International Journal of Multidisciplinary Research and Development
www.allsubjectjournal.com
ISSN Online: 2349-4182 ISSN Print: 2349-5979
Received: 20-04-2024, Accepted: 12-05-2024, Published: 05-06-2024
Volume 11, Issue 6, 2024, Page No. 25-35

Examining the outcome of lean principles and its implementation in supply chain management of Ghana upstream oil and gas

Solomon Adjei Boateng
Department of Business and Management Studies, Texila American University, Guyana

Abstract
The study examines the outcome of lean principles and its implementation in supply chain management of Ghana upstream oil and Gas industry. A survey was administered across Ghana upstream oil and gas supply chain to individuals who are in a supervisory and management role and work in supply chain, engineering, operations, and business development department, and are familiar with lean concepts and techniques, performance, and strategies for implementation in both IOC and Oilfield Service Companies. The outcome of the studies indicate that lean tools and techniques are implemented in supplier development and Ghana upstream oil and gas supply chain, and improvements were found in the performance of health and safety, quality, product development, customer expectation, delivery reliability, innovation, cost reduction and problem-solving, as a result of implementing lean tools and techniques in other of ranking from highest to lowest, such as customer involvement, continuous improvement/kaizen and the rest are 5S/housekeeping, Standardization, Root cause Analysis (5Whys), Employee Involvement, Supplier Involvement/Integration, Pull system/Kanban, Value Stream Mapping (VSM), Visual Control/Management, and Just-In-Time (JIT). However, in supplier development, 5S/housekeeping, pull system/Kanban, and Employee Involvement obtained highest rating, and this is in variant with the literature which observed customer and supplier integration, standardization, and continuous improvement as the lean tool mostly used in upstream oil and gas supply chain. Recommendations and direction for future studies are presented.

Keywords: Lean principles, Lean tools and techniques, supply chain management, Ghana upstream oil and gas supply chain

Introduction

Background of the study

The Ghana upstream oil and gas supply chain exist in regulated environment where the supply chain partners are expected to comply with local content laws and regulation as they participate in upstream oil and gas activities. The Upstream Oil and Gas supply chain involves National Oil Company, The International oil Companies, and the Service Company, exposed and subjected to external suppliers within the country of operations without the capability and the capacity to meet industrial requirements (supply of quality product and services; meeting and reducing variable lead time and international standards, as well as reducing rig down time). The activities of the upstream oil and gas supply chain are exploration, development, and production, which are technical and require supply chain partners who have the right capabilities and capacity to meet the industry requirement. Downey (2009) [13] establishes that the upstream oil and gas industry is made up of exploration and production activities supported by service companies, which provide equipment and services, such as seismic analysis, oil drilling and production services, oilfield equipment maintenance, geophysical/reservoir services, drill bits, pumps and all other tools to the exploration and production (E&P) companies. The industry is as well govern by laws and regulations such as Ghana's National Petroleum Corporation Law, 1983 (P.N.D.C.L 64) (GNPCL Law), Petroleum Exploration and Production (PEP) Law, 1984 (P.D.C.L 84) (PEP LAW), Petroleum Income Tax (PIT) Law 1987 (P.N.D.C.L 188) (PIT Law), Petroleum Agreements (PAs), Petroleum Commission Act (2011, Act 821), and Local Content and Local Participation Regulations (L.I 2204) (PWC, 2011; Ernest & Young, 2012).

However, in the local content environment, the regulator expects the local companies to participate in the supply of equipment and services, which Azaah, (2013) argues that the main challenge posed by the implementation of local content policy in the Ghana oil and gas industry is lack of capability and capacity in virtually all sectors of the oil and gas industry. Agyei et al., (2013) [1] indicate that the major challenges faced by supply chains in Ghana are supply of low-quality products, unreliable or variable lead times, non-availability of local firms of international standard and high transportation costs. Chima (2007) [6], argue that delay in equipment such as pipes, casing, tubing's, and other accessories in exploration and production activities can lead to extensive rig downtime and consequently result in high operating costs.

Notwithstanding the challenges faced by the Ghanaian oil and gas industry, a sound supply chain management programs, involving a thorough configuration, and coordination in the oil and gas industry provide a maximum customer service at the lowest cost (Chima, 2007) [6]. This goal in the perspective of lean management can be achieved through removal of waste in the supply chain to deliver product and services to their customers (Liker and Morgan, 2006) [26]. Cudney and Elrod (2011) [8] argue that lean focuses on value adding activities and waste (such as overproduction, transportation, inventory, processing, waiting, motion, and defects), can be identified in any supply chain. Situating the work of Womack and Jones (2003) [39] in the removal of waste from supply chains and creating more value, the implementation guidelines and tools to achieve continuous flow (such as, value, value stream, flow, pull and perfection) and tools such as Kanban, 5S, TPM (Total Preventive Maintenance), Poke-Yoke, Kaizen, Cellular Manufacturing, SMED (Single Minute

Exchange of Dies), Value Stream Mapping, Levelled Production of Heijunka, Standard Work, Jidoka, Seven Quality Tools (Sakhardande, 2011). De Wardt (1994) [10] argue that the lean tools have seen some adoption in other industries, however, the oil and gas industry have achieved some adoption in oil well drilling or more appropriately well construction as well as organizational efficiency (Van Zandvoord *et al*, 2009) [37].

Statement of the Problem

The evolution of Ghana Upstream oil and gas supply chain, and challenge faced by local content implementation due to unavailability of suppliers with capability and capacity to support the activities and operations of National Oil Company, The International oil Companies, and the Service Companies, there has been the use of lean principles in other industries which has closed the gap in such environment where the adoption of lean principles in the supply chains have shown positive result such as linking breakthroughs of individual companies up and down the value chain to form a continuous stream, and as well satisfying internal customers and external customers through internal value system (activities performed by the organization) and supply chain partners of the customers respectively (Karlsson and Ahlstrom, 1997 [17]; Mohan and Sharma, 2003). However, the Ghana Upstream Oil and Gas supply chain has not seen level of implementation of lean principles to reduce and eliminate supplier capability issues as well as overcoming the challenge of low-quality products, unreliable or variable lead times, non-availability of local firms of international standard and high transportation costs as experience in the Ghana upstream oil and gas supply chain (Azaah, 2013; Agyei *et al*., 2013) [1].

It appears there is a dearth of study that focuses on lean principles in supply chain management of Upstream Oil and Gas industry, and many researchers position the lean principles and implementation research in the supply chains of manufacturing, automobile sector, process sector, and construction sector (Panwar, *et al*., 2015 [32]; Meng, 2019 [28]; So and Sun, 2010; Moyano-Fuentes *et al*., 2010) [29]. More so, most of these studies conducted were in the Western World with no mentioning of developing country such as Ghana, hence this study therefore aims at closing the gap and contributing to existing literature.

Objectives of the Study

1. To identify lean principles, tools, techniques, and implementation in supply chain of Ghana upstream oil and gas industry;
2. To evaluate through data collection and literature review the success of lean principles, tools, techniques, and its implementation in supply chain of Ghana upstream oil and gas supply chain;
3. To draw conclusion on the level of adoption of lean principles, tools, techniques, and implementation in the supply chain of Ghana upstream oil and gas industry.

Scope of the study

This study focuses on the examination of the outcome of lean principles and implementation in supply chain management of Ghana Upstream Oil and Gas industry. Other type(s) of lean principles and implementation in industries other than Ghana upstream oil and gas supply chain is outside the scope the studies, and generalizing the findings could be misleading.

Significance of the Study

The study is significant in that practitioners in upstream oil and gas supply chain are exposed to information regarding the use of lean principles, and better understanding of the adoption of lean principles in the industry. Stakeholder such as National Oil Company, The International oil Companies, the Service Company, Local Suppliers and Regulators are also exposed to the need to adopt the use of lean principles in the Upstream Oil and Gas value chain to realize the benefit of lean management.

Literature Review

The Lean Concept

The lean concept was developed out of Toyota Production System (TPS) and Just-In-Time (JIT). Krafcik (1988) [19] came up with the term lean when comparing the Ford system and Toyota system to explain the notion of having buffered system and lean operations respectively. The Fordism buffered system against uncertainties, whereas Toyota practiced lean to have inventory at absolute minimum and problems quickly detected and solved on continuous flow. The TPS was discovered during the 1973 oil crises which led to recession that affected government, business, and society (Ohno, 1988) [30]. The recession affected the profitability of the Toyota Motor Company (TMC) and necessitated a review of production system used by Toyota which relied on conventional American mass production system and could not be sustained when rapid growth stopped (Ohno, 1988) [30], as well, could not be sustained under volume-variety paradigm (Mohan and Sharma, 2003). The changes in the business environment, such as technological complexities, demanding markets, explosion of knowledge and increasing global competition impact improvement tools and techniques (Mohan and Sharma, 2003), and the ability to adapt flexibility in turbulent environment as market change is far more valuable than relying on any strategy (Hayes and Pisano,1996; Mohan and Sharma, 2003). The introduction of lean system was not only to contain the changing business environment but to move from Fordism (a pure mass production system, which focuses on vertical integration of raw materials at one end) to a system which achieves a high performance, productivity, flexibility, quality and mixed complexity, as well transfer the concept to the customers and the suppliers supply chain.

Lean Principles

The lean principle was postulated by Womack and Jones (1996) after studying the success of great companies in a wide range of sectors for implementing lean concept, not including companies in upstream oil and gas supply chain (Dhandapani, Potter and Naiml, 2004) [11]. The lean principles are explained by Womack and Jones (1996) [38] as providing a way to specify value, line up value-crating actions in the best sequence, conduct these activities without interruption whenever someone request them, and perform them more and more effectively. The lean principles were expanded further as five principles, which are specify value from the customer view, map the value stream, establish flow, let the customers pull the product, Strive for perfection (Womack and Jones, 2003) [39]. It is added by Womack and

Jones (2003) [39] that the lean principles focus on the upstream and downstream of the organization, where the internal and external partners are customers and suppliers that forms the upstream and downstream respectively. The application of lean principles as observed by Mohan and Sharma (2003) is to satisfy internal customers and external customers through internal value system (activities performed by the organization) and supply chain partners of the customers respectively. Karlsson and Ahlstrom (1997) [17] added that the lean principles proposed by Womack and Jones led to the idea of linking breakthroughs of individual companies up and down the value chain to form a continuous stream. These two applications of lean principles establish the wide application of lean, where Womack and Jones (1996) [38] added by enumerating the implementation of lean concept in organization such as automobile manufacturing, jet engine manufacturing, delivering health services, distribution, construction, and food production. Womack and Jones (2003) finally articulated a comprehensive business logic on lean management which is called lean thinking or lean principles and arranged as follows;

Specify value from the end customer view

The logic of specifying value from the end customer is to find out the customers desire for product and service (Womack and Jones, 1996) [38]. Obtaining specification from end customer deliver the value the customer expects and the opposite leads to wrong product and service due to the failure to specify value correctly. Cudney and Elrod (2011) [8] argued that organizations activities are made up of value added and non-value-added so focusing on the value from the end customer allows the organizations to focus resources on the value-added activities.

Map the value stream

The value stream mapping uses the specification from the end customer as the reference to organize the activities of the business. Womack and Jones (1996) [38] however, argue that the value stream is all the specific actions require to bring a specific product through product definition (from concept through detailed design and engineering to product lunch), information management (from order taking through detail schedule to delivery) and physical transformation (from raw materials to a finished product in the hands of the customer), which are the three critical activities of any business. Other researchers argue that mapping the value stream can lead to compression of lead times; reduce costs, and improving customer service which are linked to business improved performance as well as achieving productivity improvement at supplier end (Taylor, 2009 [35] and Seth and Gupta, 2005).

Establish flow

Establishing the flow principles require reorganizing activities (designing, ordering, and production) from beginning to end to flow continuously to eliminate waiting, downtime or scrap within or between each step which are prevalent in batch-and-queue system (Womack and Jones, 1996). Womack and Jones (2003) [39] added that this flow can be achieved after defining the value and identifying the entire value stream and finally focusing on the actual object, which are stated above as specific design, specific order, and the product itself. Liker (2004) [25] contributing to the flow argument added that the continuous flow of the critical activities shortens the elapse time from raw materials to finished good or service and does leads to the best quality, lowest cost, and shorted delivery time.

Let the customers pull the product

The pull principles explain how the expected value to the end customer is initiated and obtained through continuous flow by tying the whole value stream together. The logic behind the pull principles is that the activities of the upstream should not commence until downstream customer ask for product or services from the upstream (Womack and Jones, 2003). Womack and Jones (1996) [38] argue that organizations experiencing obsolete design, finish-goods inventories, elaborate inventory tracking system, and remaindered goods no one want, can eliminate these when customers are allowed to pull the product from the value stream. Liker (2004) [25] added to the pull principles argument by establishing that companies eliminate the push system when pull principle is initiated at the call of customer demand to supply goods and services which obsolete design, finish-goods inventory, prevent elaborative inventory tracking system and remaindered goods no one want.

Strive for perfection

The principles of perfection eliminate the notion of one-time fix in improvement. Womack and Jones (1996) [38] argue that the process of reducing efforts, time, space, cost and mistakes in organization cannot end in anyway when the organization is focusing on offering products that the customer want. They further added that focusing on the customer wants exposes the entire hidden problem in the value stream as customer pulls the value from the value stream (Womack and Jones, 2004). This argument assert that perfection will have to be pursued through continuous radical and incremental improvement due to the exposure of hidden problems in the value stream as a customer pulls value. This radical and incremental improvement require reviewing of the lean principles from value specification, value stream, flow and pull to identify none-value added activities and deciding on the order in which none-value added activity can be eliminated to achieve perfection.

Lean Tools and Techniques

The implementation of the principles requires tools and techniques to ensure that the concept is achieving the purposes for which it was developed. The tools and techniques, however, describe the way to accomplish the implementation of the principles. In the context of lean management, the tools and techniques provide the means to achieve operational excellence through implementation of the lean principles in organizations (Liker, 2004) [25]. Liker (2004) argues that the lean principles drive lean tools and techniques, and these tools and techniques should not be seen as a secret weapon to transform business since organizations rely solely on the tools and techniques and not understanding the lean principles as a system which is internalized in the entire organization. Nicholas and Soni (2006) added that lean principles and the tools are seen as a system and its implementation is dependent on each other, thus the need to implement one before the other so that the benefit of reducing efforts, time, space, cost, and mistakes in organization (Womack and Jones, 1996) [38] can be achieved.

Just-In-Time (JIT)

The JIT technique is associated with product and service flow in lean environment, and to achieve this flow, product and service are to be delivered to the point of need only at the time of need and only the amount needed is delivered (Cudney and Elrod, 2011 [8], Ohno, 1988) [30]. The JIT application was first introduced in repetitive environment such as manufacturing which is characterized by high volume, low variability and inflexible process but has also found its way in non-repetitive environment, such as upstream oil and gas supply chain characterized by highly customized products, tailored to meet individual customers' needs (Bortolotti, Danese and Romano, 2013). When implementing JIT in the non-repetitive and intermittent business environment, that is upstream oil and gas supply chain, Diaz and Ardalan (2010) [12] argue that the incorporation of customer waiting information as added information in making a sequencing decision process improves system performance when implementing JIT in intermittent business environment.

Value Stream Mapping (VSM)

The VSM, as a lean tool and technique is used to identify value added activities and non-value-added activities through a process all the activities required to produce a product/service or product family from conception to lunch, order to delivery and raw materials to the customer is identified (Cudney and Elrod, 2011) [8]. When using VSM, the entire process (of supply chain, company, or a department) is documented on a single sheet of paper to encourage dialogue and better understanding of the process (Cudney and Elrod, 2011) [8]. Also, in area of process visualization, identifying processes main criticalities, analysis and redesign of production and supply chain process (including material flow and information flow), VSM is the best and effective lean tool to use (Matt, 2014 [27]; Braglia, Carmignani and Zammori, 2006). Howell (2013) also added that VSM is a high-level visualization tool for recording all of the process that touch the product as it proceeds to the market or point of delivery. Matt (2014) [27] however, argue that the VSM is applied in high volume repetitive environment such as manufacturing and its applicability in non-repetitive (where activities are in projects, make-to-order, and Engineer-to-order) such as upstream oil and gas environment require some guidelines to optimize the process between current and future state mapping due to variation in times, workload, and inventory level.

Supplier Involvement/Integration

The application of supplier involvement and integration in lean operations is leading to fixing of the organizations challenges and supplier challenges in the areas of capability, capacity, cost, quality, and lead time (Womack and Jones, 2003) [39]. To achieve a common goal of quality, cost and JIT delivery which forms part of daily complex coordination in supply chain management, Liker (2004) [25] argues that suppliers are considered as extended family to grow with the business by adopting the processes and philosophies of the business such as lean philosophy through teaching and working on project as well as challenging suppliers to improve with aggressive targets and challenging them to meet these stretched targets. Feng, Sun and Zhang (2010) [15] also argue that supplier involvement is a strategic resource and has effect on competitive advantage such as high-quality levels, cost leadership, fast and reliable delivery, sufficient flexibility and satisfactory services.

Standardization

The concept of standardization is used in lean environment as a tool to combine material, workers and machine to produce efficiently (Ohno, 1988) [30]. Ohno (1988) [30] added that the standard work procedure involves cycle time (that is, the time allotted to produce one piece or a unit), work sequence (sequence of operations, or the order of operations in which item is process by worker) and standard inventory (which is the minimum intra-process work-in-process require for operation to proceed). Nicholas and Soni (2006) argued to differentiate standard work and work standard which is important to lean operation where continuous improvement is important. He argues that the standard work is created by a team of workers on the shopfloor or on the job whereas the work standard is imposed already developed standards by specialist.

Customer Involvement

The use of customer involvement as a lean tool and technique defined the use of information; requirement and specification from the customer in creating value that meet the customer expectation. In an argument by Womack and Jones (2003) to support the involvement of customers in lean environment to create value, they added that the customer involvement contributes to achieving improved product development, order taking and production activities. Lau (2011) [24] added that customer involvement through integration helps identify market and technology opportunities, reduce poor design in the early stage and generate new ideas about product innovation leading to better product innovation performance as well as optimizing the total performance of the partners in the supply chain. He also added in the context of dynamic environment that external integration with customers increase the efficiency of the application of specialized knowledge in product innovation (Lau, 2011) [24].

Continuous Improvement/Kaizen

The use of continuous improvement as a lean tool is to pursue perfection through radical incremental improvement in the value stream. Womack and Jones (2003) argued that, for organization to become lean enterprise that organization is require pursuing perfection in the whole value stream through continuous improvement and not in single activities. Kerrin (2002) [18] also added in the context of supply chain management that, the engagement of external agencies such as customer and suppliers provides a source of problems and opportunity which require improvement through continuous improvement activities where the customer and supplier share information on supplier cost and production techniques which they look at how savings can be made and quality can be improved, and also allowing the supplier to make an acceptable profit. In another argument by Kerrin (2002) [18] he added that organizations encourage continuous improvement through quality circles, improvement workshop and suggestion schemes and allows the integration of continuous improvement in production and other targets where yearly targets are improved when there are deviations to the targets, and continuous improvement activities become useful in environment where standardization is functioning (Liker, 2004) [25].

Root cause Analysis (5Whys)

The root cause analysis (5Whys) is used as a lean tool to uncover root problems of any activities and task and correct it (Ohno, 1988) [30]. Womack and Jones (2003) [39] add that the implementation of root cause analysis using the five Whys leads to elimination of root causes of variances that result in firefighting by managers. Liker (2004) [25] argues in the context of correct application of the five whys for root cause analysis, and that it should not lead to jumping to preconceive conclusions but rather recognizing the simple but true answer to the question. He also cautions that the five whys is note pre-developed template format and should not be forced into five boxes by trying to identify the correct chain with five answers, but rather focus on simpler and more obvious answers in order to allow the discovery of all possibilities and also knowing that the causal chain may branch at any level and yield unknown answers (Liker, 2004) [25].

Employee Involvement

The employee involvement tool plays a major role in the lean activities where the employees become responsible towards sustaining the continuous improvement in the organization. Nicholas and Soni (2006) argued that the way to achieve work organization cleanliness and commitment to continuous improvement in quality and process is through engaging the employees who are actually involve in the work. In another argument by Amah and Ahiauzu (2013) [4] concerning the effect of employee involvement on organizations profitability, productivity and market share, the employee's involvement in decision making and implementation result in the ownership and responsibility of the employees towards the organization and their commitment to the performance of the organization in profitability, productivity, and market share.

Visual Control/Management

The Visual control or management tool also known as management by sight in lean environment discloses the standards, status and performance of systems and activities to the workplace through posting of charts or diagram (Nicholas and Soni, 2006 Womack and Jones, 2003) [39]. Nicholas and Soni (2006) argued by comparing visual management to management by report where in a case of visual management, cards and charts, such as quality, schedule and performance are posted at the workplace and the use of diagrams to illustrate procedures for standard of operation, setup, equipment maintenance and workplace organization; whereas in case of management by report, computer is used to accumulate data, summarize, refined and sanitized, which is invaluable but not for group communication (Dennis, 2007) [9]. It is added that visual control or management makes facts and figures alive and close to the workforce and make information necessary for decision making available in hands of people who must act on the decision.

Pull system/Kanban

The pull system and Kanban tools have different functions within lean environment but are used together, this means one rely on the other to achieve their purpose in lean system. A pull system in lean environment is described as a system that prevents or block the flow from the upstream until the customer downstream asks for it, whereas the Kanban signals or make information flow smoothly backwards at the same rate products flow forward (Womack and Jones, 2003). In area of pull and Kanban functioning together, Liker (2004) [25] argued that the Kanban initiate the pull system by signaling the previous step which then creates the pull which cascade backwards to the beginning of the cycle.

5S/housekeeping

The 5S or housekeeping is lean tool used to achieve a clean and manageable work area in organization practicing lean (Womack and Jones, 2003) [39]. The 5S is well explained when the Japanese source is used to explain it meaning, which are; seiri (organization), seiton (tidiness), seiso (purity), seiketsu (cleanliness) and shitsuke (discipline) (Womack and Jones, 2003) [39]. Liker (2004) [25] also added that the 5S is a series of activities that eliminate errors, defects and injuries in the workplace and argued that without the 5S problems at the workplace will be covered up and also result in dysfunctional way of doing business. However, the 5S create a continuous process for improving the work environment (Liker, 2004) [25].

Overview of Ghana Upstream Oil and Gas Supply Chain and Challenges

The upstream oil and gas supply chain is made up of integrated activities such as exploration, development, and production, supported by services companies which provide equipment and services to exploration and production (E&P) companies (Downey, 2009) [13]. Supply chain is explained by Stevens (1989) as a connected series of activities which is concerned with planning, coordinating and controlling, parts and finished goods from suppliers to the customer and further added that it has objective of synchronizing the requirements of the customer with the flow of materials from suppliers to have a balance in the conflicting goals between the customer and supplier in area of high customer service, low investment in inventory and low unit cost. However, in the upstream oil and gas supply chain, the Oil and Gas Service Companies are classified as the suppliers which engage in exploration and production activities through provision of equipment and services to the Independent or International Oil Companies (IOCs) with National Oil Companies (NOCs) who are the customers.

Application and the role of Lean tools and techniques in the Ghana Upstream Oil and Gas Supply Chain

The integration of the upstream oil and gas supply chain requires continues supply of service and equipment to sustain it operation to deliver value to shareholders, however the industry and the supply chain is suffering from lack of local supplier capability to support the industry in oilfield services as well as government regulations which empowers the local suppliers, such as the Ghana local content law (Chima, 2007 [6]; Azaah, 2013; Agyei *et al*., 2013) [1]. Agyei et al., (2013) [1] enumerated some of the challenges facing the supply chains in Ghana, which is supply of low-quality products, unreliable or variable lead times, and non-availability of local firms of international standard and high transportation cost.

Supplier Involvement/Integration in Ghana Upstream Oil and Gas Supply Chain

The supplier involvement/integration lean tool extends the lean journey to suppliers/ contractors who are a large and essential part of the business. The reduction of the number of suppliers and building long-term relationship results in significant supply chain improvement where the contractors are now business partners with increased level of involvement, responsibility, and engagement for the long term. De Wart (1994) argues that the adoption of supplier involvement/integration support cost reduction that is needed to develop and produce hydrocarbons economically in the on-going challenge of upstream oil and gas industry. When explained further the application lean tool in oil and gas drilling activity, he added that the identification of lean application in drilling and production industry requires analogy between the automobile and the oil industry in which management and organization methods are applied successfully.

Customer Involvement in Ghana Upstream Oil and Gas Supply Chain

The Customer Involvement lean tool used in government regulated environment where local content law and supplier involvement is a requirement in upstream oil and gas supply chain, the customers who are the IOCs and Service companies provides the information; requirement and specification that enable the local suppliers to create value that meet the customer expectation. Womack and Jones (2003) [39] added that an improvement achieved in this situation is product development, order taking and production activities, this is because the suppliers have the required information and specification through engaging the customer from the beginning of the purchasing process through to delivery of the final product and services.

Standardization in Ghana Upstream Oil and Gas Supply Chain

The standardization tool used in upstream oil and gas supply chain has contributed to the bottom-line, with cycle time reduction and improve quality. Allan, Gold and Reese (2013) [2] added to the application of lean principles in the oil and gas industry and argued that the oil and gas industry is slow to adapt to new technology and techniques. However, lean manufacturing mentality has introduced new ideas and ways of performing knowledge work that may change this paradigm and contribute to the bottom-line with reduce cycle time and improve quality. This will also ease geoscience and engineering professionals from fixing less issue and concentrate on creative work. However, the use of standardization and standards for work products and information in the area of knowledge management, that is, use of templates to document geological field studies has led to removal conflicting interpretations of data so that users see a single interpretation.

Oil and Gas Supply Chain

The continuous improvement/Kaizen lean tool used in the Ghana upstream oil and gas supply chain is to achieve perfection through incremental improvement in the value stream (Womack and Jones, 2003) [39]. The application of standards as well as engaging customers and suppliers in the Ghana upstream oil and gas supply chain does not end there but require pursuance of perfection in the whole value stream through continuous improvement (Womack and Jones, 2003) [39] to bring the local suppliers to a level of industrial acceptable capability and capacity to support the industry. The Ghana upstream oil and gas supply chain could benefit from the use of continuous improvement and kaizen where the IOCs and Oilfield Service company engage the suppliers and their activities for improvement to achieve efficiency in delivery of services and reduction of their inventory to support the oil and gas industry. Liker, (2004) [25] argued that the use of continuous improvement(kaizen) can make waste and inefficiencies visible when process is stable and standardized.

Empirical Review

Ugolo (2021) [36] investigated the effect of LEAN supply chain management on the profitability of oil & gas firms in Nigeria. The study shows that establishment of lean process for organizations supply chain management is critical to competitiveness and sustainable profitability in the oil and gas industry. Also, Al Saadi *et al*., (2024) [3] study the impacts of lean supply chain practices on supply chain performance in the procurement department in Oman's oil and gas sector. The study concluded that value stream mapping directly affects supply chain performance, and delivery performance. Equally, Rachman and Ratnayake (2019) [33] investigated the "Adoption and implementation potential of the lean concept in the petroleum industry", and the finding was that lean principles have been used to improve operational and technical aspects, contractor/supplier relationships, team organization and project management practice in the petroleum industry.

Methodology

Research Design

A quantitative study was employed for this study. Kumar (2018) [22] lists experimental, non-experimental, quasi-experimental research, correlation research and cross-sectional survey designs as the forms under re quantitative approach. A cross-sectional survey was adopted for this study since data were sent and retrieved from respondents within a particular period.

Population of the study

The population is the whole set of entities that decisions relate to (Easterby-Smith *et al*., 2015) [14]. The population for this study therefore comprises National Oil Company, The International oil Companies, and the Service Companies in the Ghana Upstream Oil and Gas supply chain.

Sampling Technique and Sampling Size

Sampling techniques are population reduction methods used to restrict data collection to a subgroup of a population since it is almost impossible to collect data from every single individual or units within a population in most cases. The snowball sampling technique was adopted since the population is not known and in such situation n = (Z σ/E) ^2 formular is used with parameters, Z-score (Z = 1.645), standard deviation (σ = 0.5) and margin of error (E = 0.1) to obtain the sample size of 68, where n is the sample size (Smith, 2013). Cudney and Elrod (2011) [8] adopted similar strategy in a survey (study of lean implementation in supply chain) and selected sample from a group of people who Practise lean in the supply chain and obtained seventy-five

respondents to the survey questionnaire where the approximate respondent needed to have a valid sample size was sixty respondents.

Sources of data

The main source of data for the study was online survey (SurveyMonkey). A close-ended structured questionnaire was used in carrying out the survey.

Data Analysis

All data received were transformed through data cleansing and analyzed in SurveyMonkey. Descriptive statistics (used to describe the basic features of the data in a study, and carried out through frequency distributions, summary statistics) and charts to present the final survey data.

Validity and Reliability of Data

The quality of a research work is viewed from the validity (the degree to which the research measure what it purports to measure) and reliability (the degree to which comparable results could be reproduced under similar condition) (Stoop and Harrison, 2012) [34]. There are internal validity and external validity (Creswell, 2018) [7]. From Creswell (2018) [7] internal validity avoids the contradiction of study results, that is, its extent is to claims that the independent variable truly influences the dependent variable.

In this study, the questionnaire was pre-tested using 10 staff from International oil Companies, and the Service Companies in the Ghana Upstream Oil and Gas supply chain, who works in supply chain, engineering, operations, and business development department, the simple reason that the characteristics of the respondents were like those in the study (Ghana Upstream Oil and Gas Industry). On the other hand, external validity deals with the possibility of generalizing the findings of the study beyond the population used.

It raises concern regarding the conditions and types of subjects for which the study can be used (Creswell, 2018) [7]. Due to the different characteristics of lean practitioners in Ghana Upstream Oil and Gas Industry and others, claims of the outcome of the study being generalized to other industries will depart much from the outcome of this study.

Ethical Consideration

The issue of ethics is important in all forms of research and this research work is not different from carrying out or considering ethical issues in relation to the research work. An important aspect of this research work is that it took place in Ghana upstream oil and gas environment where information security and confidentiality is critical. However, the research seeks to study the adoption of lean tools and techniques in Ghana upstream oil and gas supply chain and the information required is not one of the information seen to be critical in the oil and gas environment, such as pricing strategy and internal financial information. Also, the research is not covering area of human protection such as abuse or exposing to vulnerability. However, the result from the survey represents the accurate reflection of the information provided by the respondents (Oldendick, 2012) [31], which is important in fulfilling the research ethics criteria. Also, other issues considered in this survey work are protection of respondent confidentiality, willingness, and consent of respondent.

Discussions and results

Background Characteristics

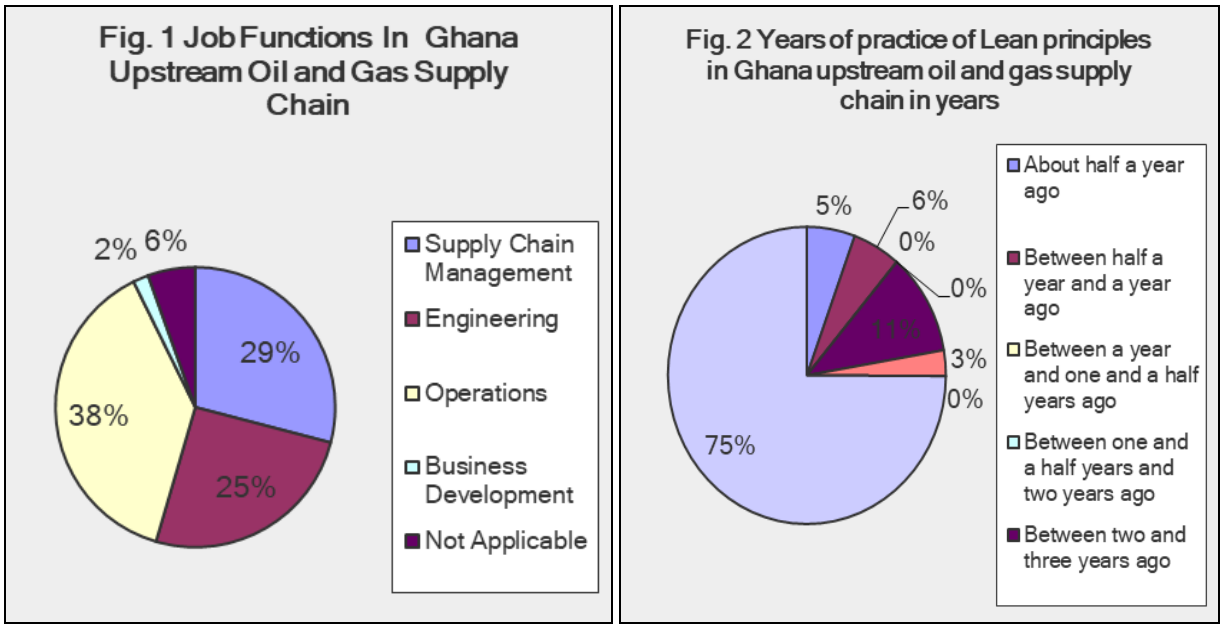

Fig 1&2: Author's Fieldwork (Author, 2023)

The findings from the survey response regarding the job function of the participants indicate operations (38%), supply chain management (29%), engineering (25%), business development (2%), and others (6%). As part of demography to identify the years of practicing lean principles in the Ghana upstream oil gas supply chain by the participants, the results indicate a ranges of half a year to over five years, that is about half a year (5%), between half a year and over a year (6%), between two and three years (11%), between three and four years (3%), more than five years (75%)

Use of Lean tools and techniques in Ghana upstream Oil and gas supply chain

In examining the use of lean tools and techniques in Ghana upstream oil and gas supply chain, the survey results shows a range of lean tools and techniques used and through ranking, customer involvement came up as the most lean tool used followed by continuous improvement/kaizen and the rest are 5S/housekeeping, Standardization, Root cause Analysis (5Whys), Employee Involvement, Supplier Involvement/Integration, Pull system/Kanban, Value Stream Mapping (VSM), Visual Control/Management, and Just-In-Time (JIT). The work of Soni and Nicholas (2006) and Cudney and Elrod (2011) [8] support this result and their work provide the same list of lean tools and techniques used to improve health and safety, quality, product development, customer expectation, delivery reliability, innovation, cost reduction and problem-solving. The survey result also shows the impact of lean tools on these business performances, which are listed as per the ranking result; health and safety as the most rank followed by quality, and product development, customer expectation, delivery reliability, innovation, cost reduction, problem-solving, information sharing, process cycle time, and inventory reduction. De Wardt, 1994 [10] and Van Zandvoord *et al*., 2009 [37] argued that oil and gas industry achieve this kind of improvement when lean tools and techniques are implemented. Figure 3 and 4 below present the average ranking of the survey result of addressing the first research objective of identifying lean tools, and techniques, and implementation in Ghana upstream oil and gas industry.

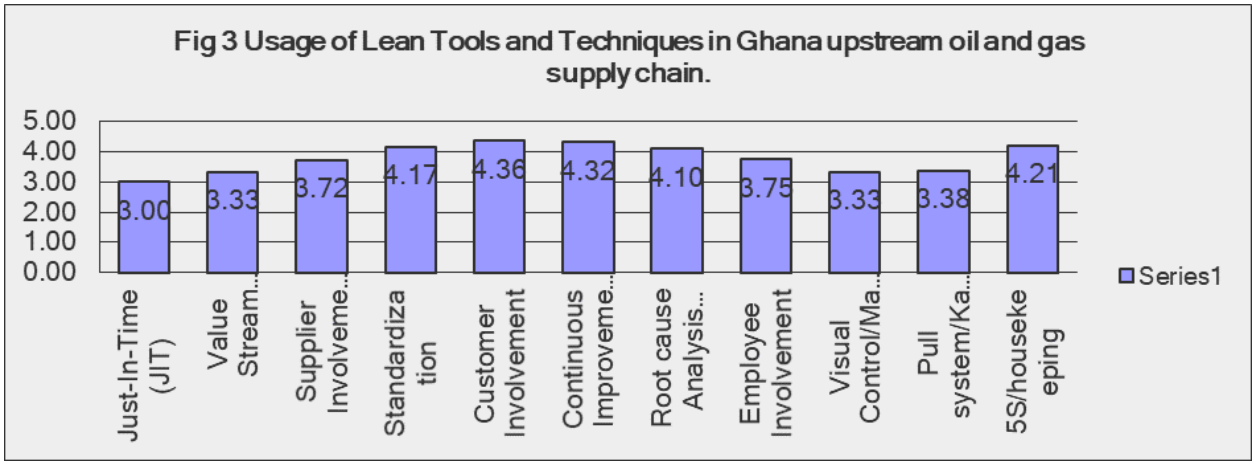

Fig 3: Author's Fieldwork (Author, 2023)

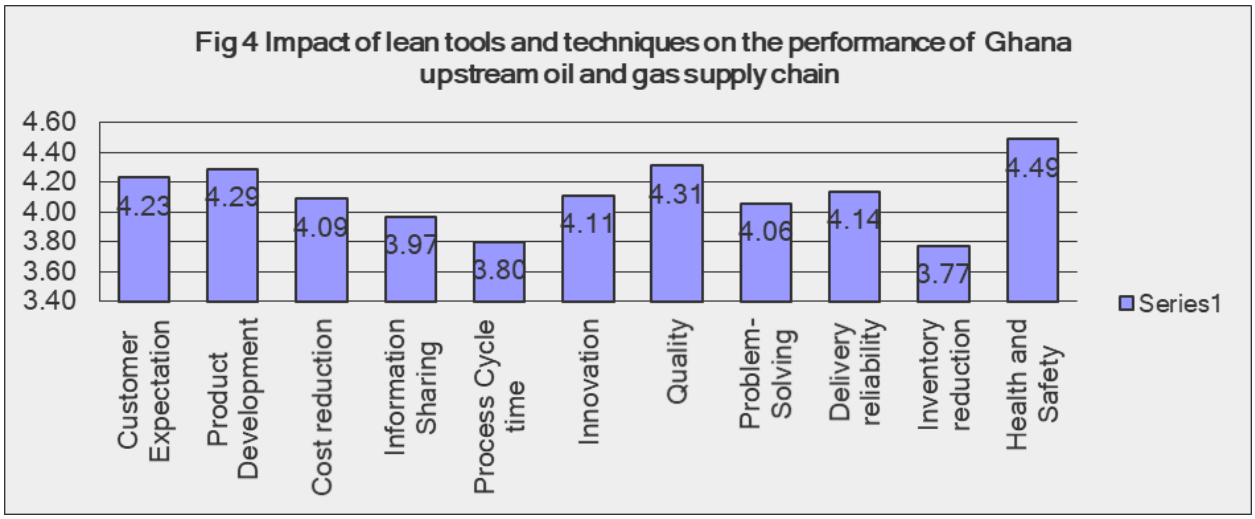

Fig 4: Author's Fieldwork (Author, 2023)

Adoption of lean tools and techniques in Ghana upstream oil and gas supply chain

The adoption of lean tools and techniques in Ghana upstream and oil and gas supply chain through the survey in the context of supplier development in a local content environment, shows that 5S/housekeeping is ranked highest followed by Pull system/Kanban, Employee Involvement, Visual Control/Management, continuous improvement/kaizen, Root cause Analysis (5Whys), customer involvement, Standardization, Just-In-Time (JIT), Supplier Involvement/Integration, Value Stream Mapping (VSM), The work of De Wardt (1994) [10] and Van Zandvoord *et al*., (2009) [37] argued that the upstream oil and gas industry has had some level of adoption of lean tools and techniques through customer and supplier integration, standardization, and continuous improvement. The survey result is however in variant to observation of De Wardt (1994) [10] and Van Zandvoord *et al.*, (2009) [37] where 5S/housekeeping, Pull system/Kanban, and Employee Involvement as highly ranked. Soni and Nicholas (2006) and Cudney and Elrod, (2011) [8] added that these lean tools and techniques are used in regulated business environment where suppliers lack capability and capacity such as Ghana upstream oil and gas supply chain (Agyei *et al.*, 2013 [1];

Azaah, 2013). The other response obtained from the survey revealed local supplier improvement because of lean tools and techniques implementation, and the result is that delivery lead time is ranked high as highly proved followed by business performance, supplier response time, knowledge of product and supplier awareness of the industry. The work of Soni and Nicholas (2006) and Liker (2004) [25] argued that the use of these lean tools and techniques lead to achieving this set of improvement with the suppliers. Figure 4 and 5 below shows the survey response and addresses the research objective of determining the level of adoption of lean tools and techniques in Ghana upstream oil and gas supply chain.

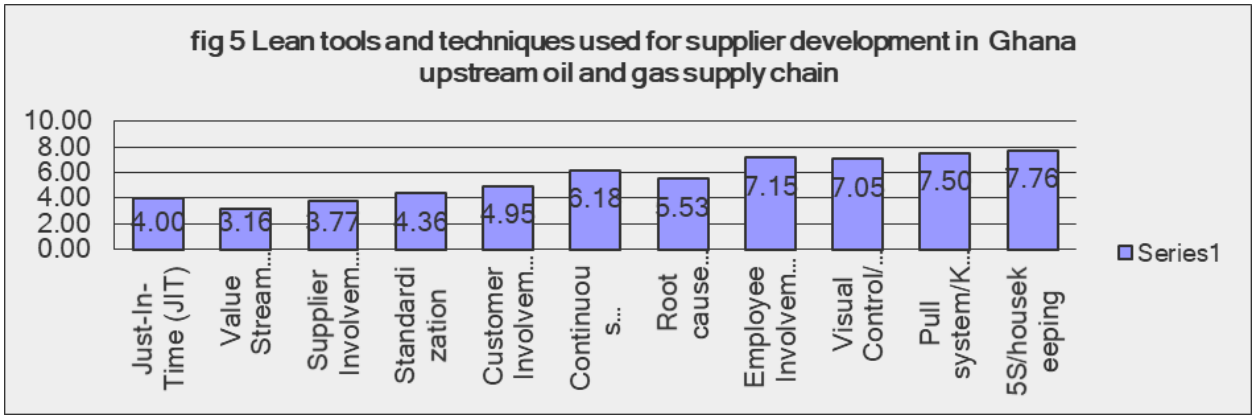

Fig 5: Author's Fieldwork (Author, 2023)

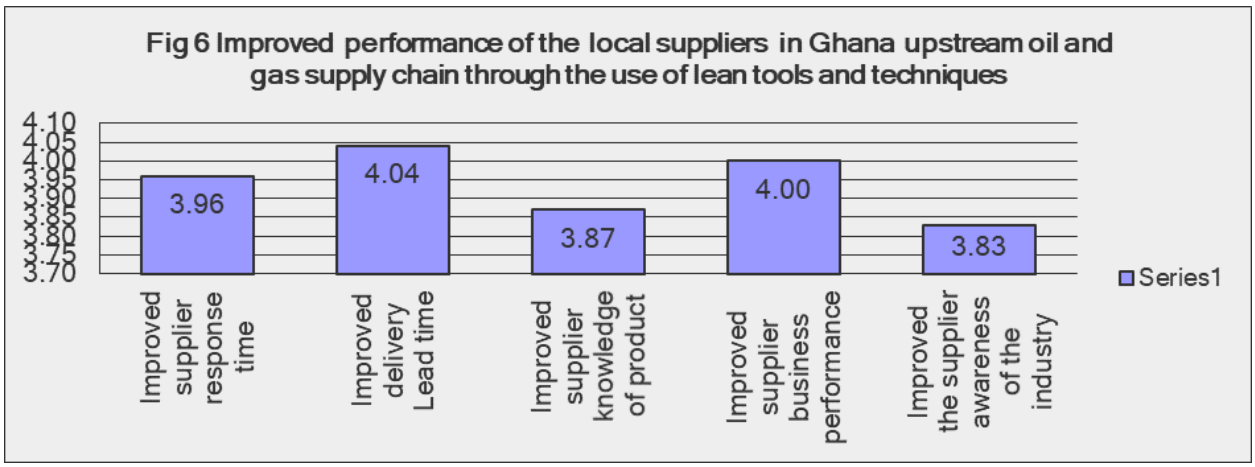

Fig 6: Author's Fieldwork (Author, 2023)

Conclusions and Recommendations

Conclusion

1. It can be concluded that all the lean tools and techniques (customer involvement came up as the lean tool mostly used followed by continuous improvement/kaizen and the rest are 5S/housekeeping, Standardization, Root cause Analysis (5Whys), Employee Involvement, Supplier Involvement/Integration, Pull system/Kanban, Value Stream Mapping (VSM), Visual Control/Management, and Just-In-Time (JIT)) tested are used in Ghana upstream oil and gas supply chain.
2. From the result of the studies, continuous improvement/kaizen, 5S/housekeeping, Standardization, Root cause Analysis (5Whys), Employee Involvement are the most used lean tools and techniques in Ghana upstream oil and gas supplier chain.
3. It was revealed that 5S/housekeeping, pull system/Kanban, Employee Involvement, Visual Control/Management, continuous improvement/kaizen, Root cause Analysis (5Whys) are highly used for supplier development in upstream oil and gas industry, however the literature indicates that customer and supplier integration, standardization, and continuous improvement are critical for supplier development.
4. The result revealed that business performances in area of health and safety, quality, product development, customer expectation, delivery reliability, innovation, cost reduction, problem-solving, information sharing, process cycle time, and inventory reduction were improved when the lean tools are implemented in Ghana upstream oil and gas supply chain
5. It was also noticed from the survey result that local supplier performance has improved (that is delivery lead time, business performance, supplier response time, knowledge of product and supplier awareness of the industry) when lean tools and techniques are employed in Ghana upstream oil and gas supply chain.

Recommendation

1. Management and managers in Ghana upstream oil and gas industry are to increase awareness of use and benefit of lean principles, tools, and techniques in their organizations.

2. Supplier development is critical in local content environment; hence management are to continuously adopt the use of critical lean tools such as customer and supplier integration, standardization, and continuous improvement even though the other equally used lean tools have some impact on supplier development and their performance in the Ghana upstream oil and gas supply chain.

Future Studies

The studies focused on the international oil companies (IOC) and Oil service companies without including the local supplier in the Ghana upstream oil and gas supply chain, hence future studies can include the local supply base to expand the sampled population. Including the local supply base in Ghana upstream oil and gas supply chain can test the improvement achieved by IOC and Oil Service company in supply development. Other researchers can carry out further studies in other sector where supplier capability and capacity need to be developed.

Reference

1. Agyei EK, Sarpong KO, Anin EK. The challenges of supply chain in the gold mining sector of Obuasi municipality of Ghana. Int J Bus Soc Res, 2013, 3(9).
2. Allan ME, Gold DK, Reese DW. Application of Toyota's Principles and Lean Processes to Reservoir Management: More Tools to Overload the Toolbox or a Step Change in Our Business? SPE Econ Manage,2014:6(2):67-87.
3. Al Saadi AGK, Amuthakkannan R. An Impact of Lean Supply Chain Practices in Oil and Gas Sector in Sultanate of Oman–A case study. Tuijin Jishu/Journal of Propulsion Technology, 2024, 45(1).
4. Amah E, Ahiauzu A. Employee involvement and organizational effectiveness. J Manag Dev,2013:32(7):661-74.
5. Butler P, Tregaskis O, Glover L. Workplace partnership and employee involvement–contradictions and synergies: Evidence from a heavy engineering case study. Econ Ind Democracy,2013:34(1):5-24.
6. Chima CM. Supply-chain management issues in the oil and gas industry. J Bus Econ Res,2007:5(6).
7. Creswell JW, Creswell JD. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2018.
8. Cudney E, Elrod C. A comparative analysis of integrating lean concepts into supply chain management in manufacturing and service industries. Int J Lean Six Sigma,2011:2(1):5-22.
9. Dennis P. Lean Production Simplified,2nd ed. Productivity Press, 2007.
10. de Wardt JP. Lean Drilling–Introducing the application of automotive LEAN manufacturing techniques to Well Construction. In SPE/IADC Drilling Conference and Exhibition, 1994. SPE-27476.
11. Dhandapani V, Potter A, Naim M. Applying lean thinking: a case study of an Indian steel plant. Int J Logist Res Appl,2004:7(3):239-50.
12. Diaz R, Ardalan A. An analysis of dual-Kanban just-in-time systems in a non-repetitive environment. Prod Oper Manag,2010:19(2):233-45.
13. Downey M. Oil 101. Wooden Table Press, 2009.
14. Easterby-Smith M, Thorpe R, Jackson P. Management research. 4th ed. Sage Publications, 2012.
15. Feng T, Sun L, Zhang Y. The effects of customer and supplier involvement on competitive advantage: An empirical study in China. Ind Mark Manag,2010:39(8):1384-94.
16. Grove SK, Gray JR, Burns N. Understanding Nursing Research: Building an Evidence-Based Practice. 6th ed. Elsevier Saunders, 2015.
17. Karlsson C, Åhlström P. A lean and global smaller firm? Int J Oper Prod Manag,1997:17(10):940-52.
18. Kerrin M. Continuous improvement along the supply chain: the impact of customer-supplier relations. Integr Manuf Syst,2002:13(3):141-9.
19. Krafcik JF. Triumph of the lean production system. Sloan Manage Rev,1988:30(1):41-52.
20. Kohfeldt D, Langhout RD. The five whys method: A tool for developing problem definitions in collaboration with children. J Community Appl Soc Psychol,2012:22(4):316-29.
21. Leavy P. Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches. Guilford Publications, 2022.
22. Kumar R. Research methodology: A step-by-step guide for beginners. 4th ed. Sage, 2018.
23. Lamming R. Squaring lean supply with supply chain management. Int J Oper Prod Manag,1996:16(2):183-96.
24. Lau AK. Supplier and customer involvement on new product performance: contextual factors and an empirical test from manufacturer perspective. Ind Manag Data Syst,2011:111(6):910-42.
25. Liker JK. The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer. McGraw-Hill, 2004.
26. Liker JK, Morgan JM. The Toyota way in services: the case of lean product development. Acad Manage Perspect,2006:20(2):5-20.
27. Matt DT. Adaptation of the value stream mapping approach to the design of lean engineer-to-order production systems: A case study. J Manuf Technol Manag,2014:25(3):334-50.
28. Meng X. Lean management in the context of construction supply chains. Int J Prod Res,2019:57(11):3784-98.
29. Moyano-Fuentes J, Sacristán-Díaz M, Martínez-Jurado PJ. Cooperation in the supply chain and lean production adoption: Evidence from the Spanish automotive industry. Int J Oper Prod Manag,2012:32(9):1075-96.
30. Ohno T. Toyota Production System: Beyond Large-Scale Production. Productivity Press, 1988.
31. Oldendick RW. Survey research ethics. In: Handbook of survey methodology for the social sciences. Springer New York, 2012, 23-35.
32. Panwar A, Nepal BP, Jain R, Rathore APS. On the adoption of lean manufacturing principles in process industries. Prod Plann Control,2015:26(7):564-87.
33. Rachman A, Ratnayake RC. Adoption and implementation potential of the lean concept in the petroleum industry: state-of-the-art. Int J Lean Six Sigma,2019:10(1):311-38.

34. Stoop I, Harrison E. Classification of surveys. In: Handbook of survey methodology for the social sciences. Springer New York, 2012, 7-21.
35. Taylor DH. An application of value stream management to the improvement of a global supply chain: a case study in the footwear industry. Int J Logist Res Appl,2009:12(1):45-62.
36. Ugolo OJ. Application of LEAN supply chain management as a panacea to sustainable future profitability in the Nigerian oil and gas industry. In: SPE Nigeria Annual International Conference and Exhibition, 2021. p. D031S020R004.
37. van Zandvoord WEJ, et al. Applying lean principles to achieve breakthrough performance gain from existing asset. In: SPE Asia and Pacific Oil and Gas Conference and Exhibition, 2009, 1-4.
38. Womack JP, Jones DT. Beyond Toyota: How to root out waste and pursue perfection. Harv Bus Rev,1996:74(5):140-51.
39. Womack JP, Jones DT. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. Free Press, 2003.