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Assessment of Terminal Capacity for Cargo Handling in Lagos Airport, Nigeria

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Assessment of Terminal Capacity for Cargo Handling in Lagos Airport, Nigeria

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I. Introduction

The capacity of airports to handle cargo traffic is measured by the rate at which cargoes are processed for transhipment. Generally, capacity refers to the ability of an airport to handle a given volume and types of cargo demand without operational penalty. Airport capacity for cargo handling is constrained when the infrastructure and facilities provided at terminals can no longer perform effectively to handle the demanded tonnage of cargo efficiently.

Airport capacity constrain is expressed as the inability of an airport to handle the maximum number of units of demand that can be accommodated during a given period of time and under given conditions (Senguttuvan, 2006). Bilotkach and Polk (2011) stated that airports which are capacity constrained in one or the other way will have difficulty accommodating new airlines or expanded services by the incumbent carriers. The airport capacity and the demand for service by aircraft operators form the major features in the measurement of traffic growth of any airport. These features influence the volume and types of cargoes that an airport can attract.

The focus of airport management is to ensure adequacy of capacity to handle the anticipated demand of traffic in an efficient manner. The overall capacity of any airport to provide cargo handling services with efficiency is determined by the quantity and condition of its infrastructure such that cargoes are processed without delay and at reduced cost. The delay in cargo traffic at airports results into high cost and increased transhipment time. To this end, this study is set to assess the capacity of Lagos airport in the handling of cargo traffic in terms of the adequacy and condition of warehouse, handling equipment, processing shed, and storage facilities.

The paper is structured under five sections. Following this section is section 2 – literature review, the presentation of detailed methodology for the study is under section 3, section 4 presents the results and discussion while section 5 gives the conclusion and policy implication of the study.

II. Literature Review

There are several studies on airport capacity across many nations of the world. The focus of many studies in airport capacity has been in relation to aircraft, taxiway and runway. Gelhausen (2011) looked at airport capacity constraints in relation to passengers' airport choice in Germany. Also, Xiao, Fu, Oum&Yan (2017) modelled airport capacity choice in consideration for the real option of expansion. The issue of airport-airline choice was investigated with a focus on airport capacity by Xiao, Fu, Oum & Yan (2017) with a focussing its effect on airport capacity. Magana, Mansouri & Spiegler (2017) considered the need for improving air cargo demand forecasting of handling industry's to provide adequate capacity, while Jacquilat & Odoni (2017) synthesised major interventions available to manage airport demand and capacity. The study of Nommik & Antov (2017) modelled airport terminal capacity to avoid over-design of infrastructure for the provision of cargo handling services in Estonia. Recently, Picard, Tampier and Wan (2019) assessed airport capacity and slot allocation efficiency of flight departures at peak times. Amaruchkul & Lorchirachoonkul (2011) studied air cargo capacity allocation for multiple freight forwarders. The study considered single air-cargo carrier allocating cargo capacity to multiple forwarders before booking starts. Anderson, Wirasinghe & Alexandre (2008) studied the overall level of service (LOS) measures for airport passenger terminals in a single scale according to user perception. Suryani & Chen (2010) studied air passenger demand forecasting and passenger terminal capacity expansion: a system dynamics framework in order to develop a model to forecast air passenger demand and to evaluate some policy scenarios related to runway and passenger terminal capacity. Polak

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(2014) investigated whether the capacity of Schiphol airport and expected demand would balance in the year 2015, and measures that should be taken to accomplish a balance.

The implication from the several studies is that adequate attention had been given to the overall airport capacity in relation to demand, constraints, aircraft flight, and airline choice. This indicates a need for a research that looks at the airport capacity in relation to cargo traffic. Therefore, this study is carried out to assess the adequacy and condition of cargo terminal infrastructure provided by cargo handling companies at Murtala Mohammed International Airport (MMIA), Lagos, Nigeria.

III. Methodology

The study adopts survey research method as a means to collect data from the population for the study. The study is designed to select a sample of respondents from the targeted population for questionnaire administration with quantitative approach to analyse data. The goal of this is to expand the frontier of knowledge in the area of air cargo operations at airports using survey and interview methods. The survey successfully administered questionnaire to 337 respondents to form the sample size for the study. The administration of questionnaire was conducted with the use of simple random sampling technique. The major respondents were cargo agents and customs officers. The focus of the questionnaire is the assessment of the capacity of the cargo terminals at the Murtala Mohammed international airport (MMIA), Lagos. The view of the respondents were sought in terms of the adequacy and condition of the terminals' warehouse, handling equipment, processing shed and storage facilities. There are three cargo terminal at MMIA, which are under the operation of NAHCo Aviance, SAHCOL and DHL.

The questions on the airports' capacity assessment were presented in a 3 point Likert scale to indicate level of respondents' perception of the adequacy and condition of cargo terminals' infrastructure. The choice of the 3 point Likert scale is to capture only the positive polar responses ranking as "fairly adequate, adequate and highly adequate" to measure the adequacy of the airports' terminal infrastructure. For the condition of the infrastructure, 3 point Likert scale showing positive responses of "fairly ok, good and excellent" were used. Only positive responses were sought because the negative polar responses of "inadequacy and "poor condition" do not exist with the airports' terminal infrastructure for cargo handling in practical situation.

The study employed simple descriptive method in the form of charts, percentages and frequencies, Chi Square and Kruskal Wallis tests to analyse data regarding the capacity utilisation at cargo terminals in MMIA. The Kruskal-Wallis or one way ANOVA on ranks is a non-parametric method for testing whether samples originate from the same distribution. It is used for comparing two or more independent samples of equal or different sample sizes. The test statistics of the Kruskal-Wallis analysis the evenness of the distribution of the ranking positions of different groups in the sequence of joint ranks, and if no ties exist it is calculated as follows.

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i - 3(N+1)} \quad (1)$$

where N is the total number of observations.

The Kruskal-Wallis model is calculated when ties exist with.

$$H' = \frac{H}{1 - \sum_{i=1}^{m} \frac{T_i}{(N^3 - N)}} \quad (2)$$

where m is the total number of tied sets.

The significance level (at 0.05) is based on the x^2 distribution, with $k - 1$ degrees of freedom.

IV. Results and Discussion

a) Assessing the Airports' Capacity in Cargo Handling

Infrastructure at cargo terminals are put in place to ensure the capacity of airports to carry out cargo handling services with efficiency. The measurement of airport capacity in cargo operation is determined by the volume of cargo the airport infrastructure can process at a given time. The degree of efficiency of cargo operations is dependent upon time and cost of service delivery. The cost for cargo handling services will increase with increased processing time. This happens when cargo stay longer than required at airport terminal resulting into demurrage, which makes cargo handling services inefficient. The goal of cargo operations at any airport is to ensure timely transit of cargo to its final destination through a network of guaranteed service providers who provide infrastructure capacity for efficient handling.

The level at which the respondents are familiar with the airport's infrastructure in cargo handling in terms of warehouse, handling equipment, processing shed and storage facilities were sought in order to determine the reliability of information provided for the study. Table 1 shows that all the respondents are familiar with cargo operations at the airport. This guarantees that information provided by the respondents can be relied upon for the purpose of the study. The result on the familiarity of the respondents to air cargo operations at MMIA provides the basis for the reliability of the results presented in subsequent tables.

Table 1: Respondents Familiarity with Cargo Operations at MMIA

	Frequency	Percent
Yes	337	100
No	-	-
Total	337	100.0

Source: Authors' Field Survey

Table 2 shows that cargo traffic volume at MMIA can be said to be at average level. This is implied from the results showing about 55% of the respondents indicated that the cargo traffic at MMIA is "average" in relation to the capacity of the airport. It implies that the present level of the airport's cargo traffic volume is not motivating the respondents who were majorly cargo agents and customs officers whose operations and revenue depends on the level of cargo traffic at the airport. The test statistics shows Chi-square (X^2) = 128.356 with 2 degrees of freedom, which is significant at $\alpha = 0.01$ implies that the difference in the view of the respondents for moderate, average and below average cargo volume at MMIA cannot be attributed to chance.

Table 2: Perception of Cargo Volume at MMIA with Chi-Square Statistics

	Percent	Observed N	Expected N	Residual	Test Statistics	
Moderate	39.5	133	112.3	20.7	Chi-Square	128.356[a]
Average	54.9	185	112.3	72.7	Df	2
Below Average	5.6	19	112.3	-93.3	Asymp. Sig.	.000
Total	100	337				

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 112.3

Source: Authors' Field Survey

The implication from Table 2 relates to the result presented in Table 3 indicating that the capacity of the airport in cargo handling is optimally utilised. This accounts for 78% response of the respondents. It therefore implies that the volume of cargo flow at the airport within a given period of time is not beyond the handling capacity of the airport's infrastructure. The Chi-square (X^2) test statistics equals 307.341 with 2 degrees of freedom, which is significant at $\alpha = 0.01$ implies that the difference in the perception of the respondents about the level of capacity utilisation at MMIA as "underutilised, optimally utilised and over utilised" is not due to chance (See Table 3).

Table 3: Perception of MMIA Capacity Utilisation with Chi-Square Statistics

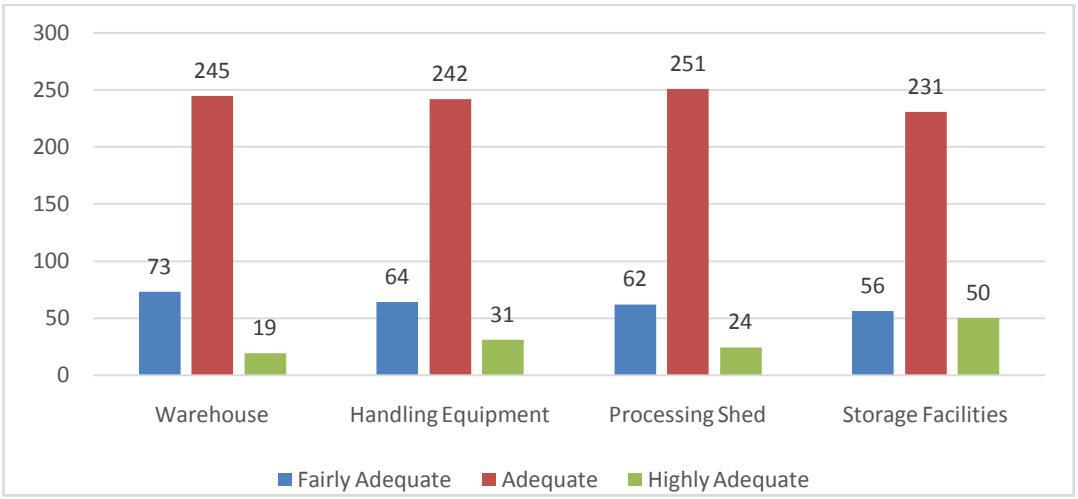
	Percent	Observed N	Expected N	Residual	Test Statistics	
Under Utilised	17.5	59	112.3	-53.3	Chi-Square	307.341[a]
Optimally Utilised	77.8	262	112.3	149.7	Df	2
Over Utilised	4.7	16	112.3	-96.3	Asymp. Sig.	.000
Total	100	337				

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 112.3

Source: Authors' Field Survey

b) Adequacy of infrastructural capacity at terminals of MMIA in cargo handling

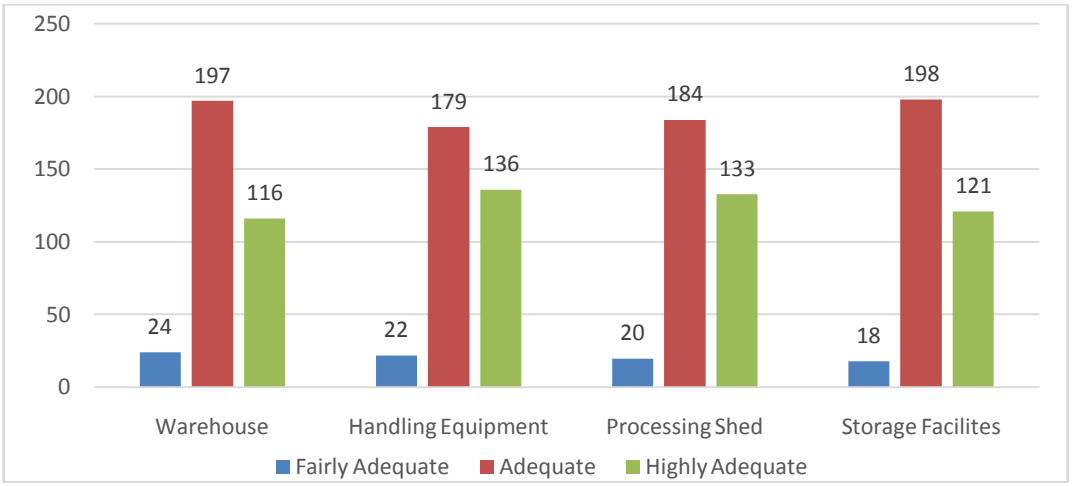
The Murtala Mohammed International airport is managed such that cargo handling services of the airport are carried by two major handling companies alongside the services of DHL. The two major handling companies are NAHCo Aviance and SAHCOL. These companies provide, manage and operate infrastructure for cargo operations under customs authority. The primary operation of the companies is to handle aircrafts and cargo for transhipment. But DHL which functions as both express carrier and integrator handles cargo it mainly carries. The capacity utilisation of the airport to handle cargo traffic assessed in terms of the adequacy and condition of warehouse, handling equipment, processing shed and storage facilities of NAHCo Aviance, SAHCOL and DHL is based on the perception of the respondents about the terminals.



Source: Authors' Field Survey

Figure 1: Adequacy of NAHCo Capacity at MMIA

For the adequacy of infrastructure at NAHCo Aviance terminal, Figure 1 implies that the warehouse, handling equipment, processing shed, and storage facilities are adequate to handle the present cargo traffic. This is accounted for by the responses of the respondents showing that 245, 242, 251, and 231 representing 73%, 72%, 74% and 69% responses respectively for warehouse, handling equipment, processing shed and storage facilities of NAHCo Aviance. The results in Figure 1 indicates that NAHCo Aviance has the capacity to optimally handle the present flow of cargo at the airport. Going by this, it is indicative that NAHCo Aviance is expected to provide efficient handling of cargo at the airport.

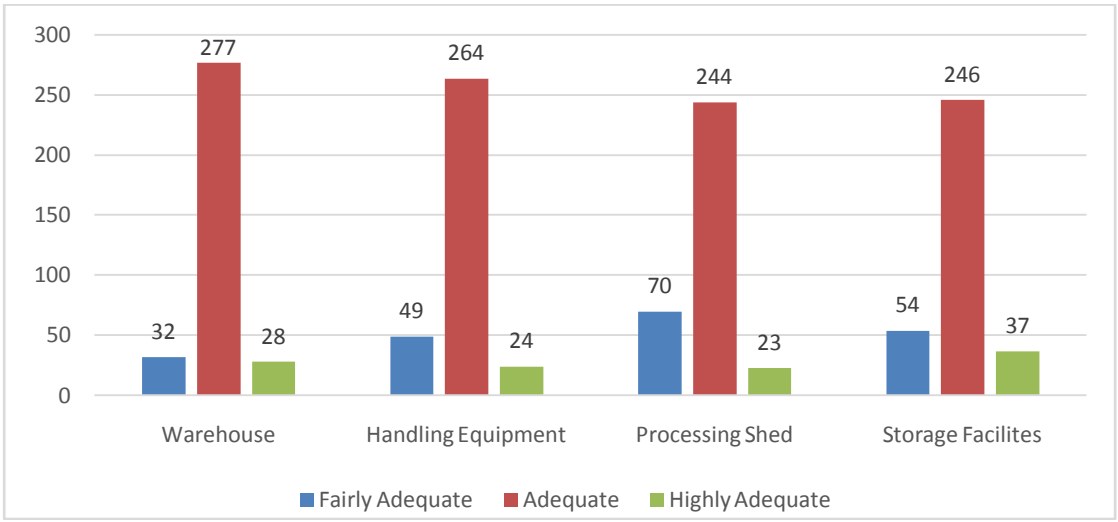


Source: Authors' Field Survey

Figure 2: Adequacy of SAHCOL Capacity

The adequacy of the infrastructure provision by SAHCOL in terms of warehouse, handling equipment, processing shed and storage facilities at the airport is reflected by the results presented in Figure 2. Adequacy of capacity is evident at the terminal. This accounts for the fact that majority of the respondents indicated that warehouse (197 respondents; 58.5%), handling equipment (179 respondents; 53.1%), processing shed (184 respondents; 54.6%), and storage facilities (198 respondents; 58.6%) are adequate to handle the present flow of cargo at the airport. The significance of the respondents who indicated that the infrastructure provision at SAHCOL is "highly adequate" indicates that SAHCOL has the capacity to handle more than it is presently handling. It also implies that SAHCOL will be able to efficiently handle significant increased cargo traffic at the airport in the future without need for capacity expansion in terms of more infrastructure provision.

The adequacy of the capacity at DHL, which majorly handles express cargo and courier at the airport, was assessed with the results presented in Figure 3. This shows that majority of the respondents are of the view that DHL has adequate facilities to handle the present cargo traffic. This is accounted for as 82%, 78%, 72%, and 73% of the respondents identified DHL warehouse, handling equipment, processing shed, and storage facilities to be adequate respectively.

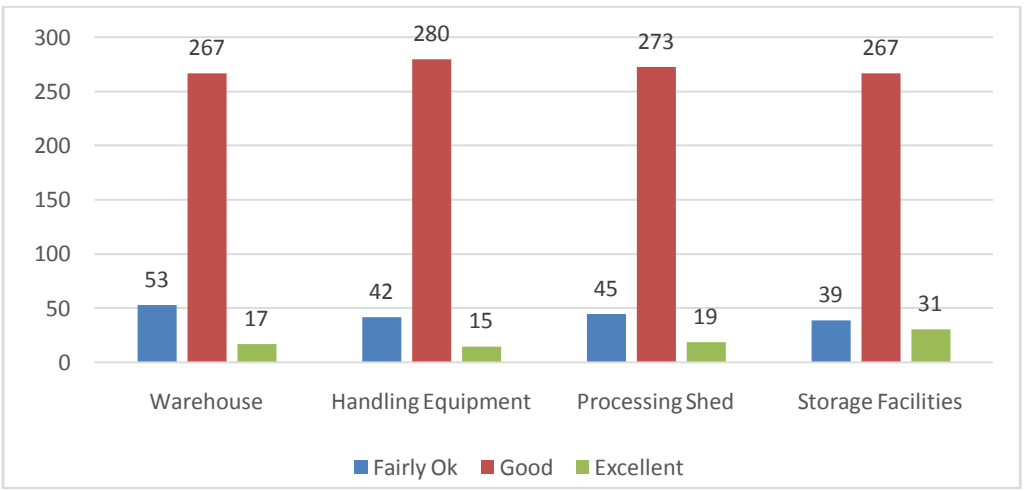


Source: Authors' Field Survey

Figure 3: Adequacy of DHL Capacity

c) Condition of infrastructural capacity at terminals of MMIA in cargo handling

A further assessment of terminal capacity at MMIA in cargo operations looked at the condition of infrastructure provided by handling companies with respect to warehouse, handling equipment, processing shed and storage facilities. The condition of infrastructure provision at NAHCo Aviance terminal can be judged to be "good". This is as a result of the responses of the respondents accounting for 79%, 83%, 81%, and 79% for warehouse, handling equipment, processing shed and storage facilities respectively as presented in Figure 4.

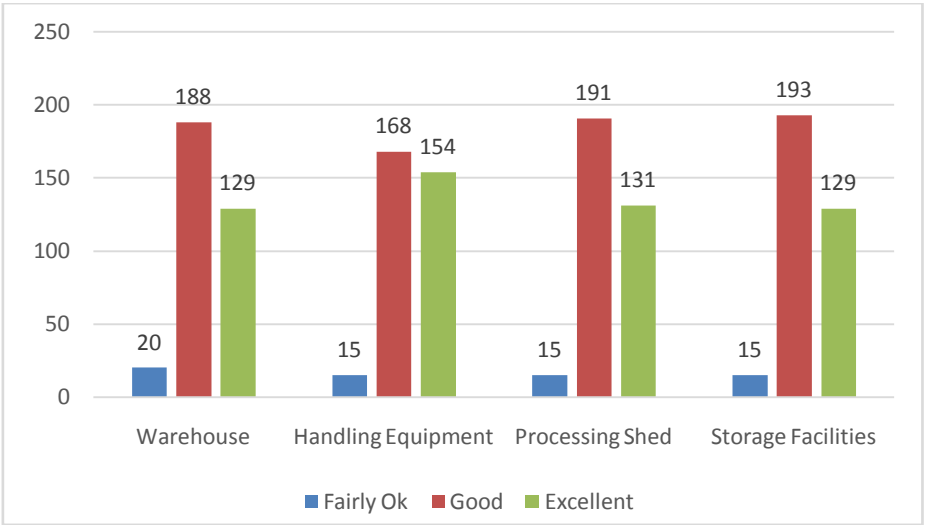


Source: Authors' Field Survey

Figure 4: Condition of Infrastructure at NAHCo Aviance Terminal

The respondents' view of the condition of NAHCo Aviance infrastructure implies that, in the overall, the facilities and equipment at NAHCo Aviance can efficiently handle the present rate of cargo flow. It should be noticed from Figure 4 that very few of the respondents claimed that the condition of NAHCo Aviance infrastructure is excellent. This predicts an implication for NAHCo Aviance in the sense that efficient cargo handling operations may fail with increased cargo traffic in the nearest future.

The condition of the infrastructure provision at SAHCOL cargo handling terminal is seen to be good by majority of the respondents. This arise from Figure 5 showing that 56%, 50%, 57%, 57% of the respondents indicated that the condition of infrastructure at SAHCOL is good. This indicates that infrastructure at SAHCOL terminal is optimally utilised to handle the present flow cargo traffic at the airport.

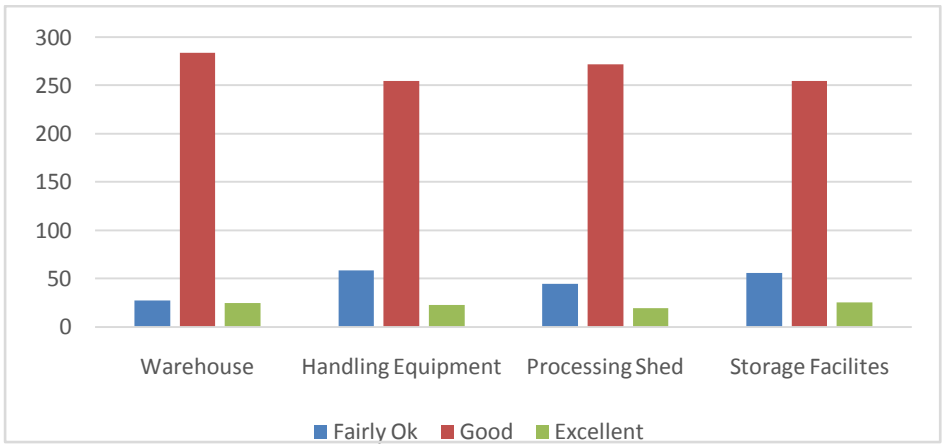


Source: Authors' Field Survey

Figure 5: Condition of Infrastructure at SAHCOL Terminal

However, the uniqueness about the respondents' view of the condition of infrastructure at SAHCOL is the fact that the number of respondents who indicated that the condition of infrastructure at SAHCOL as excellent is significant. This accounts for 38%, 46%, 39%, and 38% for excellent condition of warehouse, handling equipment, processing shed, and storage facilities respectively. The implication of this is that SAHCOL is providing efficient services with an assurance that efficiency of operations will not fail with increased cargo traffic.

The case of the condition of infrastructure at DHL terminal resembles that of NAHCo Aviance. This is from the results presented in Figure 6 showing that majority of the respondents indicated that the condition of warehouse, handling equipment, processing shed, and storage facilities is good. This accounts for 84%, 76%, 81%, and 76% of the respondents view respectively. This implies that DHL is handling cargo volume commensurate with the infrastructure capacity in an efficient manner.



Source: Authors' Field Survey

Figure 6: Condition of Infrastructure at DHL Terminal

d) Infrastructural capacity constraint to cargo handling at MMIA

This study assesses the level of capacity constraint with respect to cargo traffic at MMIA from the perspective of the respondents. The respondents were made to rank their perceived level of capacity constraint for cargo demand at the airport. The data collected were subjected to Kruskal-Wallis (H-Test) mean rank analysis. The Table 4 presents the descriptive results of the analysis showing the airport infrastructure (ware house, handling equipment, storage facilities, and processing shed), the rank levels (fairly constrained, constrained, highly constrained), N, number of respondents, and the mean rank. The high mean rank indicates a more significance.

Table 4: H-Test Descriptive of Infrastructure for Cargo Handling at MMIA

	Levels of Airport Constraint	N	Mean Rank
Warehouse Constraint	Fairly Constrained	142	168.37
	Constrained	145	163.12
	Highly Constrained	50	187.84
	Total	337	
Handling Equipment	Fairly Constrained	142	158.31
	Constrained	145	176.72
	Highly Constrained	50	176.98
	Total	337	
Storage Facilities	Fairly Constrained	142	177.77
	Constrained	145	163.21
	Highly Constrained	50	160.89
	Total	337	
Processing Shed	Fairly Constrained	142	171.82
	Constrained	145	173.39
	Highly Constrained	50	148.26
	Total	337	

Source: Authors' SPSS Computation

It therefore implies that warehouse at MMIA is highly constrained with a mean rank of 187.84. The case of the capacity of handling equipment is unique such that mean ranks of 176.98 and 176.72 is attributed to highly constrained and constrained respectively. The capacity of the airport's storage facilities can be said to be fairly constrained with the highest mean rank of 177.77. The view of the respondents as reflected in the Kruskal-Wallis (H-Test) results for the capacity of processing shed showed the mean ranks of 173.39 for constrained. The results of the Kruskal-Wallis analysis present a situational view about the infrastructure capacity utilisation for cargo handling at MMIA. It reflects that cargo types which require specific handling equipment, and general warehousing are dominant at the airport. And that cargo types which requires storage facilities are fewer in number for handling at the airport. This implies that warehouse and handling equipment at the airport has more cargo volume to handle, which will consequently lead to capacity constraint than storage facilities with less demand.

The H-Test Statistics (Table 5) for the infrastructure capacity constraint at MMIA presented in Table 5 shows whether there is an overall significance difference among the three groups of responses (fairly constrained, constrained, and highly constrained). Notice that the *p*(sig.) values for warehouse, handling equipment, storage facilities, and processing shed account for 0.254, 0.185, 0.321, and 0.216 respectively. These values are greater than 0.05 which is the significant level set for the test statistics. It therefore indicates that there is no significance difference among the groups of responses, that is, fairly constrained, constrained, and highly constrained. This implies that infrastructure capacity of the airport is not constrained in relation to ware house, handling equipment, storage facilities and processing shed are not significantly different in the handling of cargo. The conclusion from the H-Test analysis implies that MMIA has the infrastructure capacity to handle its cargo traffic without constraints.

Table 5: H-Test Statistics[a,b] of Infrastructural Capacity Constraint at MMIA

	Warehouse	Handling Equipment	Storage Facilities	Processing Shed
Chi-Square	2.744	3.380	2.270	3.065
Df	2	2	2	2
Asymp. Sig.	.254	.185	.321	.216

Source: Author's SPSS Computation

V. Conclusion and Policy Implication

This study successfully assessed the infrastructural capacity of cargo terminals in Nigeria using Murtala Mohammed International Airport, Lagos by gathering the views of cargo agents and customs officers regarding the adequacy and condition of warehouse, handling equipment, processing shed, and storage facilities. It is justifiable to conclude from the study that Murtala Mohammed International Airport, Lagos, Nigeria has adequate capacity to handle cargo traffic at its terminals. The adequacy of terminal capacity to handle cargo traffic is a critical means of ensuring

operational efficiency at any airport. The study also showed that cargo infrastructural capacity in terms of the adequacy and condition of warehouse, handling equipment, processing shed and storage facilities at SAHCOL will perform better than NAHCo Aviance in the provision of efficient operations and DHL.

It is evident that efficient cargo operations at airports cannot be achieved without adequate capacity to handle traffic at terminals. In same manner, the condition of infrastructure is paramount to the operational efficiency of cargo handling. To this end, airport management under the control of the Federal Airport Authority of Nigeria (FAAN), need to develop policy to ensure timely upgrade of infrastructure at cargo terminals for adequacy and improved condition. This is necessary since air cargo traffic will continue to increase at airports with regard to increasing population, trade volume and economic activities. Nevertheless, care must be taken to avoid over design of infrastructure such that leads to underutilisation of capacity.

Acknowledgement

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