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An Assessment on Logistics Cost Optimization on Terminal Handling Operations. (A Study on Intels Logistics Services, Onne)

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Abstract: *This study is on an assessment on logistics cost optimization on terminal handling operations with a study on Intels logistics services onne. This work is aimed at assessing the optimization of logistics cost of operations at Onne terminal specifically to various objectives. The research methodology adopted to conduct this study is dependent on the research objectives after the above process of reviewing the related literature and identifying the problem statement. As the data involved for this study are small and restricted to the operating terminal and the berth planning personnel of the terminal operator. This study employs two types of data collection methods; the primary and secondary data. Secondary data was collected, prepared and analysed. The analysis shallassesslogistics cost optimization on terminal handling operations using the various variables (cost, quantity, time of delivery, number of origin and destination),Transportation model was use to analyse secondary data obtained from the company. From the analysis, the result of the five companies operating at the onne port terminal shows that the facilities (storage capacity and the pipes) for the cargo handling operation of the liquid bulk cargo (petroleum product) are efficient. This study explored the transportation model optimization to solve the physical distribution problem (Tora) of cargoes at Onne Port Lighter Terminal, from several vessels at berth in the lighter terminal to various destinations as in storage capacity (depots) in order to get a minimum cost and time for efficient distribution. It was observed that the size of the pipe determines the speed, (litre per hour) and time of discharging the cargo from the vessel at the berth to the storage capacities. It is therefore recommended that the management of the organization should integrate operation research techniques in their decision-making processes.*

Keywords: *Logistics cost, Optimization, Terminal handling equipment, Terminal Operation.*

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I. Introduction

Ever since the development of logistics from 1950s, as a result of the pattern of nationalization and globalization in late decades, the importance of logistics administration has been progressing in various territories. For firms, logistics streamlines the existing production and distribution mechanisms as regards to related resources via administration methods for progressing the efficiency as well as intensity of enterprises (Chang, 1998).

Logistics is characterized as the administration procedure for the development of merchandise crosswise over nation or over the globe. Organizations outline the transportation of their products into a store network, or a way of transport that they utilize over and again to have merchandise sent to them or to clients. At the point when products are moved, they are transported considering a blend of travel strategies that incorporates trains, vessels, trucks, and planes. Organizations utilize logistics in other to manage the planning and area of their products as regards to transport and this being one of their general store network administrations (Hartman, 2013).

Logistics is a mind-boggling discipline with a few distinct fields of accentuation, including acquirement logistics, circulation logistics and creation logistics. Each organization has its own particular one of a kind inventories networks, with profoundly individualized logistics costs. Many organizations utilize logisticians to apply proficient learning to the progressing difficulties of enhancing the logistics inside a production network. They will likely authorize a consistent stream of merchandise or materials through their system of transportation connections and capacity focuses, or hubs, in the most productive and financially savvy way. They likewise get ready for crises, for example, generation delays or concentrated parts or gear transport that are desperately expected to anticipate occurrences, for example, a transportation delay, media communications disappointment or grounded plane (Hartman, 2013).

In many markets, firms contend after some time by minimizing assets with the point of diminishing expenses. In some cases, the expenses of decreasing speculations work straightforwardly on cost. A manufacturer goes into new item improvement or preparing at insignificant expenses to empower more client requests and for the maker, more benefit making. Hence, item improvement can have an indistinguishable extreme impact from direct cost decrease. Truth be told on the off chance that one thinks about the item as the administrations rendered to clients, then item improvement frequently is simply taken a toll lessening.

Not many organizations produce goods that utilizes imported raw materials, while the item producing plants of some organizations are found abroad. Keeping the cost of production low conveying or requesting for basic merchandise in various countries or states allows most organizations to obtain profits but on the other hand, the logistics expenditure that is involved in moving and putting away goods can reduce those profits. Entrepreneurs however, can benefit through understanding logistics, as well as the exact costs involved, as this will increase their competitive advantages while minimizing costs (Hartman, 2013).

In recent worldwide business, seaports or sea transportation assume an essential part of being many countries' real portal for global exchange and are a decent instrument for measuring the financial soundness of a country since extensive volume of cargoes or merchandise is transported utilizing ocean method of transport and thusly it requires terminals with offices to handle such cargoes. (Ogunsiji and Ogunsiji, 2010, UNCTAD, 2008).

Ndikom (2008) posits that, the opposition between terminal administrators and ports, particularly in Nigeria, brought about an intermittent moving of transporters to various terminals or ports so as to keep up cost control, accomplishment of higher profitability and ensured berthing and benefits. The consequence of this is terminal taking care of operations have stayed extremely stable since their presentation with few increments in spite of the adjustments in the ocean cargo rates and extra charges after some time. This is most likely because of lower expenses accomplished through more elevated amounts of efficiency and better contract terms from terminal administrators.

Terminal administrators need to manage their logistics well with a perfect understanding of cost and implementation involved, given that the most cost-effective means of transportation is very slow in terms of movement. Logistics costs incorporate charges for various transportation plans which include trucks, air, sea and train transportation. Further logistics costs include; petroleum, stocking space, security, packaging, protection of goods, taxes and requirements.

In the meantime, terminals' real customers request for steady quality and proficiency at reduced prices. The progressions so far, in the delivery business require terminal administrators and logistics benefit suppliers to consistently improve their implementation and certification regular operations. Particularly, the increasing incorporation of oil terminal in Nigeria and the subsequent higher helplessness of the chains to disturbances in and operations, exert more pressure on organizing and improving the implementation of the diverse parts of the chain. Moreover, more tasks have been given to terminal administrators with the present taking off of fortification costs. During fuel scarcity, vessel make use of ease back steaming keeping in mind the end goal to chop down petroleum costs and fast terminal managing turns out to be more urgent in keeping up vessel turnaround time in the port. In these situation, terminal limit turns out to be rare and rivalry among terminal administrators. Streamlining model will be of an extraordinary improve ideal use and cost minimization of maritime logistics in the terminal business (Sciomachen, Acciaro and Liu, 2009). The study therefore is to assess the extent of logistics operations improvement at the designated terminals on logistics cost optimization of terminal handling operations.

The aim of this study therefore is to assess the optimization of logistics cost of operations at Onne terminal. Specifically, these study objectives are stated:

- To assess the optimal allocation of shipment of cargo between terminal and storage facility.
- To determine the optimal cost of cargo distributed to various storage facilities.
- To assess the capacity utilization of storage facilities for inbound cargoes.
- To ascertain the capacity of cargo handling equipment at the terminal.

II. Material and Methods

The research methodology utilised in other to conduct this study is dependent on the objectives of the study after the above process of reviewing the related literature and identifying the problem statement. At that point, continue to characterize the limit of the exploration with data on problem, goal and extent of the examination. As the data involved for this study are small and restricted to the operational personnel from the operating terminal, the berth planning personnel of the terminal operator and boarding Shipping Agents. Census will be carried out to collect data and information by mean of face to face interviews with the secondary data collected.

This study focuses on Intels that has developed its achievement based upon the establishment of Oil Service Centre's (OSC) philosophy, offering a "One Stop Shop" solution to its customers. Its solutions are specially made parcels of services, port equipment, facilities and customised items for each client. Companies serving the Oil & Gas sector, managing consignments from overseas at Intels bases, have the ability to store the goods in areas chosen by the client, thereby ensuring timely delivery to the final destination.

Integrated logistics service Nigeria limited (intels Nig. Ltd) is located in federal ocean terminal and federal lighter terminal in Onne port complex in rivers state, which happens to be the largest oil and gas free zone in the world. It was not fully utilized and the building was uncompleted, but from 1982 until 1995, when the very first ocean container moored at Federal Ocean Terminal (FOT's) berth No. 1, Intels Nigeria limited renovated it. As a result, this became the only berth for deep offshore support.

The main instruments that was used in collection and gathering of data are personal interview, observation and existed data from Intels service.

This is the first hand data concerning the research at hand. Personal observation is a type of primary data as well as personal interview. The primary data used in this work are as follows:

Some of the explanatory produces are based on the researcher observations and experiences, as he visited various places for on the spot assessment of events for onward inclusion into his findings.

The interview technique involves the meeting at which the researcher asks the respondents series of questions similar to the observations. The researcher undergoes free discussion and face to face conversation with the staffs of the Intels Nigeria limited where the project is being undertaken.

The entire operational staffs of fifteen (15) were interviewed of which all were selected, in other to get intrigue facts about the study.

Pre-Field Work Study;At this point, three tasks were achieved: First, the input output variable as well as data needed was identified via exhaustive literature review and also possible sources of data and key contact individuals was identified. The variables identified to assess the cost minimisation of the Intel services are categorized as cost of distribution; number of origin and destinations, time of delivery, quantity distributed.The second task is preparing the interview question.

Secondary data was sourced from published and unpublished papers, such as seminar papers, Intel Logistics Services annual report, internets, journals, magazines, and conducted research study from Intel Logistics Services Library etc.

Statistical Analysis

The study utilizes transportation model statistics to treat the data collected from secondary source. Secondary data was collected, prepared and analysed. The analysis was toassesslogistics cost minimisation on terminal handling operations using the various variables (cost, quantity, time of delivery, number of origin and destination). Transportation model was used to analyse secondary data obtained from the company. There are numerous ways by which transportation issues may be resolved. This research centred on the least-cost method. This model however dwells on the initial and a feasible solution (that is to say that it must meet all the supply and demand constraints) and also determines the most favourable allocation of limited resources in other not to jeopardise its objectives. The resources may be efficiency performance, time of delivery, terminal handling equipment, and cost of delivery and storage facility. Tora 2.0 version software was used to run the analysis (Taha 2007). Transportation modelling is formulated as

$$\text{Min } Z = \Sigma_{i=1} \Sigma_{j=1} CijXij \quad \textit{Eqn 1}$$

$$\text{S.T. } \Sigma_{j=1}Xij = a_{i,} \text{ for } i = 1,2,\dots,m \quad \textit{Eqn 2}$$

$$\Sigma_{i=1}Xij = b_{j,} \text{ for } 1,2,\dots,n \quad \textit{Eqn 3}$$

$$X_{ij} \geq 0 \text{ for all i and j.} \quad \text{Eqn 4}$$

The feasible solution property: A transportation problem will have a feasible solution if, and only if:

$$\Sigma_{i=1} Si = \Sigma_{j=1} d_j \quad \textit{Eqn 5}$$

Where:

a_i = number of units being provided by source i

dj = number of units being gotten by destinationj

C_{ij} = cost per unit provided from source I to source j

X_{ij} = amount provided from source I to source j

III. Result

The sample comprises of cargo brought to the port through the vessels berthing at various berths at the terminal and storage tank farms of various oil companies operating within the Onne Lighter terminal port, Port Harcourt, Rivers State. This particular sample size was examined as a result of the availability of data together with the recommendations on the smallest sample size needed to estimate the number of parameters in the models being tested (Staat, 2001; Zhang & Bartels, 1998). The utilized secondary data are mostly gotten from various company depots and the main company at the Onne port. The tank farms (depots) are in a distance from the vessel berthing area at the port. They are FORTE Oil Company, SAHARA Oil Company, OANDO Oil Company, TANKS Oil Company and TONIMAS Oil Company. Furthermore, the study focuses on the region operations of the South-South port operational logistics, a case of Onne Port (Onne lighter terminal). Important statistics for the discharge of product in litre per hours relating to the sample are summarized in table1-5 below. Moreover storage/berth input and output capacity and other facilities for cargo handling of bulk liquid cargo are shown in table 6-10 below. The litre of the product per hour is what we are minimizing as our cost. Invariably we are minimizing litre of product per hour during discharging the product from the vessel.

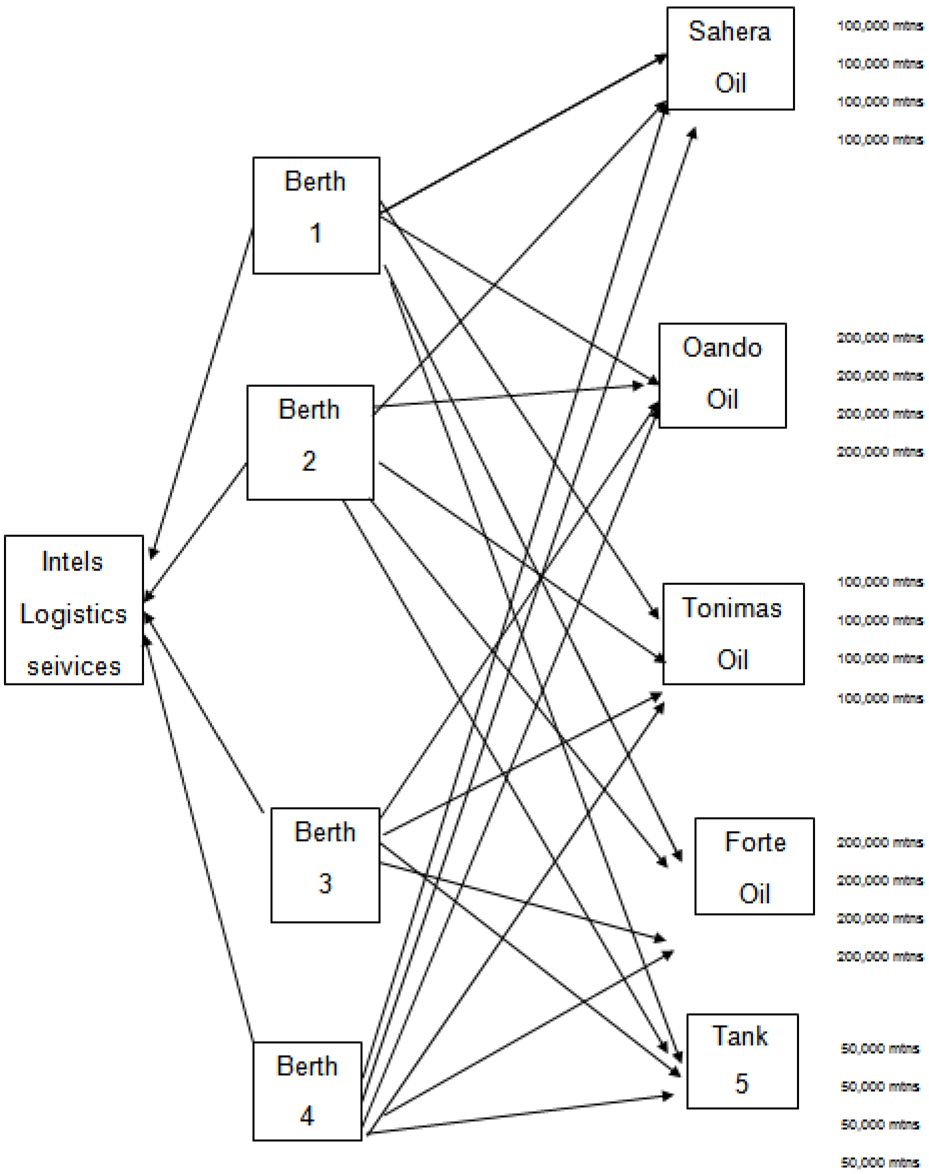

Figure 1. Network representation of Oil Product distribution

Table 1: Time for transportation of bulk liquid cargo per litre for Sahara Oil

Berths	1	2	3	4
1	140	120	145	130
2	70	70	65	90
3	140	135	125	100
4	70	100	80	125

Source: Intels service limited

Table 2: Time for transportation of bulk liquid cargo per litre for Forte Oil

Berths	1	2	3	4
1	140	143	145	140
2	70	78	80	75
3	140	145	142	140
4	140	144	140	145

Source: Intels service limited

Table 3: Time for transportation of bulk liquid cargo per litre for Oando Oil

Berths	1	2	3	4
1	140	148	148	145
2	140	150	145	140
3	140	145	150	148
4	70	75	70	76

Source: Intels service limited

Table 4: Time for transportation of bulk liquid cargo per litre for Tank 5 Oil

Berths	1	2	3	4
1	70	74	78	80
2	71	78	70	75
3	74	75	75	70
4	70	73	76	70

Source: Intels service limited

Table 5: Time for transportation of bulk liquid cargo per litre for Tonimas Oil

Berths	1	2	3	4
1	140	143	145	140
2	70	75	70	75
3	70	68	75	78
4	70	65	70	80

Source: Intels service limited

Table 6: SAHARA Oil Storage capacity and Vessel Capacity

BERTHS	**STORAGE CAPACITY**	**SIZE OF PIPE**	**COST OF BERTHING**	**DISTANCES**	**VESSEL CAPACITY**
BERTH 1	100,000 mtns	4" inches pipe	4,000,000	1000, meters	80,000 mtns
BERTH 2	100,000 mtns	2" inches pipe	4,000,000	800 meters	80,000 mtns
BERTH 3	100,000 mtns	4" inches pipe	4,000,000	700 meters	70,000 mtns
BERTH 4	100,000 mtns	2" inches pipe	4,000,000	400 meters	50,000 mtns

Source: Intels service limited

Table 7: FORTE Oil Storage capacity and Vessel Capacity

BERTHS	**STORAGE CAPACITY**	**SIZE OF PIPE**	**COST OF BERTHING**	**DISTANCES**	**VESSEL CAPACITY**
BERTH 1	200,000 mtns	4" inches pipe	4,000,000	7000, meters	80,000 mtns
BERTH 2	200,000 mtns	2" inches pipe	4,000,000	800 meters	100,000 mtns
BERTH 3	200,000 mtns	4" inches pipe	4,000,000	700 meters	100,000 mtns
BERTH 4	200,000 mtns	4" inches pipe	4,000,000	500 meters	100,000 mtns

Source: Intels service limited

Table 8: OANDO Oil Storage capacity and Vessel Capacity

BERTHS	**STORAGE CAPACITY**	**SIZE OF PIPE**	**COST OF BERTHING**	**DISTANCES**	**VESSEL CAPACITY**
BERTH 1	200,000 mtns	4" inches pipe	4,000,000	1000, meters	150,000 mtns
BERTH 2	200,000 mtns	4" inches pipe	4,000,000	900 meters	100,000 mtns
BERTH 3	200,000 mtns	4" inches pipe	4,000,000	800 meters	100,000 mtns
BERTH 4	200,000 mtns	2" inches pipe	4,000,000	600 meters	100,000 mtns

Source: Intels service limited

Table 9: TANK 5 Oil Storage capacity and Vessel Capacity

BERTHS	**STORAGE CAPACITY**	**SIZE OF PIPE**	**COST OF BERTHING**	**DISTANCES**	**VESSEL CAPACITY**
BERTH 1	50,000 mtns	2" inches pipe	4,000,000	400, meters	300,000 mtns
BERTH 2	50,000 mtns	2" inches pipe	4,000,000	500 meters	400,000 mtns
BERTH 3	50,000 mtns	2" inches pipe	4,000,000	600 meters	500,000 mtns
BERTH 4	50,000 mtns	2" inches pipe	4,000,000	400 meters	50,000 mtns

Source: Intels service limited

Table 10: TONIMAS Oil Storage capacity and Vessel Capacity

BERTHS	STORAGE CAPACITY	SIZE OF PIPE	COST OF BERTHING	DISTANCES	VESSEL CAPACITY
BERTH 1	100,000 mtns	4” inches pipe	4,000,000	800, meters	80,000 mtns
BERTH 2	100,000 mtns	2” inches pipe	4,000,000	500 meters	80,000 mtns
BERTH 3	100,000 mtns	2” inches pipe	4,000,000	060 meters	80,000 mtns
BERTH 4	100,000 mtns	2” inches pipe	4,000,000	700 meters	70,000 mtns

Source: Intels service limited

TABLE 11: Transportation Model Output Summary of Forte Oil
Objective Value (Minimum litres/hr): Min Z= 46,200,000 litres/hr

From	To	Amt Sipped	Obj. Coeff	Obj. Contribution
S1: BERTH 1	D4: STORAGE 4	80000	140.00	11200000.00
S2: BERTH 2	D1: STORAGE 1	100000	70.00	7000000.00
S3:BERTH 3	D4: STORAGE 4	100000	140.00	14000000.00
S4: BERTH 4	D3: STORAGE 3	100000	140.00	14000000.00
S5: DUMMY S	D1: STORAGE 1	100000	0.00	0.00
S5: DUMMY S	D2: STORAGE 2	200000	0.00	0.00
S5: DUMMY S	D3: STORAGE 3	100000	0.00	0.00
S5: DUMMY S	D4: STORAGE 4	20000	0.00	0.00

Source: This Study

From the analysis done using the Tora software, the Vogel approximation result gave only one iteration as shown in appendix A1. More so, the final optimal solution shows various objective coefficients with policy implications which can be derived from table 11 above. From the transportation model output summary of FORTE OIL Company in table 11 above, the total litre per hour of transporting the products at minimal objective value (litre/hour) is 46200000 litre/hour. The result shows that the storage capacity 1, storage capacity 2, storage capacity 3 and storage capacity 4 has a surplus of 100000mtns, 200000mtns, 100000mtns, and 20000mtns of the cargo after receiving the quantity demanded from the vessel at the berth to the storage capacities. That means the vessels capacity is less than the storage capacity. A dummy S variable is therefore introduced to balance the transportation model as the demand is not equal to supply of the product. The storage 4 capacity (depot) is the most cost-effective supply point for vessels at berth 1 and berth 3 for the companies with 80000mtns, and 100000mtns. Furthermore, storage 1, and 3 also were supplied by vessels at berth 2, and berth 4 with cargo of 100000mtns and 100000mtns respectively. This final optimal solution shows how the company can make their distribution and minimize cost and time. Their policy on economic way of distribution can be achieved through this solution. This will enhance the ports and companies to achieve their objective which is optimization of little resources to maximize profit and minimize time and cost.

TABLE12: Transportation Model Output Summary of Sahara Oil Company Result
Objective Value (Minimum litres/hr): Min Z= 5,680,000 litres/hr

From	To	Amt Sipped	Obj.Coeff	Obj. Contribution
S1: BERTH 1	D2: STORAGE 2	8000	120.00	960000.00
S2: BERTH 2	D3: STORAGE 3	8000	65.00	520000.00
S3: BERTH 3	D4: STORAGE 4	7000	100.00	700000.00
S4: BERTH 4	D1: STORAGE 1	50000	70.00	3500000.00
S5: DUMMY S	D1: STORAGE 1	50000	0.00	0.00
S5: DUMMY S	D2: STORAGE 2	92000	0.00	0.00
S5: DUMMY S	D3: STORAGE 3	92000	0.00	0.00
S5: DUMMY S	D4: STORAGE 4	92000	0.00	0.00

Source: This Study

From the analysis using Tora software, the Vogel approximation result gave four iteration as shown in the appendix A2-A5. More so, the final optimal solution shows various objective coefficients with policy implications which can be derived from table12 above. Iteration 1, 2, 3, and 4 shows the objective value as 6555000liter/hour, 6355000liter/hour, 6180000liter/hour, and 5680000liter/hour respectively. From the transportation model output summary of SAHARA OIL Company in table 4.12 above, the total litre per hour of transporting the products at minimal objective value (litre/hour) is 5680000 litre/hour. The result shows that after supplying the cargo from the vessels at berth 1, 2, 3, and 4, there was surplus demand for cargo at the storage capacity. Thereby a dummy variable will be created for storage capacity 1, storage capacity 2, storage capacity 3 and storage capacity 4 to accommodate the surplus of 50000mtns, 92000mtns, 92000mtns, and 93000mtns at zero time during transportation of the cargo. That means the vessels capacity is less than the storage capacity. This dummy S variable that is introduced is used to balance the transportation model as the demand is not equal to supply. The storage 1 capacity (depot) is the most cost-effective supply point for vessels at berth 4 for the company with 50000mtns. Furthermore, storage 2, 3, and 4 were supplied by vessels at berth 1, 2 and 3 respectively with cargo of 8000mtns, 8000mtns and 7000mtns respectively. This final optimal solution shows how the company can achieve their distribution and minimize cost and time. The policy on economic way of distribution can be achieved through this solution. This will enhance the ports and companies to achieve their objective which is optimization of little resources to maximize profit and minimize time and cost.

TABLE 13: Transportation Model Output Summary of Oando Oil Company Result
Objective Value (Minimum litres/hr): Min Z= 56,250,000 litres/hr

From	To	Amt Sipped	Obj.Coeff	Obj. Contribution
S1: BERTH 1	D1: STORAGE 1	100000	140.00	14000000.00
S1: BERTH 1	D4: STORAGE 4	50000	145.00	7250000.00
S2: BERTH 2	D4: STORAGE 4	100000	140.00	14000000.00
S3: BERTH 3	D1: STORAGE 1	100000	140.00	14000000.00
S4: BERTH4	D3: STORAGE 3	100000	70.00	7000000.00
S5: DUMMY S	D2: STORAGE 2	200000	0.00	0.00
S5: DUMMY S	D3: STORAGE 3	100000	0.00	0.00
S5: DUMMY S	D4: STORAGE 4	50000	0.00	0.00

Source: This Study

Analysing OANDO oil company's data using Tora software, the Vogel approximation method result gave four iteration as shown in the appendix A6-A9. More so, the final optimal solution shows various objective coefficients with policy implications which can be derived from table 13 above. Iteration 1, 2, 3, and 4 shows the objective value as 57000000liter/hour, 56750000liter/hour, 56750000liter/hour, and 56250000liter/hour respectively. From the transportation model output summary of OANDO OIL Company in table 4.13 above, the total litre per hour of transporting the products at minimal objective value (litre/hour) is 56250000 litre/hour. The result shows that after supplying the cargo from the vessels at berth 1 were supplied to storage 1 capacity and storage 4 capacities, vessels at berth 2 and 3 were supplied to storage 1 and storage 3 capacities, after the supplies, there was surplus of demand for cargo at the storage capacity. Thereby a dummy S variable will be created for storage capacity 2, storage capacity 3, and storage capacity 4 to accommodate the excess demand of 200000mtns, 100000mtns, and 50000mtns at zero time during transportation of the cargo. That means the storage capacity is more than the vessel capacity at the berth. This dummy variable that is introduced is used to balance the transportation model as the demand is not equal to supply. The storage 1 capacity and storage capacity 4 are the most cost-effective demand point for vessel at berth 1, 2 and vessel at berth 3 for the company with 100000mtns, 100000mtns, 50000mtn and 100000mtns respectively. Furthermore, storage capacities 3 were supplied by vessel at berth 4 with cargo of 100000mtns. This final optimal solution shows how the company can achieve their distribution and minimize cost and time. The policy on economic way of distribution can be achieved through this solution. This will enhance the ports and companies to achieve their objective which is optimization of little resources to maximize profit and minimize time and cost.

Table 14: Transportation Model Output Summary of Tanks Oil Company Result
Objective Value (Minimum litres/hr): Min Z= 14,150,000 litres/hr

From	To	Amt Sipped	Obj.Coeff	Obj. Contribution
S1: BERTH 1	D1: STORAGE 1	50000	70.00	3500000.00
S1: BERTH 1	D2: STORAGE 2	0	74.00	0.00
S1: BERTH 1	D5: DUMMY D	250000	0.00	0.00
S2: BERTH 2	D3: STORAGE 3	50000	70.00	3500000.00
S2: BERTH 2	D5: DUMMY D	350000	0.00	0.00
S3: BERTH 3	D4: STORAGE 4	50000	70.00	3500000.00
S3: BERTH 3	D5: DUMMY D	450000	0.00	0.00
S4: BERTH 4	D2: STORAGE 2	50000	73.00	3650000.00

Source: This Study

Based on the analysis TANKS oil company's data using Tora software, the Vogel approximation method result gave five iteration as shown in the appendix A10-A14. More so, the final optimal solution shows various objective coefficients with policy implications which can be derived from table 14 above. Iteration 1, 2, 3, 4, and 5 shows the objective value of 14500000liters/hour, 14250000liters/hour, 14250000liters/hour, 14150000liters/hour and 14150000liters/hour respectively. From the transportation model output summary of

TANKS Oil Company in table 14 above, the total litre per hour of transporting the products at minimal objective value (litre/hour) is14150000liters/hour. The result shows that after supplying the cargo from the vessels at berth 1 has excess cargo to supply. Because the demand from the storage capacity less, 50000mtns was supplied to storage capacity 1, 0 to storage capacity 2 from vessel at berth 1. The 250000mtns excess cargo at berth 1 was now supplied to a dummy D storage capacity to accommodate the excess cargo. Vessel at berth 2 supplied 50000mtns and still has excess cargo of 350000mtns. This leads to the creation of dummy variable to accommodate the excess cargo. More so, cargo form vessel at berth 3 were supplied to storage capacity 4 with 50000mtns, also have an excess cargo of 450000mtns. Because of this excess cargo, a dummy variable is formed to accommodate the cargo. Cargo from vessel at berth 4 was supplied to storage capacity 2 with 50000mtns. This dummy variable that is introduced is used to balance the transportation model as the demand is not equal to supply. The storage capacities of the TANKS Oil are not cost-effective demand for vessel at berth 1, 2, 3 and 4 respectively. This final optimal solution shows how the company can achieve their distribution and minimize cost and time. The policy on economic way of distribution can be achieved through this solution. This will enhance the ports and companies to achieve their objective which is optimization of little resources to maximize profit and minimize time and cost.

Table 15: Transportation Model Output Summary of Tonimas Oil Company Result
Objective Value (Minimum litres/hr): Min Z= 26,890,000 litres/hr

From	To	Amt Sipped	Obj.Coeff	Obj. Contribution
S1: BERTH 1	D4: STORAGE 4	80000	140.00	11200000.00
S2: BERTH 2	D3: STORAGE 3	80000	70.00	5600000.00
S3: BERTH 3	D1: STORAGE 1	50000	70.00	3500000.00
S3: BERTH 3	D2: STORAGE 2	30000	68.00	2040000.00
S4: BERTH 4	D2: STORAGE 2	70000	65.00	4550000.00
S5: DUMMY S	D1: STORAGE 1	50000	0.00	0.00
S5: DUMMY S	D3: STORAGE 3	20000	0.00	0.00
S5: DUMMY S	D4: STORAGE 4	20000	0.00	0.00

Source: This Study

Analysing TONIMAS oil company's data using Tora software, the Vogel approximation method result gave two iteration as shown in the appendix A15-A16. More so, the final optimal solution shows various objective coefficients with policy implications which can be derived from table 15 above. Iteration 1 and 2 shows the objective value as 26990000liters/hour and 26890000liters/hour respectively. From the transportation model output summary of TONIMAS Oil Company in table 15 above, the total litre per hour of transporting the products at minimal objective value (litre/hour) is 26890000 litres/hour. The result shows that after supplying the cargo from the vessels at berth 1 to storage capacity 4 with 80000mtns, vessel at berth 2 supplied 80000mtns to storage capacity 3, vessels at berth 3 supplied 50000mtns to storage capacity 1 and 30000mtns to storage capacity 2 respectively while vessel at berth 4 supplied 70000mtns to storage capacity 2. After the supplies there was surplus of demand at storage capacity 1, 3 and 4. Because of this, dummy S variable is created to accommodate the cargo with zero time/litre. The dummy S variable that is created is for storage capacity 1, storage capacity 3, and storage capacity 4 to accommodate the excess demand of 50000mtns, 20000mtns, and 20000mtns at zero time during transportation of the cargo. That means the storage capacity is more than the vessel capacity at the berth. This dummy variable that is introduced is used to balance the transportation model as the demand is not equal to supply. The storage 1 capacity and storage capacity 2 is the most cost-effective demand point for vessel at berth 3 and vessel at berth 4 with cargo of 30000mtns and 70000mtns respectively. This final optimal solution shows how the company can achieve their distribution and minimize cost and time. The policy on economic way of distribution can be achieved through this solution. This will enhance the ports and companies to achieve their objective which is optimization of little resources to maximize profit and minimize time and cost.

IV. Discussion of Findings

From the analysis, the result of the five companies operating at the Onne port terminal shows that the facilities (storage capacity and the pipes) for the cargo handling operation of the liquid bulk cargo (Petroleum product) are efficient. The ones that are efficient and costs/time minimization in optimizing the quantity of product demand and supplied are SAHARA Oil Company, FORTE Oil Company, OANDO Oil Company and TONIMAS Oil Company. While TANKS Oil Company cargo handling equipment is not enough to handle their cargoes. This is because during the analysis, SAHARA Oil Company, FORTE Oil Company, OANDO Oil Company and TONIMAS Oil Company storage capacity, pipes and flow station with the pressure of the facilities were able to accommodate the cargoes and as well have excess which made the company to create a Dummy S variable. But on the other hand, the TANKS Oil company storage capacity was not enough to store the cargo (petroleum product) because of low storage capacity; this led to the creation of Dummy D to accommodate the excess cargo (product) supplied from the vessels at berth 1, 2, 3, and 4. This dummy D will attract a zero cost/time. Policy implication is that if the Onne port follows the order of distribution as analysed using Tora software, they will always optimize their distribution of the products on time, thereby reducing waiting time at the port. Therefore, they should follow the final output summary analyses to discharge their cargo, because this will enhance inbound logistics in the port.

V. Conclusion

This study explored the transportation model optimization to solve the physical distribution problem of cargoes at Onne Port Lighter Terminal, Port Harcourt from several vessels at berth in the lighter terminal to various destinations as in storage capacity (depots) in order to get a minimum cost and time for efficient distribution. The transportation problem was formulated as a linear programming problem, and solved with Tora 2.0 version software to obtain the optimal solution, using Vogel's approximation method (VAM). Significantly, cost and time savings can be achieved using the models developed for determining the most economical methods of moving goods from different sources to different destinations. It was observed that the size of the pipe determines the speed, litre and time of discharging the cargo from the vessel at the berth to the storage capacities.

It is therefore recommended that the management of the organization should integrate operation research techniques in their decision-making processes. There is also a need to pay more attention to re-order levels in order to avoid surplus supplies which can lead to deficit in the future. There is equally a need for rational decisions on the transportation costs/time associated with each depot, using this outcome of this study as a guide.The management of the organization should equally increase the size of pipes which is in turn improve effectiveness in terms of speed and increase the turnaround time of vessel.

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