

Ship Maintenance and Repair Services in the Tema Drydock and Shipbuilding Yard in Ghana: Some Challenges, Opportunities and Prospects

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Abstract

This article explored existing policies (if any) and current management structure which govern operations within the yard, examine some major challenges facing the ship maintenance and repair services in Tema Drydock and Shipbuilding Yard, Ghana, identified few drivers that impact positively on the ship repair market with particular reference to the Tema Shipyard. It concludes by proposing sustainable management and maintenance strategies for improved repair services of the yard as well as analyzing the findings obtained in the data presentation and discussion sections during the research project. The main finding is that the PSC Tema Shipyard's ship maintenance and repair services are really overwhelmed with major challenges, representing 55% after summing up four (4) out of the seven (7) captured in the study and are threatening its sustainability, if not properly researched and addressed once and for all. As already stated, carefully analysed conclusions were drawn to effectively address these challenges, followed by suggestions for future research to forestall its cascading effects on the Ghanaian economy as a whole.

Keywords

Ghana, Tema, Drydock and Shipbuilding Yard, Repair Services, Challenges, Sustainable Management

1. Background

The search for an economical means to facilitate trade and commerce is dated back in the ancient century. Consequently, it led to the discovery and invention of various equipment, namely ships, airplanes and lorries. With the aid of these equipment, goods and services can be moved from one place to another by three

main modes: by ship, by air and by road depending largely on the factors of geographical location, costs of transport, value, which determine the actual mode. Of all these three types of transportations, shipping industry is the most preferred medium of transportation in the world. Shipping is said to carry 90% of the world's 10.702 billion tonnes of international trade (Alhouli, 2011, p. 43 and UNCTAD/RMT/2018, p. 5) [1] [2] according to United Nations Conference and Trade Development (UNCTAD), this predominance is particularly pronounced in developing countries where trade structures, including the low volumes of intraregional trade, leave limited space for land transport and air transport (UNCTAD/RMT/2018, p. 4) [2].

The growth of the world trade seemingly has a direct correlation with the expansion of the shipping industry. If the world trade grows, it automatically triggered off rapid increase in supply and demand for shipping to carry huge volumes of goods from one node to the other node. As the demand for shipping increases more than the supply, the freight rates also rise hence shipowners and operators will be acquiring and deploying more vessels in order to earn high freight rates.

Yousef Alhouli said: "as the world trade continues to grow, the maritime shipping industry transports the biggest share of the world trade, which has resulted in the expansion of the shipping industry around the globe (Alhouli, 2011, p. 43) [1]".

However, it always has an inevitable disadvantage in shipping. It usually characterizes by shipping cyclicity, bringing about over capacity and low demand when more newbuilds are delivered into the already existing fleet thereby leading to freight rates fall.

Besides, the technological development in the shipping industry has also impacted substantially on ship size and automation development. Today, the technologically advanced shipbuilding yards, have been able to build biggest vessels, because of their economies of scale, which sizes exert enormous pressure on drydocks, seaports and cargo handling facilities. Overall, these trends have thrown many challenges to both shipowners and operators about where and how their ships will be maintained in good working condition for effective performance. They are constantly in search for a shipyard with the capacity and capability to carry out effective and efficient ship maintenance and repair services on their ships to ensure safety of their ships. The answer is maintenance because it is a crucial factor in a ship's performance which can affect the shipping company's revenue (Alhouli, 2011, p. 18) [1].

2. Introduction

Generally, ship maintenance and repair industry is one of the core sectors that contributes substantially to the development of the maritime industry and the world's economy. It does this by generating maximum revenue, creation of employments and transfer of technology through the rendering of effective and ef-

ficient ship repair services to its customers.

Therefore, the sustainable management of shipyards the world over, has occupied the attention of policy makers, planners, engineers, environmentalists and researchers in recent times. While some progress has been made in terms of the contribution of shipyards to national development, the sector has equally been fraught with some challenges (ECORYS Consulting and Research, 2009, pp. 7, 8, 9, 12 and Center on Globalization, Governance and Competitiveness, Duke University, 2017, pp. 9, 52, 53, 54, 70, 71, 73) [3] [4]. Indeed, a growing number of developed economies and emerging economies such as Europe and Asia have been tackling these challenges to create a sustainable shipbuilding and ship repair industry so as to maintain growth of their economies and development (ECORYS Consulting and Research, 2009, pp. 13, 14, 15, 16, 17, 26, 27 and Center on Globalization, Governance and Competitiveness, Duke University, 2017, pp. 71, 72, 73, 74) [3] [4]. Among major steps taken by some of these countries include the installation of modern and efficient advanced technological shipbuilding and repair equipment (Iqba, Zakaria & Hossain, 2010, pp. 148, 149, 151, 152, 153, 154 & 155) [5].

Ghana is no exception in terms of efforts to improve its shipyard management. Like other countries, the sector has received some attention which resulted in expansion and contributing to the growth of the Ghanaian economy and facilitation of other infrastructural development. However, like business entity, the ship repair industry in Ghana, faces numerous global challenges. In a bid to find solutions to these problems, little research attention by Yawson has been directed to the sector (Yawson, 2017, p. 2) [6].

Any planning effort which seeks to address in this sector sustainably needs to be grounded in research to ensure that strategies outlined to address the problems are context specific and not divorced from reality. The thrust of this paper is to contribute to ongoing discussions on sustainable management of the yard by shedding light on pertinent issues and strategies that could help manage the facility for improved service delivery.

2.1. Structure of Paper

The paper is divided into four (4) major sections, namely, introduction, methodology, results and discussion, conclusion, including other equally important sub-sections. The detailed discussions of these individuals major and sub-sections have preceded in this article for clarity and enhancement of the readers' understanding.

2.2. Literature Review

The immense contributions of shipbuilding and ship repair industry to the developed, emerging and least developed economies in the world cannot be quantified but equally face some challenges (ECORYS Consulting and Research, 2009, pp. 7, 8, 9, 12 and Center on Globalization, Governance and Competitiveness,

Duke University, 2017, pp. 9, 52, 53, 54, 70, 71, 73) [3] [4], which persistently retard accelerated development. To effectively deal with these challenges, ship maintenance and repair services must accord experts and research attention to properly researched and addressed them holistically.

Similarly, the Tema Shipyard's ship maintenance and repair services are plagued with some major challenges.

By ECORRYS Consulting and Research "*ship construction includes ship repair (and conversion) and is directed at the larger sea-going vessels, as represented by Community of European Shipyards Associations (CESA) (ECORRYS Consulting and Research Limited, 2009, p. 22) [3]*". Therefore, ship maintenance and repair services are simply aimed at putting the ship in a good order so as to earn maximum revenue and create employment through its reliability performance.

This research is primarily centred on some challenges, opportunities and prospects of ship maintenance and repair services of the Tema Shipyard in Ghana. It does not intend to examine the various types of ship maintenance & repair, vessel planning scheduled for ship repairs, engineering, Key Performance Indicators of the Tema Shipyard.

Several studies conducted by the developed economies had identified some major challenges and measures being taken to reduce and nip them in the bud so as to maintain and facilitate development of their economies (ECORRYS Consulting and Research, 2009, pp. 7, 8, 9, 12 and Center on Globalization, Governance and Competitiveness, Duke University, 2017, pp. 9, 52, 53, 54, 70, 71, 73) [3] [4]. By K. Shahriar Iqbal, *et al.*, most of the Bangladeshi shipyards are also facing many of these major challenges (Iqbal, Zakaria & Hossain, 2010, pp. 151-155) [5].

The Tema Shipyard's management ratified the ISO to ensure compliance with safety, health and environmental standards, stated by a Departmental head. Arguably, its direct implementation appears inconsistent and contradictory to the continual use of a banned silica sand as abrasive blasting method to still do ship repairs (https://www.osha.gov/dts/maritime/standards/guidance/shipyard_guidance.htm) [7].

It appears these challenges facing the Shipyard have attracted little attention of researchers, excluding Yawson (2017) who discussed very few of them in his case study. The author's motivation to undertake this research project is centred on these challenges and main objectives already summarized in the abstract in order to tap the opportunities and prospects of the industry. Various available data and statistics analysed in the end tail of the discussion section of this article indicate the positive impacts of few drivers have on the shipbuilding and ship repair industry (UNCTAD/RMT/2018, p. 5) [2].

2.3. Problem Statement

In worldwide, effective and efficient management of shipyards to promote their

sustainability of late, has become an essential issue to all policy makers, planners, engineers, environmentalists and researchers. The contributions of the ship-building and ship repair sector to many nations' economic growth and development, particularly the developed economies are crucial despite the concurrent existing challenges (ECORYS Consulting and Research, 2009, pp. 7, 8, 9, 12 and Center on Globalization, Governance and Competitiveness, Duke University. 2017, pp. 9, 52, 53, 54, 70, 71, 73) [3] [4]. Whilst some advanced countries have taken holistic approach in addressing some of these major challenges facing their shipyards, the least developed countries, like Ghana, seems to be overwhelmed with these challenges. Although the Tema Shipyard, over the past few years, has implemented some safety standards: ISO 14001: 2015 and ISO 45001: 2018, specifically aimed at improving its reputation internationally as stated by one of the departmental heads. It simply looks like, the yard still lacks the capacity and capability to solve these challenges permanently so as to make the sector earns the necessary revenue, create employment and become very competitive in the industry.

Currently, lack of capacity, obsolete maintenance equipment, lack of equipment, inadequate skilled labour, are some of the major challenges facing the ship maintenance and repair services in the Shipyard. The continual existence of these unsolved challenges either in the past or present, directly and indirectly affects the economic, social and environmental aspects of ship maintenance and repair services as well as its sustainable development.

Thus, this research considers it necessary to examine the objectives stated in both the abstract and research objectives logically and impartially in order to also contribute to the sustainable management and development of the Tema Shipyard in Ghana.

2.4. Research Questions

Under this section, the study intends to use the following important and essential questions in order to come out with an unbiased article that will contribute to the knowledge industry and enhance revamping of the Tema Shipyard.

- 1) Are there any effective policies and management structure governing the operations of the Tema Shipyard?
- 2) What types of challenges facing the ship maintenance and repair services in the Shipyard?
- 3) How do they affect the ship maintenance and repair service delivery of the Shipyard?
- 4) Why must the Shipyard pay the necessary attention to some drivers impacting positively on shipbuilding and ship repair industry in the world?
- 5) What kinds of sustainable management measures are put in place to improve service delivery of the shipyard?

Suffice to say, that these questions and other issues have been thoroughly analysed in the discussion section of the research project.

2.5. Research Objectives

This article also seeks to:

Explore existing policies and current management structure, govern operations within the yard.

Examine some major challenges facing the ship maintenance and repair services in Tema Drydock and Shipbuilding Yard Ghana.

Identify few drivers impacting positively on the ship repair market with particular reference to the Tema Shipyard.

Propose sustainable management and maintenance strategies for improved repair services of the yard.

2.6. Research Methodology

Strategically, this research is a mixed method of both quantitative and qualitative techniques, seeking to give an in-sights into investigations on the already existing pieces of previous academic research on the subject-matter—the already stated research objectives. The main reasons are: the quantitative data, deals with numbers which can be analysed using the statistical tools whereas, the qualitative data, processes the information of people's judgements, ideas, emotions into detailed descriptions without using numbers. In the qualitative data, the definition of the concepts and process of investigation will be more tentative and explorative than in quantative research

(https://edisciplinas.usp.br/pluginfile.php/2317618/mod_resource/content/1/BLOCO%20_Research%20Methods%20The%20Basics.pdf) [8].

It is a case study which depends heavily on documentation, archival records and interviews used in a case study for the data collection (Alhouli, 2011, p. 99) [1]. Data for this paper came from two sources—primary and secondary sources. The primary data derived from designed questionnaire and in-depth interviews held with key experts and stakeholders in the Ghana's maritime organizations. The secondary data, came from research articles, reports, google scholar, research gate, E-books, companies' websites, aim to achieve the objectives of the study.

2.7. Explores Existing Policies and Current Management Structure, Govern Operations of the Shipyard

Ship maintenance and repair services worldwide, are often governing by internal and external standards that regulate the activities of the drydock industry. These regulatory standards aim to improve safety and healthy environment, for efficient work practices of all the personnel and stakeholders in the Industry. The Tema Shipyard has ratified and implemented the ISO 14001: 2015 and ISO 45001: 2018 provisions despite the myriad of challenges it faced so as to attract and optimise its competitiveness within the Industry, stated by a departmental head. The Shipyard is qualified as a member state drydock to drive the benefits embedded in the ISO 45001: 2018

(<https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100427.pdf>) [9].

2.8. The Structure of the Tema Shipyard

The research has found that the Tema Shipyard adopted the Vertical Organizational Chart for its management structure to manage the entire business affairs. The hierarchy of the company starts from the highest top to the least bottom of the Shipyard. All decision making, information and communications within the company must follow the same pattern, flows from the highest authority to the lowest bottom and vice versa.

The Shipyard is under the jurisdiction of Ministry of Transportation, and it is the Chairman, who is the Head of the Governing Board. He/She is always accountable to the President of the Republic of Ghana through the Minister of Transportation. By the Ghana Ports and Harbours Authority (GPHA) Act, 1986, the members of Board shall be appointed by the President in accordance with Article 70 of the Constitution of Ghana

(<http://extwprlegs1.fao.org/docs/pdf/gha93378.pdf>) [10]. Following directly under the Chairman, is the Chief Executive Officer, (CEO) including his nine (9) Departmental heads and heads of the various divisions

(<https://www.temashipyard.com.gh/#1594812675004-d4510890-a75f>) [11].

Figure 1: below is demonstrating the PSC Tema Shipyard's vertical organizational chart, indicating the positions of the Board of Directors, Chairman, the CEO and his management team.

From the above mentioned, one can identify the three levels of management with their responsibilities permeating the Tema Shipyard's hierarchy of authority—top management, middle management and operative management

(<http://www.ddegjust.ac.in/studymaterial/mcom/mc-101.pdf>) [12].

2.9. Data Presentation

For the research to achieve its intended objectives and meet the other essential recognised research requirements, questionnaires were distributed and interviews conducted with the targeted groups to solicit their understanding and expertise on the effects of the challenges facing the ship maintenance and repair services in the Tema Shipyard. The amount of findings generated in this research project came from three (3) key marine organizations in Ghana: PSC Tema Shipyard, Ghana Maritime Authority (GMA) and Shipowners and Agent Association of Ghana (SOAG)/Cadesmee International Limited.

This section presents and analyses the data collected on the challenges facing the ship repair services in the Shipyard. The interviews were planned in accordance with the organizational hierarchy, the top management level, middle management level and operative management level from the three key marine organizations in Ghana. The reasons for the selected organizations were to obtain their understanding of how these challenges facing the ship maintenance and repair services affect the Shipyard and propose sustainable management and strategies for improved service delivery in the Shipyard.

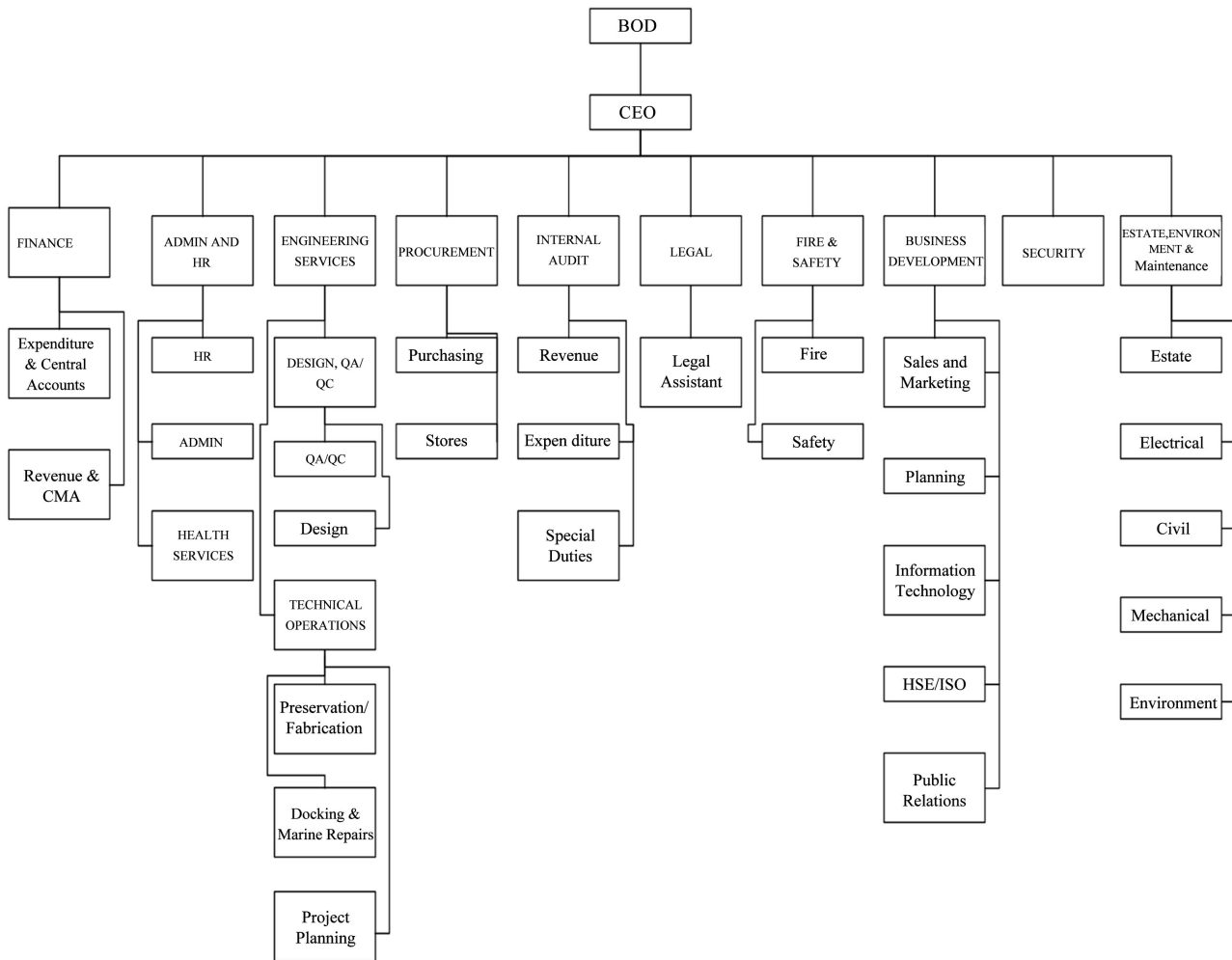


Figure 1. Above shows the PSC Tema shipyard’s organizational chart (<http://pm4dev.com/resources/free-e-books/46-roles-responsibilities-and-skills/file-html>) [13].

- The GMA, PSC Tema Shipyard and SOAG are the main stakeholders in Ghana’s shipbuilding and repair industry. The selection of these three organizations was justified on the basis of their considerable data sets, their kind agreement to make that data available and accessible for this research (Alhouli, 2011, p. 115) [1]. The interviews were conducted within two months period, starting from November 2019 to December 2019.

3. Analysis of the Interviews

The research adopted the interpretative approach in order to examine and identify the present status of the challenges facing the ship maintenance and repair services in the Shipyard (Alhouli, 2011 p. 116) [1]. The findings were presented in summary of tabular presentations in the following sections below (Alhouli, 2011 p. 116) [1].

The first section presents **Tables 1-3:** showing the biographic data of the participants, summary of the answers provided by the participants, basic functions of ship maintenance and repair services, respectively. It has followed up directly

by examining some major challenges facing the ship maintenance and repair services in the shipyard and finally proposed sustainable management and maintenance strategies for improved repair services of the yard.

In order to identify the challenges faced in the ship repair and maintenance, participants were asked to state the challenges they encounter in carrying out their repair and maintenance services. **Table 3**, lying beneath **Table 2**, is showing the summary of the participants' responses and followed with the examination of four selected challenges from the seven challenges stated due to the scope of the study.

Table 1. Below, shows the biographic/Profile of Participants.

Participants' particulars:	Descriptions of the particulars:
Number of Participants	4
Age Range	35 - 55
Position in the Organisations	<ol style="list-style-type: none"> 1) The Executive Member of SOAG/CEO Cadesmee International. Ltd. 2) Project Planning Manager of Tema Shipyard. 3) Supervisor of Dock 1 Machining Section, Tema Shipyard. 4) Port State Inspector & Flag Surveyor of GMA.
Educational Background and Responsibilities	<p>Technical and Tertiary.</p> <p>Responsibilities The Executive member of SOAG/CEO Cadesmee Int. Ltd, the ultimate source of authority and lays down goals, policies and plans for the organisation (http://www.ddegjust.ac.in/studymaterial/mcom/mc-101.pdf) [12].</p> <p>Responsibilities Tema Shipyard's Project Planning Manager: Developing the project plans, implementing the plans, Evaluating & Coordinating, (http://pm4dev.com/resources/free-e-books/46-roles-responsibilities-and-skills/file-html) [13].</p> <p>Responsibilities Tema Shipyard's Dock 1 Machining Section Supervisor: Paying detail attention to all the machine and the workers operating them, Performing record keeping (http://www.talentcor.com/blog/4-skills-to-look-for-in-machine-operators) [14].</p> <p>Responsibilities GMA's Port State Inspector: inspects Documents of Compliance, Safety Management Certificates, working charts [3] (Anderson, 2005, p. 8) [15]. Flag State Surveyor: Article 94 of the United Nations Convention on the Law of the Sea (UNCLOS) 1982 outlined the duties of the Flag State as follows: <ol style="list-style-type: none"> 1) Every state shall effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag (https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf) [16].</p>
Number of Years Worked	<p>Ranging from three to above twenty Years working experience.</p> <p>Below is the breakdown: The Executive member of SOAG/CEO Cadesmee Int. Ltd., over 20 years' experience, Tema Shipyard's, Project Planning manager, above 20. Dock 1 Machining Section Supervisor, 17 years' experience. The GMA's Surveyor, 3 years' experience.</p>

Table 1: above, biographic/profile of participants (Microsoft Word, 2013) [17]. **Table 1: above**, shows the summary of the targeted senior officers working at various capacities in the shipyard, shipping regulatory and shipping lines interviewed during the study. Given that, their direct and indirect involvement in the ship constructions, ship maintenance & repair services and the commercial operations of shipping is very crucial. Hence, it meant to gather authentic and reliable data for procession that will also contribute academic knowledge and practically-related experience so as to enhance the course of the knowledge dissemination industry.

Table 2. Below shows the basic Functions of ship maintenance and repairs in the Tema Shipyard.

Theme	Sub-Theme: Functions
Ship Maintenance	Performs two main types: 1) In Shipyard: ship must be dry docked for major overhaul. 2) In harbor: medium maintenance (Alhouli, 2011, p. 45) [1].
Ship Repairs	Basic functions include: sandblasting, preservation, drilling works, welding & cutting of steels.

Table 2: above, functions of ship maintenance and repair (Microsoft Word, 2013) [17].

Table 3. Below represents the summary of the answers provided by the participants about some major challenges facing ship maintenance repairs in Tema Drydock and Shipbuilding Yard. Please, delete the yellow highlighted one.

Responses	Number of Responses	Percentage of Respondents
Lack of Equipment	3	33%
Obsolete Equipment	2	22%
Lack of Trained Staff in Modern Technologies	1	11%
Lack of Capacity of the Tema Drydock	1	11%
Lack of Financial Support from Government of Ghana	1	11%
Political interference	1	11%
Competition from Neighbouring Shipyards	1	11%

Table 3: above, summary answers by participants (Microsoft Word, 2013) [17]. **Table 3 above**, shows that 33% of 3 stated lack of equipment as the main challenge among the challenges followed by obsolete equipment 22% of 2 and the rests of the five (5) challenges all 11% each. Overall, the sum up of all these five (5) challenges made up the highest percentage of 55% indicating that there are really issues confronting the shipyard.

The analyses below here are focused on four challenges: lack of equipment, obsolete equipment, lack of skilled labour, lack of capacity, due to the scope and other limitations of the research.

On the issue of lack of equipment, three (3) **participants B, C and D** responded to the two questions below:

“Are there any challenges facing the ship maintenance and repair services of the Tema Shipyard” and “Do you need modern machines”?

“Participant B, Not necessarily modern machines but we need more machines”.

“Participant C, Limited shipyard and equipment”.

“Participant D, Lack of tools and equipment to operate the shipyard”.

It has emerged from the study that the issue of the obsolete equipment attracted two participants’ responses:

“Participant i. obsolete equipment”.

“Participant ii, obsolete infrastructure and tools”.

Concerning the challenge of lack of trained staff, participants A and B agreed that the issue exists.

About the issue of lack of capacity, participant C stated that:

“vessels of certain length and breadth can't be admitted”.

Deducting from the participants' responses, it was unanimously agreed by all the participants that:

“the above mentioned challenges facing the ship maintenance and repair services in the Tema Shipyard have substantial negative economic, social, health and environmental implications for the Ghana's maritime industry and other sectors of the economy”.

The below are the objective examination of the challenges.

3.1. Lack of Capacity

By the recent statistical data, there is a trend of consistent rapid growth in the numbers and sizes of the world merchant fleet due to economic reasons and technological advancement in ships construction. Just within a one (1) year period, about **1010 vessels** were added to the world merchant fleet based on the calculated difference between the UNCTADs' Jan., 2017 & Jan., 2018 world fleet figures. For example, on the **1 January, 2017**, the world commercial fleet has increased from **93,161 ships** with a combined tonnage of **1.86 billion dead-weight-tonnes (dwt)** to **94,171 vessels**, with a combined tonnage of **1.92 billion dwt in 1 January, 2018** (UNCTAD/RMT/2017 & UNCTAD/RMT/ 2018, p. 23) [2] [18]. In addition, MSC. Gulsun is now the largest containership in the world with a **draught of 16.5 metres**, under service between Europe and Asia (<https://www.temashipyard.com.gh/facilities/> and <http://www1.eurogate.de/fr/About-us/Press/Press-release/FIRST-PORT-CALL-OF-THE-MS-C-GULSUEN-WORLD-S-LARGEST-CONTAINER-SHIP-DOCK-S-IN-BREMERHAVEN>) [19] [20]. Correspondently, there is a little growth and development in the drydocks' equipment and infrastructure globally to efficiently handle the rapid growth in the world's merchant fleet and sizes, except the form 10 in Marseille, one of the world's largest shipbuilding Yards with the modern advanced technology capacity and capabilities to handle such increases (https://www.sgdp.it/upload/news_news/allegati/7_cnmprreseformel0inmarseille.pdf) [21].

However, the Tema Shipyard, has not undertaken any significant expansion and dredging projects on the quayside and docks in order to accommodate vessels for effective and efficient repair services. The quayside's draught = **6 m** and Dock 1's **draught = 10 m are lower than the current largest container ship, MSC. Gulsun's draught of 16.5 m.**

One participant out of the total number of four (4) respondents confirmed the limited capacity nature of the berths and docks, by stating that:

“the yard did not have enough space and deeper draughts berths and docks to host a lot of vessels at the same time”.

Thus, the Shipyard is equally losing a lot of ship repair businesses to its competitors even though it is the largest shipyard on the African Continent.

3.2. Obsolete Maintenance Equipment

A critical look at the Tema shipyard's super infrastructure and ship maintenance & repair equipment attested that some of the yard's equipment are not safe to render repair services and are legally banned in certain jurisdictions. Almost the whole yard's physical facilities are deteriorating substantially and are now seriously struggling to survive. Some of the workshops' roofs have been torn and stripped off, perhaps, due to the corrosion of the sea breeze and storm weather coupled with lack of maintenance culture.

Today's technological advancement in ships design and construction in relation to their sizes, engines, deadweight-tonnes, has made the 1960s made ships repair equipment no longer fit for purpose. The application of advanced technology, in ship repairs and building highly sophisticated ships is aimed at prevention of pollution from marine and shipping operations. The installation and application of a unique Cofferdam system to repair a ship without it entering a drydock and floating dock

(<http://www.dormac.net/services/cofferdam-repairs/>) [22] is a classic example.

However, the Tema Shipyard's repair equipment are absolutely obsolete, inefficient and unable to carry out ship repair services effectively because they were installed in the Shipyard since 1960. They have not yet been replaced with the modern types of advanced technological equipment: Computer Numerical Control Machines (CNC). The CNC machines are automatically-operated and have good precision in cutting whereas the Tema Shipyard's machines are manually-operated and have very poor cutting precision, stated by one participant. Some shipowners do not allow the yard to use them to do repairs on their vessels because they are banned in their jurisdictions, stated by the participant.

Furthermore, a second participant has confirmed that a high number of critical equipment, including the dock 1's two cranes and two winches have also been completely broken down for many years without being repaired. These winches were used to pool in a ship inside the dock 1 for commencement of repairs whilst the cranes performed the lifting off/on some heavy equipment from/to the vessels during repair services at the dock.

These outdated equipment cause a significant delay in the repaired vessels turnaround time with rising costs of operation for the shipowners and operators, the participant stated.

The research has also established that the Shipyard continual usage of a banned silica sand as a blasting abrasive to perform repairs can cause loss of lives because of the silica dust. Silica dust is generated by using blasting abrasives that contain Crystalline Silica, namely quartz rock, river sand and beach sand. This dust contains high levels of toxic air contaminants rising from the blasted base materials, the removed surface coatings, the abrasives used. An employee who

breaths in fine respirable particles of crystalline silica is at risk of developing silicosis disease which attacks the lungs and can result to death (https://www.osha.gov/dts/maritime/standards/guidance/shipyard_guidance.html) [7].

Evidently, the second participant has even confirmed the health hazards involved in using abrasive blasting in his affirmative answers to a repeated question of, you still do sandblasting, which is not?

“Yes, we still do sandblasting because it produces dust, the operator accumulatively many years of doing the same job, you are definitely going to expose to health hazards for inhaling the dust pollution, there are organic substances in the system which is environmentally-friendly. But again, we have no alternatives available in Ghana to mitigate the health risk, stated by the participant”.

Paradoxically, this is a clear indictment to the Shipyard’s decisions in approving and implementing the ISO 45001: 2018 which upholds the International Standard for Occupational Health and Safety (OH & S)’s provisions, aim at protection of safety of the employees and maintaining safe working environment for all workers. It might lead to occupational injuries, including, corresponding law suites, legal costs and substantial payment rewards (Boris, 2014, p. 140) [23].

3.3. Lack of Equipment

Additionally, the pervasive prevalent of obsolete and malfunctioned equipment situation, automatically results to lack of equipment as one of the major challenges facing the yard.

The Tema Shipyard, over the past years, has not acquired some considerable number of essential and critical ship repair equipment with the exception of just taken the delivery of the dock 2’s two pumps to boost its repair services, stated by one participant. It really lacks cranes, folk lifts, especially, the recent modern CNC machines to perform efficiently. According to the participant, the shipyard’s warehouse is just like a white elephant. It’s virtually empty, no single simple spare part is in it because the yard has no fund to stock it up with spare parts. In effect, it rather causes inconveniences to its customers, by letting them sourcing for spare parts by themselves amid the high risks of insecurity, safe and costs, or the yard must go through a lengthy, expensive and labourious procurement processes to procure spare parts in accordance with the provisions of Ghana’s Public Procurement Act, cited by the participant. By the participant, these procurement processes do take them averagely three (3) days to procure spare parts and about three weeks to execute one ship repair job, coupled with accumulative increase in the costs of operation for the customers and quickly asked for Public Private Participation in running the shipyard.

It has also revealed that three (3) participants out of the total number of four (4) respondents, categorically agreed that the shipyard actually lacked equipment to meet the internationally recognized shipyard’s standards as referenced in this article.

These situations are compelling the Shipyard’s management to consistently

rely on the support services from Ghana Ports and Harbours Authority's mobile cranes and tugs to help them carry out ship repairs at the dock. Certainly, it is time consuming and has a trickle-down effect on both parties engage in these types of business transactions because the equipment might be pre-occupied or faulty at the time one party needs them. So, that party must either be prepared to spend its productive time waiting for the other party to finish using the equipment, depending on the emergency of the work or look for alternative. Thus, the customers of the GPHA and the PSC Tema Shipyard may be over burdened with payments of demurrage caused by extra-time added to the agreed contract time and may stop calling for its services. Demurrage basically defines to as extra charge on a vessel which exceeds its port stay time during loading and discharging operations, including delay in sailing in accordance with the terms and conditions of the type of contract agreed upon between the shipowner and the charterer. Normally, it is always the charterer's responsibility to pay the demurrage to the shipowner.

CMA CMG defines "Demurrage": as *"the charge, related to the use of the equipment only, the Merchant pays for carrier's equipment kept beyond the free time offered by the Carrier for taking delivery of goods in the port, terminal or depot"*

(<https://www.cma-cgm.com/static/DemDet/Attachments/Conditions%20Generales%20DD.pdf>) [24].

Additionally, there seems to be embedded risks in moving mobile cranes from one place to another. Safe working procedures for demobilisation and mobilization of these mobile cranes must be duly followed by competent persons from both parties to guarantee their safe movements, depending on where their services are most needed. Cranes are part of lifting appliances. The International Labour Standards defines "lifting appliance" *"covers all stationary or mobile cargo-handling appliances, including shore-based power-operated tramps, used on shore or board ship for suspending, raising or lowering loads or moving them from one position to another while suspended or supported (Humblet, et al., 2002, p. 591) [25]"*. The term "competent person" refers to a person possessing knowledge and experience required for the performance of a specific duty or duties and acceptable as such to the competent authority (Humblet, et al., 2002, p. 589) [25].

The Tema Shipyard could probably not meet its revenue target and in the long run might compulsorily relying on government's subvention, no more internally generated funds to settle its production costs for survival if this issue is not solved.

3.4. Lack of Skilled Labour

This research, has also affirmed the widely accepted philosophy that, almost all the various industries, manufacturing, institutions, have been grappling with supply of inadequate skilled labour to competently man their activities.

The Shipbuilding and ship repair industry, has been hard hit by this inevitable phenomenon, because the educational institutions world over, might have lacked the qualified academic staff to do effective teaching. By ECORYS Consulting and Research, the national education systems in both developed and least developed economies, could not even provide sufficient qualified people to man the sector ECORYS Consulting and Research, 2009, p. 114) [3].

Overall, the fast growing age population and workforce, in relation to the present situation and future continuous to pose an increasing threat to the shipbuilding and ship repair industry. It is expected to present worse problems in the future. For instance, in 2030 and 2050, South Koreans' growing age population is expected to rise to 46% and 50% respectively (ECORRYS Consulting and Research, 2009, p. 117) [3]. Most of the Bangladesh's local shipyards are facing lack of machine operators due to the owners' perception that every human resource development programme is a drain, not gain (Iqbal, Zakaria & Hossain, 2010, p. 153) [5]. What kind of future lies ahead? Is there any serious strategic plan to facilitate the accelerated development of the industry?

As Alagidede, *et al.*, put it: “*unbridled establishment of degree awarding institutions staffed by wholly unqualified and untrained academic staff, and inadequate evaluation of the would be private tertiary institutions by the National Accreditation Board has led to mushrooming of fly-by-night awarding academic institutions in every hook and corner of the country. This development is somehow a reflection of the lousy mind-set of a populace seeking certificates over skills, and the emphasis on business and management training to the neglect of science and technology has opened a gaping hole in the set of skills required by industry and the genus of graduates produced by the tertiary institutins Alagidede, (Baah-Boateng & Nketiah-Amponsah, 2013, p. 24) [26]*”.

These may result to low productivity leading to loss of revenue, safety risks of ships which undertake repair services at shipyards, staffed by unqualified and untrained staff because they lack the set of skills right from their various tertiary institutions.

As a matter of fact, the study has identified that Tema Shipyard is not immuned to these issues. It is directly and indirectly affected hence it lacks that calibre of personnel. The inadequate supply of properly-educated skilled labour and loss of a few specialised labour to migration simply makes it not attractive to ships which are required to undergo repair services in the Tema Shipyard. The inadequate supply of properly-educated skilled labour does not just have significant negative economic implications for the Tema ship maintenance & repair services only.

Its trickle-down effects also weigh heavily on the Ghanaian economy with the introduction of modern advanced technologies in shipbuilding and ship repair services. The Tema Shipyard may also be interested in training its inadequate skilled labour in these advanced technologies to perform efficient ship repair services for increased productivity.

However, a participant has made the following startling statements during the study:

1) Participant said, the yard's staff are not fully trained in modern technologies prevail on present day ships thus, limiting their capabilities in ship maintenance and repair equipment.

2) Presently, there is even a lack of expertise to perform in-house services of rewinding motors. What all these means are that, they cause a significant damage to the image and marketability of the shipyard leading to revenue reduction and unsustainability of the yard.

3) *“Some of the workers are showing lackadaisical attitudes and reluctant to work more than the prescribed working hours because it is a public-owned institution as stated by the participant”.*

4) Perhaps, there could be an inherent high risk or unidentified risks in the PSC Tema Shipyard's ship maintenance and repair services. For that matter, the workers will always fear for their lives most and feel reluctant to work even if the other conditions of service are attractive. In short, the workers might not be familiar and satisfied with some of the safe working procedures and technical requirements they must follow to carry out safe ship maintenance and repair services at the drydock in accordance with the current International Labour standards.

One of the technical measures of the International Labour Standards, states that: *“workers have the right to participate in ensuring safe work with regard to equipment and methods of work under their control, and to express their views on the working procedures affecting safety 46 (Humblet, et al., 2002, p. 599) [25]”.*

3.5. The Few Drivers Impacting Positively on the Ship Repair Market with Particular Reference to Tema Shipyard

Although the shipyard is bedeviled with these overwhelming challenges, finding antidotes can turn around the fortunes of the Shipyard within the short, medium and long-term periods.

3.6. Growth in the International Seaborne Trade

The study has found out that the international seaborne trade is always growing at unproportional rate which has, direct and indirect influence on the ship-building and ship repair industry and other sectors of the world economy. It is estimated that the shipping industry continues to carry the **90%** of the world's rapid growth of **10.702 billion tonnes** of international seaborne trade (Alhouli, 2011, p. 43) and UNCTAD/RMT/ 2018, p. 5) [1] [2]. Just within one (1) year period, 1,010 ships were added to the world merchant fleet based on the calculated difference of the United Nations Conference and Trade Development, 2017 and 2018's statistics On 1 January, 2017, the world commercial fleet has increased from 93,161 vessels with a combined tonnage of 1.86 billion dead-weight-tonnes (DWT) to 94,171 vessels with a combined tonnage of 1.92 billion

dwt in 1 January, 2018 49. (UNCTAD/RMT/2017, p. 23 & UNCTAD/RMT/2018, p. 23) [2] [18]. It presents a growing demand for even bigger ships because of economies of scale as cited by Kavussanos and Visvikis (2016). Both Shipowners and Operators now prefer to acquire and deploy biggest vessels so as to carry a high volume of goods with a less operation unit costs over long distance.

According to Dong-Wook Song, capacity increased in ship-sized increments, meant that when trade was growing, vessels had to be ordered in multiples dictated by the service frequency, with sufficient capacity to cater for future growth (Song, 2017, p. 3) [27]. Since, more newbuilds will be ordered and supplied with the anticipation of high demand for shipping, it automatically added up to the already existing fleet, thereby increasing the total number of the world fleet.

All these trends are geared towards the strong growth of the world fleet which have an equal growth opportunities for ship repair and conversions.

As ECORRY Consulting and Research stated that:

“The strong growth of the world fleet from 660 mln dwt in 1990 to 1,040 mln dwt in 2007 has lead to an equal growth of opportunities for ship repair and conversions”. “Worldwide, the annual turnover in ship repair has been estimated at USD 10 - 12 billion (ECORRY Consulting and Research, 2009, p. 34) [3]”.

Thus, the Tema Shipyard should make good on this consistent growth in the international seaborne trade in tandem with increase in demand and supply of shipping to maximize revenue through rendering of effective and efficient ship repair services.

3.7. Introduction of New Environmental Regulations

Attempts to regulate shipping globally, has been a difficult issue for the international community due to a fragmented variety of legal regimes at national levels to harmonisely deal with pollution from marine and shipping operations.

Dong-Wook Song asserted in one of his research articles the difficulties involving in the regulation of shipping because of the international nature of the business, which have wide variety of national and local levels of regulating (Song, 2017, p. 6) [27].

The processes of implementing and enforcing Annex VI. of International Convention for the Prevention of Pollution from Ships (MARPOL 1973, modified 1978/1997

[http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Marine-Environment-Protection-Committee-\(MEPC\)/Documents/MEPC.176\(58\).pdf](http://www.imo.org/en/KnowledgeCentre/IndexofIMOResolutions/Marine-Environment-Protection-Committee-(MEPC)/Documents/MEPC.176(58).pdf)

[28]. directly and indirectly increase shipbuilding and repair services in shipping industry, because some ships must do repairs of scrubbers installation to make them compliance.

Maersk Line, a Danish shipping giant had developed an investment plan to install technological retrofit, a waste-heat recovery system on its existing fleet aimed at reducing the Line's energy consumption and relative Carbon Dioxide (CO₂) emissions in its operations (Song, 2017, p. 13) [27].

The Tema Shipyard, should see these developments as opportunities and prospects to explore them to the developments of its ship maintenance and repair services.

3.8. Proposes Sustainable Management and Strategies for Improved Service Delivery of the Yard

This is the last section of the research and consists of conclusions and further future research request based on the already examined challenges and other pertinent issues raised in the study. This is because their critical evaluations for long-term permanent solutions are anchored on the objectives of this research.

3.9. Conclusions

Inferring from the above analyses, shipbuilding and ship repair industry contributes immensely to the development of maritime industry and the world economy. As the increasing growing numbers, sizes and fusion of advanced technologies in the world merchant fleet continues unabated, so do the challenges facing the shipbuilding and ship repair industry worldwide. Similarly, Ghana is not isolated from this international maritime cluster, it also depends substantially on shipbuilding and ship repair industry and other sectors of shipping to run, grow and develop its maritime industry and economy.

However, the Tema Shipyard's management is consistently facing serious internally and externally generated financial constraints to revamp the shipyard. It should be stressed that the benefits of investing in expansion and dredging of the yard's capacity outweigh any losses that the limited capacity might have been incurring now. The one way this could be done, is to enter into a concessionaire agreement with any of the technologically advanced shipbuilding and repair yards to invest in the capacity expansion and dredging projects, including the upgrading of all the super infrastructural.

This particular concessionaire agreement should differ from the sea ports developmental concessionaire agreement which primarily cedes long time high share percentage ratio, ownership and management of the sea ports to the investor to operate for a long period of time so as to recoup all the resources invested in the project. In the shipbuilding and repair yard's developmental concessionaire agreement, a clause should be incorporated in the terms and conditions to specifically modify the investor's high share percentage ratio and duration of ownership. The investor must enjoy a high share percentage ratio with short ownership duration period or vice-visa after which it hands over the ownership and management to the host shipyard to continue. This type of a reformed concessionaire agreement may ensure stability in the sector and wins investors' confidence.

The effect of the obsolete equipment on the Tema Shipyard's human resource and immediate environment is a long run overwhelming effect. The way forward, is to acquire the computer numerical control (CNC) machines and other environmentally-friendly approved materials to be able to carry out quality, ef-

fective and efficient ship repair services for their customers. It is very important that the Shipyard should not just focus on getting the \$200 million investments to salvage the yard by the estimates of its business proposal. It could also enter into a contract with the marine equipment through collateral arrangements or on installment payment system depending on the terms and conditions of the contract.

The Tema Shipyard should organize internal and external marine engineering training for the staff to improve their knowledge to perform efficient ship repair services.

A selected number of staff should be attached to the developed shipyards and recognized marine institutions abroad for further training, including an improved condition of service to retain the few qualified employees and attract other workers from outside.

Overall, establishing marine engineering and maritime affairs basic and Senior High Secondary education in the country will provide a solid foundation to equip the required human resource at the tertiary institutions to be able to man the industry efficiently in the long-term. Presently, the country does not have such specialised basic and senior high educational institutions running concurrently with the already existing conventional basic and senior high secondary systems in Ghana.

4. Future Research

Further research should be conducted on the expected and hidden challenges using the regression analysis theories to assess and mitigate their effects on the shipyard.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Abbreviations

- 1) CESA: Community of European Shipyards Associations
- 2) CEO: Chief Executive Officer
- 3) CNC: Computer Numerical Control Machines
- 4) CO₂: Carbon Dioxide
- 5) DWT: Deadweight-Tonnes
- 6) GMA: Ghana Maritime Authority
- 7) GPHA: Ghana Ports and Harbours Authority
- 8) ISO: International Organization for Standardization
- 9) MARPOL: International Convention for the Prevention of Pollution from Ships
- 10) SOAG: Shipowners and Agent Association of Ghana
- 11) RMT: Review of Maritime Transport
- 12) UNCLOS: United Nations Convention on the Law of the Sea
- 13) UNCTAD: United Nations Conference on Trade and Development