Categorical regression was used to describe how Inland Freight Movement depends on population and distance. The resulting regression equation could be used to predict inland freight movement for any combination of the independent variables.

The following results were obtained:

Table 2: Gravity Model Result

Variable	Gravity Model
Distance	1.706*** [0.005]
Population	1.665*** [0.005]
R^2	*1.000*
Adjusted R^2	*1.000*
F	*15957.368*

1. Dependent variable = ln (Volume of Cargo);
2. Standard errors in brackets are robust to heteroskedasticity and serial correlation;
3. * p < 0.05, ** p < 0.01, *** p < 0.001; Statistics of the first stage.

All the variables of this predictive model are statistically significant at $\alpha = 0.05$ and hence could be used for planning. Using Gravity model, the complementary indices of the inland freight flows in the Nigerian towns under study from Port Harcourt and Calabar Ports were found to be as follows:

$Q = D^{1.706}P^{1.665}$

Where Q = Volume of Cargo

D = Distance from Ports

P = Population of Town

The model was fitted with natural logarithmic values to avoid heteroscedasticity. The goodness-of-fit was excellent with the coefficient of multiple regressions at 100%. The model is ideal for forecasting inland freight flows along the ten cities in focus.

However, correlation analysis was conducted to determine the relationships among the variables of inland freight movement. The coefficient of correlation between the volume of inland freight flows and the population of inland towns from seaports of study (which is 0.635) is flagged and hence is statistically significant: Thus we reject $H_{01:}$ The population size of a service town is not a significant determinant of inland freight movement from a seaport and accept z hypothesis. We can conclusively say that, within $\alpha = 0.05$, population size is a critical determinant of cargo movement from Nigerian seaports to specific towns. Also, it is clear that the coefficient of correlation between the volume of inland freight flows and the distance of inland towns from seaports of study (which is 0.574) is not flagged and is not statistically significant. Hence, we accept H_{02}: Average distance from the seaports to service areas is not a significant determinant of freight movement. We therefore conclude that distance from seaports to service areas is not a significant determinant of cargo flow to chosen towns.

Table 3: The relationships among the variables of inland freight movement

Correlations

		Volume of Cargo	Distance	Haulage cost	Population
Volume of Cargo	Pearson Correlation	1	.574	-.199	.635*
	Sig. (2-tailed)		.083	.581	.048
	N	10	10	10	10
Distance	Pearson Correlation	.574	1	.309	.936**
	Sig. (2-tailed)	.083		.385	.000
	N	10	10	10	10
Haulage cost	Pearson Correlation	-.199	.309	1	.409
	Sig. (2-tailed)	.581	.385		.241
	N	10	10	10	10
Population	Pearson Correlation	.635*	.936**	.409	1
	Sig. (2-tailed)	.048	.000	.241	
	N	10	10	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Finally from the analysis above we can conclusively say that population size of a town is a more significant predictive variable than distance.

IV. Conclusion

This study is designed to examine the cargo traffic from Nigerian seaports, using the Calabar and

Port Harcourt port complexes as the case study. The objective being to identify the function for assessing cargo movement from the seaport to different towns in the country. This lead to the model depicting the functional relationship, which exists between the variables used in the study. The regression model was used to fit a gravity model, thus $Q = D^{1.706}P^{1.665}$. The model was fitted with natural logarithmic values to avoid heteroscedasticity. The regression model obtained from the study shows reasonable estimates of actual annual cargo movements from selected ports for the period 2010-2015. During the analysis, the significance of the model was shown by the relatively high value of the coefficient of multiple determinations (R^2) of 100%.Furthermore, the fact that the signs and magnitude of the population parameter are in conformity with existing theoretical axioms, while the distance parameter understandably did not meet expectations, connotes that the regression equation obtained is plausible. In the literature review, it is quite evident in the study carried out by Onakomaiya and Smith (1972), using a seven-variable multiple regression equations to explain rail shipments from Lagos and Port Harcourt to 22 towns in Nigeria. The variables used include percentage employment, population, distance, export earnings of the towns, etc. distance and export earnings accounted for 78% of the variable in import traffics.

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