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Constraint Theory Approach Analysis of the Nigerian Shipbuilding Industry

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Abstract: Nigeria has been unable to develop a viable ship building industry over the years notwithstanding several efforts of government at achieving that. The study aimed to identify and determine the principal component constraints to ship building development in Nigeria. Adopting the theory of constraint approach, survey research design was used in which primary data were obtained from questionnaire responses from employees and management staff of shipyards in the ship building clusters in Lagos, Port-Harcourt and Warri. The data collected were analyzed using principal component factor analysis, analysis of variance and pie-chart. It was found that the principal component constraints to the development of the ship building sector in Nigeria include financial constraint with Eigen value of 31.23%, infrastructural constraint with Eigenvalue of 26.35% and poor skill and technical know-how with Eigen value of 16.23%. This implies that financial constraints, poor skill and lack of technical know-how and infrastructural constraints contribute a cumulative Eigen value of 74.259% and thus constitute the dominant constraints impeding the performance of ship yards, ship building and repair sector in Nigeria. Development of national ship building and dry-docking funding scheme, ship building research and training center among other things were recommended.

Keywords: Constraints, ship-building, development, Nigeria

1. Introduction

The Ship building sector is viewed as vital in the development process and coastal states economies. Constraints however hinder ship building development process in many developing countries such as Nigeria. Reference [1] explains that a dockyard now more aptly addressed as a Shipyard is a place

where all kinds of marine vessels are build and / or repaired. Marine vessels are very vast in category and it includes Container and bulk ships, warships, submarines, Oil rigs, passenger / cruise ships, boats, pontoons, frigates and all such types of ships. Ship yards are directly involved in the building, demolition/recycling and repairs of all marine vessel types as identified above [1].

Many coastal countries such as Australia, Brazil, China, Croatia, Denmark, Finland, France, Germany, India, Japan, the Netherlands, the Philippines, Poland, Romania, Russia, Singapore, South Korea, Sweden, Taiwan, Ukraine, and Vietnam have over the years developed their ship building and repair sector to the extent that they are now involved in the construction of complex state-of-the-art sea going vessels from large ship yards [2,3]. Asia continent with less number of but bigger and more complex ship yards than Europe which tends to have number of smaller ship yards. These countries by virtue of the ship output and productivity of their ship yards prove to have to a greater extent mastered and surmounted the principal challenges to the development of their ship building sectors; the same cannot be said of Nigeria and West African coastal nations.

Recognizing the importance and potentials of the ship building sector in gingering economic development and growth, the Federal Government of Nigeria in 2013 approved N58.6 billion ($369 million) fund for development of a ship yard in Warri[2,4]. The Government stated that an initial N40.2 billion ($253.2 million) was approved for the delivery of ship building equipment and another N18.4 billion ($115.9 million) for structural engineering works for the ship yard [4]. The existence of deficit in the ship building industry, was found to cost millions of dollars in overseas import of vessel by Nigeria [2]. It is understandable by the report that the government understood the current lack of capacity by Nigeria in the ship building, recycling and repair sector [4]. However, commitment by the government to the development of the sector remain a challenge as even the cabotage vessel finance fund (CCVF) established to handle same ship acquisition challenges in the industry over the years has remained unimplemented. The project is however yet to be realized as there seems to be a subsequent government policy which reversed the investment decision. Reference [5] notes that the ship building sector has the capacity to support economic development and local content development in Nigeria's maritime sub-sector; the problem however is that the principal challenging hindrances and bottlenecks to the development of the shipbuilding sector and ship yards in Nigeria and West Africa are yet to be determined and addressed.

In the views of the Theory of Constraints [6], the extent of achievement of set objectives by an entity, organization and/or system is limited by at least one/few principal constraint(s). One may argue in the light of the above that the achievement of the goal of developing viable ship yards and ship building sector in Nigeria is being limited by at least one or few principal constraints which must be surmounted

or eliminated in order that the sector may achieve the much-needed development. Various studies have identified some major constraints and challenges to the development of ship building in different countries of the globe and in Nigeria. For example, funding, lack of skill and technical know-how, excessive taxing, bureaucratic and regulatory challenges, poor market patronage, lack of infrastructure and ship research centers, cost and pricing constraints among others have been identified to constitute challenges to shipping yard operations and performance in Nigeria and other counties [7]. Nigeria faces a challenge of developing indigenous capacity in ship construction, repair and demolition/recycling. However, it is understandable that since several ship yards exists in different regional clusters in Nigeria, what constitute a constraint to one ship yard, may be an advantage to another. Thus finding a common variable/factor that constitutes the major/principal component factor that constrains the performances of majority ship yards in Nigeria is a need that has not been adequately addressed. There is therefore need to first identify what constitute principal common constraints to majority ship yards in Nigeria and the significance of each constraints in the plurality of challenges that the ship building, demolition/recycling and repair industry faces in Nigeria. It is also important to note that the solution to the major constraints of the ship yards in Nigeria may not be achieved without the involvement of the ship yards themselves. Involving the ship yards therefore requires that they develop relationships that will seek to correlate their individual challenges so that unified solution becomes achievable at the industry level which will equally guarantee that individual constraints of the ship yards are addressed. The aforementioned problem can be addressed by applying the theory of constraints (TOC) developed [6] in the ship building clusters identified in the various regions of Nigeria. The study therefore aims to determine the principal constraints to ship yard performances and ship building development in Nigeria; and to compare the percentage influences of the principal constraints to ship yard performances and ship building development in Nigeria.

It is the objective of Nigeria as a coastal state to develop a veritable and successful ship building and repair industry in view of the maritime endowment of the country so as to create massive employment for the people and diversify the economy through ship building for local use and export; constraints in forms of impediments and hindrances have over the years however challenged and retarded the drive of the government and the private sector operators from developing a viable ship building industry in Nigeria. The Constraints to ship building operations in Nigeria therefore represent challenges which have hindered the capacity of Nigeria to build vessels for local use and export [8,9]. The study thus was able to identify the major component constraints to ship building development in Nigeria using the major component factor analysis and it compared the differences in percentages of constraints posed by each factor. The table below (see Table 1) identifies some constraints and/or

bottlenecks that challenges ship production processes in West Africa as summarized in various literatures.

Table 1 Classification of some identified constraints/bottlenecks to ship building operations in ship yards. Source: authors

Bottleneck	Example
Physical infrastructural Bottlenecks	Non-availability/poor condition of ship building and repair facilities and research centers, equipment crunch/ unavailability, poor and non-optimal layout and design of existing infrastructure that limits job flow and productivity, employee and exposure to physical hazards, in the workplace, space crunch etc.
Policy Bottlenecks	Non- availability of /Poor Government Regulations, Lack of blue print for the development of the sector, government policy inconsistency problems, poor company policies and procedural problems, etc.
Marketing and market related Bottlenecks	Poor Sales, Poor patronage for ship repair and recycling jobs, supply cost challenges, low demand new building contracts, globalization induced competition for market share, differential costs and prices induced by market forces, etc.
Human related bottlenecks	poor employee skills and technical know-how, poor management skills and strategies, training challenges and non-availability of institution teaching and impacting skills on naval architecture and ship building cum repair, etc.
Operational bottlenecks	Use of crude implements and technology which impede quality of output, poor job design and facility layout, poor ship yard operations planning management strategies, time management constraints, etc.
Financial constraints	Lack of investment capital for ship building development, lack of easy access to credit facilities by ship yards, Non-existence of any viable public funding programme for ship building and ship yard development in Nigeria, Non-existence of any maritime bank or financial institution specialized in maritime finance and funding of ship building projects, high insurance costs, high costs of operation, etc.
Environmental bottlenecks	External and internal environmental constraints, challenges of environmental hazards posed by ship building and recycling operations and occupational accidents in work places, etc..

In the views of [10] a constraint is a factor that hinders and /or limits a firm, an organization or a system from achieving its set objectives and goals. A system in this case is an entity (complex entity) with inter-related components working and interacting together to achieve set objectives and goals. For example, NIGER DOCK as a ship yard is an entity comprising interacting components, departments and activity areas that each contribute to the output and performance of NIGER DOCK as a ship building and repair entity in Nigeria. The Nigeria ship building and repair industrial sector also exists as an entity with each existing ship building and repair yard/company (shipbuilding clusters) form a component part of the industry. Constraints in this sense are therefore bottlenecks that limit the developmental and output improvement drives of each component ship yard in the system or the entire ship building industrial sector in Nigeria. According to [10], constraints can erupt and present itself in many forms in a system; but the theory of constraint assert is that all the constraints cannot pose the same level of risks or put the same level of influences on the organization or system. There must be at least one or few principal constraints that pose the greatest risk in any given system; this could be internal or external to the firm, organization or system [10]. It is internal constraint when it is inherited from within the firm, organization or system and is external when it is caused by outsize elements that the firm, organization or system may not be able to exercise direct control over it [10,11]. Reference [11] explains that the idea drive is to try to increase the output and productivity from the constraint

using what's already available. Since idle time in the bottleneck/constraint reduces overall output and productivity, we need to eliminate non-value adding or utility creating work, limit process interruptions, provide great tools and materials, or prioritize work. [11] views the process of identifying and managing constraints in a system as a cycle. According to [11] output and productivity improvements are rarely one-time fixes; as a result, firms need to continuously remove constraints and bottlenecks and improve productivity. The cycle like approach of removing and managing the constraints as explained above is what [11] called the Five Focusing Steps (FFS). The FFS approach to constraint removal and /or management is illustrated as shown below (see Fig.1):

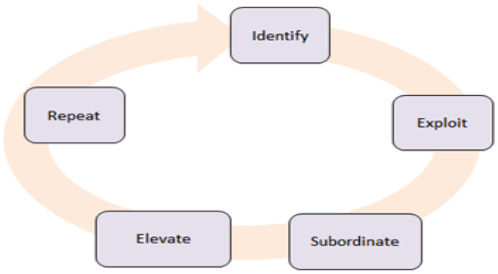

Fig. 1 The five focusing steps of the theory of constraints. Source: authors according to [6]

The five focusing steps aim to ensure that efforts put in by organizations to manage their constraint(s) to improve productivity and ensure development. The theory of constraint (TOC) refers to this as the 'process of ongoing improvement (POOGI)' [6]. Theory of Constraints constraint is thus used as a tool for driving up a firm's productivity and performance by limiting the influences of identified constraints on the operations of the firm. Further details and explanation on this principle is given in the theory of constraints under the theoretical review.

2. The Theory of Constraint (TOC)

The theory of constraints (TOC) is a project management tool which opines that all manageable projects and systems are capable of being limited from adequately achieving its set objectives by a few constraints [6]. It states that there is at least one principal constraint that inhibits a system from fully achieving its objectives. The TOC therefor concentrates efforts at identifying the principal constraint and restructuring the rest of the organization from being hindered from fully achieving its set objectives. This means that processes, organizations, systems etc., are vulnerable since the weakest non-performing or negatively performing component of it can always cause damage and stop the system and /or organization from maximizing productivity and/or performance. The theory of constraints (TOC) is viewed an overall management philosophy developed by E. M. Goldratt in a book

titled ‘The Goal’. It aims to help organizations continually reach their goals by adopting a management strategy that helps them to deal with the worst identified constraints. [6]. Reference [10] states that to fully meet a target objective; conditions exist that must be met in the first place. Some of these conditions may include but not limited to: initial investment, regulatory and legal obligations, safety, etc., thus any of the condition not properly and adequately met constitutes constraints to the target of maximization of throughput and productivity improvement. For most private businesses like ship building, the objective is to maximize profit; for other firms, making profit may be a necessary step for driving towards other objectives. For example ship building industry is a multimillion dollar capital intensive and technology driven industry and a foreign currency earner for ship building countries. It equally creates massive jobs that aids in boosting the GDP of ship building countries empowering such countries above others in the political and economic exploitation of the oceans and sea trade to their greater advantage. But to develop the ship building industrial sector which is largely driven by private sector investments and position Nigeria for example as a ship building, recycling and repair giant, the privately owned ship yards must first be able to make profits and survive the vicissitudes of the trade; it is the survival of the private ship yards through sustained profit earnings that will subsequently ensure the growth of the ship building sector and emergence of Nigeria as a ship building nation at the long run. One may thus argue that the achievement of the goal of developing viable ship yards and ship building sector in Nigeria is limited by at least one or few principal constraints which must be surmounted in order that the sector may achieve the much-needed development. The argument by [11] is that if there was nothing preventing a firm, organization, industry or system from achieving the highest level of performance and productivity; its performance and productivity will take values up to infinite. This has however been proved to be impossible in a real-life setting for reason that production processes are fraught with constraints. Suffice it to say that if the ship building and repair industry is Nigeria is not fraught with bottlenecks and constraints, the productivity and development of the sector would be infinite. The very poor and undeveloped form in which it currently exists, suggests the prevalence of principal constraints which must be adequately addressed in order that growth may commence in the sector. High import duties, tariff and other fiscal policies constitute major challenges that has crippled ship yards and ship building investments in Nigeria and scared away potential investors in the sector [12,13]. In a study carried by reference [14] in Bangladesh in which questionnaires were administered to employees of 124 registered ship yards in the country; it was identified that the major constraints challenges and problems that impede the development of the ship building and repair sector in Bangladesh to include: Technical problems, Management constraint, financial constraints, and Infrastructure constraints, among others. In conclusion, the study concluded

that in spite of having very promising ship yards holding prospects and opportunities for the development of the ship building and repair sector, the sector in Bangladesh has not kept pace with global trends due the plethora of constraints and challenges identified above [14,15].

3. Data and Methods

The study used a survey design approach to identify the major component constraints to the performance of the ship yards in all the identified ship yard clusters in Nigeria and used as sample one ship yard each from the three ship building clusters in Lagos, Port-Harcourt and Warri; and used the three ship yards namely NIGER DOCK NIGERIA LTD in Lagos, STARZ SHIYARDS in Onne Port-Harcourt and Technitrade shipyard, Warri, Nigeria as case studies.

The instrument of data collection was questionnaire administered to the employees of the three shipyards randomly selected from the three ship building clusters in Nigeria. The questionnaires were randomly administered to the management and operational members of staff of each ship yard to determine what in their opinion constitute the major component constraints to the development of shipyards and ship building in Nigeria. A total of 42 questionnaires were administered to the employees in the operations department and management staff of the ship yards where each ship yard got 14 questionnaires each. The management staff of each company got 10 questionnaires while the employees in the operations department level staff got 4 questionnaires randomly distributed among them. This pattern of distribution is to enable the management staff of the ship yards have greater input in the responses since it is believed that they as management staff understand better what constitute the developmental challenges of the ship yards and ship building than non-management staff. Out of the 42 questionnaires distributed, only 25 representing about 65 percent of the questionnaires were properly filled and returned. The questions were tailored to enable the employees and management of the ship yards identify what constitute the major challenges that ship yards face in Nigeria and to rate in percentages the extent to which each identified constraint impede the performance of ship yards and development of ship building sector in Nigeria.

The data collected were analyzed using statistical tools and models in order that inferences may be drawn from the data collected regarding the research objectives that the research problems may be solved. The statistical method of Principal Component Factor Analysis (PCFA) was used to determine which constraints constitute major component impediments to ship yard performance and ship building development in Nigeria. The method of Analysis of variance (ANOVA) was used to determine if there exist differences in the extent to which the identified major component factors constitute constraint to ship yard operations in Nigeria while the statistical tool of pie chart was used to segment the constraints

to determine the degree of constraint each poses to ship yard operations and development of ship building sector in Nigeria. The analyses were carried out by employing the SPSS analytical software version20.

4. Results and Discussion

The result of the principal component factor analysis presented above (see Table2) indicates that three constraints constitute the principal constraints to or major components challenges facing ship yards and ship building development in Nigeria. These principal components of the constraints performance of ship yards in Nigeria as shown by the result of the PCFA include Financial constraint with Eigen value of 31.23%, infrastructural constraint with Eigen value of 26.35% and poor skill and technical know-how with Eigen value of 16.23%. This implies that financial constraints, poor skill cum lack of technical know-how and infrastructural constraints contribute a cumulative Eigen value 74.259% and thus constitute the principal/major component and dominant constraints and challenges impeding the performance of ship yards and development of the ship building and repair sector in Nigeria. Beside the major component constraints as identified above, the Eigen values indicating the percentages of constraints imposed by high operating cost, management inefficiency in ship yards, poor marketing strategies, quality constraints and pricing constraints are 9.172%, 7.778%, 5.096%, 3.325% and 0.370% respectively.

Table 2 Result of the principal component factor analysis (PCFA). Source: authors

Communalities[a]		
Constraints	Initial	Extraction
FINANCIAL	1.000	0.868
SKILL	1.000	0.694
MGT	1.000	0.752
COST	1.000	0.675
QUALITY	1.000	0.730
PRICE	1.000	0.563
MARKETING	1.000	0.754
INFRASTRUCTURE	1.000	0.904
Extraction Method: Principal Component Analysis.		

Total Variance Explained[a]						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.531	31.639	31.639	2.531	31.639	31.639
2	2.109	26.357	57.995	2.109	26.357	57.995
3	1.301	16.264	74.259	1.301	16.264	74.259
4	0.734	9.172	83.431			
5	0.622	7.778	91.209			
6	0.408	5.096	96.305			
7	0.266	3.325	99.630			
8	0.030	0.370	100.000			
Note: Extraction Method: Principal Component Factor Analysis.						

Pricing therefore is the least factor that could be considered as posing constraint to ship yard operations in Nigeria. Aside, the three major components determined by the PCFA, high operating cost follows as a constraint that impedes ship yard performance in Nigeria. The levels of influence of these constraints on ship yard operations in Nigeria can be shown in the bar graph below (see Fig. 2):

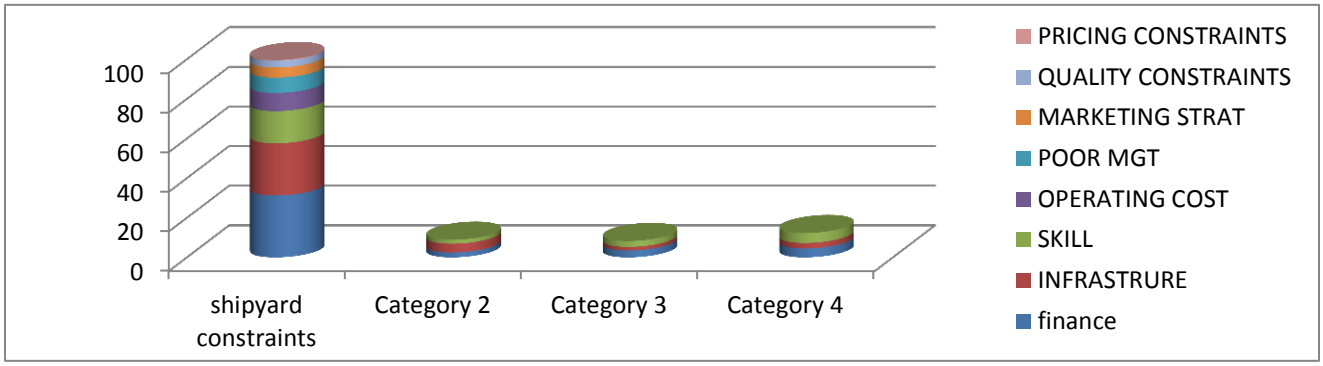

Fig. 2 Component bar chart showing the magnitude of constraint posed by each factor. Source: authors

5. Measuring the Degree of the Influence of the identified Constraints to Ship yard Operations and development of ship building sector in Nigeria.

The use of pie-chart to analyze and express degrees of the influence of the identified constraints indicates that financial constraints poses about 112.4 degrees of influence on the development of ship yards in Nigeria. Similarly, the degree of influence of infrastructural constraint is 94.9◦ while the degree of influence of poor skill and technical know-how is 58.5◦. Also high operating cost as a constraint poses a degree of influence of 33.01◦ while the degrees of the influences of management inefficiency in ship yards, poor marketing strategies, quality constraints and pricing constraints on ship yard performance and development of the ship building sector in Nigeria are 28.08 degrees, 18.35 degrees, 12 degrees, and 1.33 degrees respectively. The result of the degree of constraint posed by each identified factor is presented in a pie-chart as shown below (see Fig. 3):

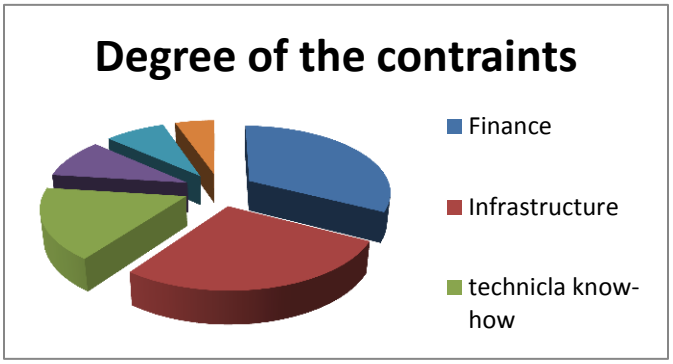

Fig. 3 Pie-chart presentation of the degree of constraints constituted by each factor. Source: authors

The results as shown it the tables above (see Table 3 and Table 4) compares the influences of the identified three principal constraints of funding constraints, lack of adequate ship building infrastructure and lack of requisite ship building skills and technical know-how with a view to determining if significant differences exist in their respective impeding influences. The result indicates an F-score of 18.95, F-critical (F crit) of 4.26, and P-value of 0.00022 at 0.05 level of significance and 24 degrees of freedom.

Table 3 Comparing the significance of the identified principal constraints to the development of the ship building sector in Nigeria. Source: authors

Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Funding constraints	25	920	36.8			
Lack of infrastructure	25	675	27	158.3333		
Poor skills/know-how	25	343	13.72	36.79333		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	1890.52	24	78.77167	0.676994	0.82708	1.98376
Columns	2204.48	1	2204.48	18.94616	0.000215	4.259677
Error	2792.52	24	116.355			
Total	6887.52	49				

Since F-score is greater than F-critical (ie: 18.95 > 4.26) at 0.05 level of significance and 24 degrees of freedom; we conclude that there is a significant difference in the constraining influence of the principal constraints to the development of the ship building, recycling and repair sector in Nigeria. Funding poses the greatest significant constraint followed by lack of infrastructure and skill/technical know-how respectively. The relative implications of this in the TOC and to the public agencies and ship yards is that greater priority should be given to the constraints that poses the greatest significant constraining influences. This means that funding challenges should be considered most devastating constraint, followed by lack of infrastructure, and lastly poor skills and technical know-how.

Table 4 Summary of results and findings. Source: authors

Decreasing order of influence of component constraints to ship yards and ship building development in Nigeria		
s/n	Constraints	% of influence (Eigen Values)
	financial constraint	31.23
	infrastructural constraint	26.35
	poor skill and technical know-how	16.23
	High operating cost,	9.172
	management inefficiency in ship yards,	7.778
	poor marketing strategies	5.096
	quality constraints	3.325
	pricing constraints	0.370

6. Conclusion

The result of the study indicates that principal components constraints to ship yards performance and development of ship building in Nigeria include financial constraint with Eigen value of 31.23%, infrastructural constraint with Eigen value of 26.35% and poor skill and technical know-how with Eigen value of 16.23%. This implies that financial constraints, poor skill and lack of technical know-how and infrastructural constraints contribute a cumulative Eigen value of 74.259% and thus constitute the major component and dominant challenges/constraints impeding the performance and development of ship yards and ship building and repair sector in Nigeria. Thus Government should create a ship building and ship yard fund domiciled with the Central Bank of Nigeria and set up a maritime bank to enable ship yards access funds/loans to improve investment in the sector. To develop the indigenous capacity of Nigeria to build vessels will therefore need government intervention by way of funding since finance has been identified as a dominant/principal factor affecting the development of the sector in Nigeria. Also the development of the ship building sector in Nigeria is dependent on investment in ship building infrastructure. Present realities as shown by the result of the study indicate that poor and inadequate infrastructure remain a major factor impeding ship building development in Nigeria. The only national ship building yard; the NIGER DOCK which already privatized by Government is performing below capacity at present. Government should therefore develop policies and support investment in ship building infrastructure and training in naval architecture and ship building in order to improve the performance of ship yards in Nigeria. There is also the need for the setting up of a ship building research center saddled with the responsibility of carrying out research for the development and advancement of ship building technology and policies in Nigeria. The table below thus presents in decreasing order of impeding influence the levels of constraints posed by each identified factor on the development of the ship building sector in Nigeria. It is evident from the result (see Table 4) of the study that financial constraints, infrastructural constraints, poor skills and technical know-how, constitute the principal dominant constraints to ship yardsperformance and ship building development in Nigeria.

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