International Journal of Petroleum and Gas Exploration Management
Vol.6, No.1, pp.11-32, 2023
Print ISSN: 2515-0863 (Print)
Online ISSN: 2515-0871 (Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Evaluation of Lean Manufacturing Concept Implementation in The Upstream Petroleum Industry Through Critical Success Factors

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doi: https://doi.org/10.37745/ ijpgem.15/vol6n11132 Published October 1 2023

Citation: Ayanaba, J., McLellan I., Kourouklis T., and Cano, M (2023) Evaluation of Lean Manufacturing Concept Implementation in The Upstream Petroleum Industry Through Critical Success Factors, *International Journal of Petroleum and Gas Exploration Management*, Vol.6, No.1, pp.11-32

ABSTRACT: *Lean Manufacturing (LM) implementation depends on careful identification and selection of appropriate critical success factors (CSFs) capable of supporting lean implementation success. Notwithstanding the ubiquity of LM, differences in culture and philosophy of an organization may call for a "unique" set of CSFs to enhance industry-specific LM implementation success. A critical review of extant literature revealed a paucity of studies of CSFs relevant for LM adoption in the upstream petroleum sector in developing economies. This paper, therefore, sought to fill this gap by proposing suitable CSFs for upstream petroleum operations in developing economies. The study adopted a survey-based approach with 115 respondents purposively sampled from upstream petroleum-based organisations. Spearman correlation and Chi-square tests were performed. Data collected and analysed showed that from a list of 48 CSFs identified, 14 were suitable for adoption within the upstream petroleum operation. Thirteen (13) guidelines were also developed for the upstream sector. The results revealed that CSFs are not independent of Lean implementation guidelines. Management Commitment, Active Leadership Sustainable Production, Training and Skills Development, Work Environment, Continuous Improvement Organization, Lean Readiness, Shop Floor Management and Visual Management were found to be among the most critical CSFs for companies operating in the upstream sector of developing economies. The study makes a significant contribution to literature within the context of the study.*

KEYWORDS: critical success factors, lean management, petroleum production process, petroleum projects.

INTRODUCTION

Intense global competition, rapid technological advances in manufacturing as a consequence of the fourth industrial revolution(Saxby, Cano-Kourouklis and Viza, 2020) coupled with

sophisticated demands from discerning customers(Karim and Arif-Uz-Zaman, 2013), has resulted in a paradigm shift in manufacturing/production towards achieving operational and/or manufacturing excellence across all economic sectors(Rishi *et al.*, 2018). In search of operational excellence among several methodologies including Japanese Total Quality Control (JTQC), Total Quality Management(TQM), Deming's System of Profound knowledge, Six Sigma(Chiarini, 2011, 2012), Lean Management (LM) has been regarded by practitioners and academics alike as one of the most effective methods capable of propelling organizations to attain operational and/or manufacturing excellence(Mostafa, Dumrak and Soltan, 2015, Abdallah and Abdulsattar Al-Ali, 2016).

Lean management is perceived as a successor of Toyota Production System (TPS) and due to its proven effectiveness (Afonso and Cabrita, 2015), it is recognized as one of the world's known management systems (Ohno, 1988, Dekier, 2012). Although the focus of LM is on waste elimination, improved operational efficiency, value addition and enhanced employee and customer satisfaction, there is no single definition for lean(Ohno, 1988, Womack and Jones, 2003, Dombrowski and Zahn, 2011, Okhovat *et al.*, 2012, Dombrowski, Ebentreich and Krenkel, 2016, Sangwa and Sangwan, 2018). Bernardo Lopes de Andrade (2017), citing Langstrand (2012), stated that "Lean can have four distinctly different meanings: a condition (being Lean); a process (becoming Lean); a "toolbox" (doing Lean), or a philosophy (Lean Thinking)".

Lean can be:

- A management strategy which focuses on the elimination of waste by optimizing processes and improving customer value (Motwani, 2003, Pedersen and Huniche, 2011a, Netland, 2016a).
- A concept which seeks to help organizations attain a 'slim shape' (Parkes, 2015a), or
- A cost reduction strategy, an important performance indicator across sectors including the manufacturing sector (Achanga *et al.*, 2006a).

With only 10 – 20% of Lean implementation initiatives successful to a desired degree (Sessoms, 2008, Bhasin, 2012, Mostafa, Dumrak and Soltan, 2013), and a 60 – 90% lean implementation failure rate (Jadhav, Mantha and Rane, 2014, Pearce, Pons and Neitzert, 2018) it allows an opportunity to explore novel approaches to enhance successful Lean adoption. The foundation of any successful Lean initiative depends on proper identification of critical success factors (CSFs) relevant to the industry or company(Shank, Boynton and Zmud, 1985, Pedersen and Huniche, 2011b), whilst being cognisant of context, and company size.

In order to successfully measure the performance of Lean implementation, a number of researchers have developed frameworks composed of lean elements and critical success factors. Bhasin (2008) proposed the use of dynamic multi-dimensional performance (DMP) framework that is more robust and holistic than the balance scorecard. Mostafa, Dumrak and Soltan, (2013) developed a four-phased project-based framework. The first phase considered the human aspect of Lean implementation while the remaining three were technical in nature.

Sessoms (2008) designed an integrated framework, interactive teaching and learning which enhances interactive learning through technological advancement. A study by Pearce, Pons and Neitzert (2018) identified knowledge as a critical success factor for implementing Lean in firms with scarce resources.

The identification of critical success factors for lean implementation mirror the continuous evolving nature of the lean methodology, and this justifies why researchers continue to explore its suitability and applicability in different economic sectors(GODOLFIM, 2012, Kundu and Manohar, 2012, Parkes, 2015b, Souza and Alves, 2018). Many researchers have explored the subject in different sectors with similar success factors emerging. Consequently critical success factors for lean implementation are said to be ubiquitous(Ayarkwa, Joshua, Agyekum, Kofi, Adinyira, Emmanuel, Osei-Asibey, 2012, Netland, 2016b, Al-Maamari *et al.*, 2017). Contrary to the assertion that critical success factors are ubiquitous, and can be applied in all sectors, some researchers hold the view that organisational requirements, size of company, national culture and geographical, religious contexts may influence the set of factors required to support lean implementation success (Douglas, 2016, Barclay *et al.*, 2021). According to (Ohno, 1988), the focus of the lean philosophy is to enhance efficiency through the reduction of waste and maximize the use of time in the production process by reducing non- value-added processes.

The petroleum industry is the driving force behind transportation and many other industries worldwide with a market value of about (USD) $3,073.4 billion, and a total volume of 46,792.5 million barrels equivalent(Tsiga, Emes and Smith, 2017). The activities within the industry include exploration, extraction, refining and transportation. Other industries tend to accrue more revenues through the provision of goods and services to support the activities of the petroleum industry(Tsiga, Emes and Smith, 2017).

The main processes in the petroleum industry can be categorized into three main sectors (1) exploration, (2) production/extraction, and (3) refining and transportation, and the sectors include the upstream, midstream and downstream(Mariano and La Rovere, 2007, Guilherme *et al.*, 2011, Solheim and Tveterås, 2017, Coppock and Christian, 2018). For this research, the upstream sector deals with exploration, discovery and production stages of crude oil; the midstream consists in the transportation of the crude oil from storage to refineries, whilst the downstream sector focuses on marketing and distribution of the final product to end-users. (Devold, 2006, 2013, Jafarinejad, 2017).

With a focus on the upstream petroleum sector in developing economies with emphasis on the Ghana upstream petroleum sector, this research encapsulates an end – to – end description of the operations of the sector and outlines how lean manufacturing principles contribute or can contribute to improved efficiencies, waste elimination, safer working environment and highly motivated employees. Drawing on insights from available literature, requirements for upstream petroleum operations in developing economies may differ slightly from operations in developed countries. Hence, implementation of quality strategies including lean need to be analysed within the geographical context(Douglas, 2016, Yadav *et al.*, 2020).

Thus, the importance of identification and selection of the most appropriate success factors aligned to operational requirements of the industry cannot be overemphasized. Lean experts opine that lean fail at implementation(Bhasin, 2012, Bhamu, 2013, Panwar, Jain and Rathore, 2015, Netland, 2016a).

The multifaceted and sophisticated nature of the upstream operations underscores the significance of an appropriate constellation of CSFs for adoption in the sector.
A framework of the upstream petroleum operations puts into context the core activities within the entire upstream operations. A schematic outline of the core activities of the upstream petroleum sector is illustrated in Table 1(Devold, 2006, 2013)

Table 1: Categorization of Upstream Petroleum Operations

Upstream Processes	Core activities	References
Exploration	• Structural geological studies • Prospecting • Seismic surveys • Drilling activities • Evaluate well data. • Analysis to establish porosity and permeability. • Mathematical modelling of reservoir • Production test data to determine flow rate.	Jafarinejad (2016) Chan (2005) Devold (2009; 2013) Foss *et al.*, (2017) Fagan (1996)
Development	• Determination of number and location of wells • Types of wells • Assessment of well recovery • Well design • Process facilities • Infrastructural facilities • Terminal/export facilities • Maintenance strategies	Jafarinejad (2016) Chan (2005) Devold (2009;2013)
Production	• Production • Well casing • Injection • Production separators • Test and injection manifold	Jafarinejad(2016) Chan (2005) Devold (2009;2013)

The petroleum industry continues to face challenges arising from market volatilities and unpredictable production rates. The search for effective solutions to the global petroleum challenges is continuously being explored. Given this, previous studies have researched the history, evolution, application and challenges of lean principles across various industries (Ohno, 1988, Womack and Jones, 2003, Liker and Morgan, 2006, Dekier, 2012).

To enhance lean implementation, the essence of identifying and evaluating critical success factors that will contribute to enhance operational excellence and improve efficiencies in the petroleum industry cannot be overemphasized Achanga *et al.*, (2006a), researched critical success factors (CSFs) that support the implementation of Lean within the small and medium scale enterprises. Also,(Pearce, Pons and Neitzert, 2018) outlined the success and obstacles involved in the implementation of Lean within the printing industry. Similarly, (Tsiga, Emes and Smith, 2017), also conducted research on critical success factors for project implementation in the petroleum industry whilst (Rachman and Ratnayake, 2019) explored the state-of-the-art in the implementation of lean principles in the petroleum industry and concluded that the subject is still very much immature. Despite this, there still exists a paucity of literature on lean application in the petroleum industry in general, and the upstream petroleum sector in particular.

This paper sought to propose a constellation of suitable CSFs for lean implementation in the upstream petroleum industry and is significantly informed by Blijleven *et al.*,(2019), who recommends extensive studies in LM due to differences in contextual conditions that can affect its implementation. Table 2 presents a selection of various definitions of Lean extracted from the literature which highlights the lack of consensus in the definition of lean; thus, a particular definition of lean is dependent on the perspective of the researcher.

Critical Success Factors

As with the term 'Lean' there is no agreed definition of the term 'success' as applicable to the petroleum industry, nor are there agreed appropriate factors which will lead to lean implementation success. Notwithstanding this however, various scholars have identified generic factors that can lead to lean success.

A project is successful when its key stakeholders are satisfied with the project outcomes and when the project's initial targets are achieved. Traditionally, business leaders measure project success based on time, cost and quality objectives. Various recent studies recommend that a new set of measures are required to measure project success(Wateridge, 1998, Atkinson, 1999). According to (Müller and Jugdev, 2012), effective criteria for measuring project success is both industry and project-specific because each project will differ in size, complexity and uniqueness. Therefore, it is difficult to identify the unique set of measures of success for all industries(Westerveld, 2003).

Antony and Gupta (2019) conducted a study of Lean Six Sigma and proffer that, the success of a project(s) is dependent on stakeholders. Therefore, project success is thwarted by lack of effective communication. If there is no continuous dialogue among all key stakeholders, then the successful implementation of a project is compromised. Moreover, when a project does not succeed, the planned strategic aim of the organization will not be met; resources will be wasted, expectations of clients will not be fulfilled and, most importantly, organizational performance will be negatively affected (Bourne, 2005). To enhance project outcomes, therefore, the identification of Critical Success Factors (CSFs), taking cognizance of their implications, is crucial. This process enhances the planning process, reduces time and ensures judicious resource utilization.

Cognisant of the fact that varied viewpoints exist on how CSFs are defined; this paper defines CSFs as the essential requirements that contribute to the attainment of desirable project outcomes. Some researchers perceive CSFs as "those key areas of activity in which favourable results are necessary for a manager to reach his/her goals", or "those factors in a project that can lead to positive outcomes of all project stakeholder expectations and requirements".(Rockart, 1982, Futerer, 2004). Similarly, CSFs are perceived as "those few things that must go well to ensure success for a manager or an organization, and, therefore, they represent those areas/aspects that must be given special and continual attention to bring about high performance"(Shank, Boynton and Zmud, 1985).

Table 2: Definitions of Lean from the literature

Perspective	Definition	Reference
Manufacturing	Lean uses less, or the minimum, of everything required to produce a product or perform a service	Hayes and Pisano, 1994
Manufacturing	A system which utilizes significantly less resources (inputs) to create the same outputs comparable to mass production system with increased varieties for customers.	Womack and Jones, 1996
Automobile	The elimination of all types of wastes and irregularities from the manufacturing operations	Ohno, 1998
Lean Thinking	A business approach which delivers better customer value through elimination of all non-value-adding processes	Womack and Jones, 2003
Manufacturing	A five-step process including the defining customer value, defining the value stream mapping, pulling from the customer back and striving for excellence.	Liker, 2004
Manufacturing	A business model that delivers far superior performance for customers, employees, shareholders and society at large.	Bhasin, 2012
Manufacturing	An integrated sociotechnical system which comprises a package of management practices that can be applied to eliminate waste and reduce variability of suppliers, customers and internal resources and processes.	Mostafa, Drumrak and Soltan, 2013
Production	A way to achieve excellence in the organisational performance that starts from product development, supply chain and manufacturing activities.	Jasti and Kodali, 2016
Industry 4.0	A multi-faceted production approach comprising a variety of industrial practices, directed towards identifying value adding processes from the purview of customer and to enable flow of these processes at the pull of the customer through the organisation.	Adam, Chola and Jens, 2016
Production	A wide set of production practices for continuous improvement by eliminating waste or any other non-value-adding activities.	Khaba and Bhar, 2018
Production	Improving product development in order to increase speed and quality, and deliver value to the customer	Alahyari, Gorschek and Svensson, 2019

However, notwithstanding variations in viewpoints about CSFs, a common underlying factor is anchored on the understanding that critical evaluation and selection of appropriate success factors constitute the cornerstone of every project implementation success.

There is sufficient evidence to attest to the fact that critical evaluation and selection of CSFs constitute a pivotal role in the implementation success of any project. Thus, studies conducted across varied industrial sectors including; Construction(Berssaneti and Carvalho, 2015), Information technology(Almajed and Mayhew, 2014), generic projects(Müller and Jugdev, 2012), and petroleum projects (Tsiga, Emes and Smith, 2017) and petroleum (Rachman and Ratnayake, 2019).

Critical Success Factors (CSFs) and Lean Implementation

Some specific-sets of CSFs relevant to the successful implementation of Lean have been identified: there are those that state that there should be generic CSFs that could be universally applied across different sectors(Ohno, 1988, Womack and Jones, 1996, Liker and Morgan, 2006), however, there are others that different sectors/environments require different approaches(Hines, Francis and Found, 2006, Netland, 2016b, Knol *et al.*, 2018). This fundamentally underpins Contingency theory on four main factors including the implementation of Lean(Netland, 2016a).

Though experts posit that the core principles of Lean are ubiquitous and hence may have universal applicability(GODOLFIM, 2012), other researchers hold a contrary viewpoint, and postulate the need for industry-specific research to identify CSFs relevant to the culture and philosophy of specific industries(Kazmi, 2008, van Dun, Hicks and Wilderom, 2017). A study by Achanga *et al.*,(2006a), shows that leadership and management, finance, skills and expertise as well as organisational culture are critical success factors for lean implementation. Similarly, (Marodin and Saurin, 2013), also argued that management commitment is a critical factor responsible for success in lean implementation. Lean implementation success hinges on the successful implementation of support for lean implementation programmes, training and education, the availability of a long-term plan, provision of resources for implementation and the application of lean tools and techniques(Netland, 2016a). In another research, Belhadi, Touriki and El Fezazi(2016), identified leadership, management and policies as factors that should be prioritized in the implementation of Lean. Abu *et al.*,(2019), highlighted 5s and employee training as CSFs for Lean implementation in the wood and furniture industry.

Also, according to Alhuraish, Robledo and Kobi (2017), top management commitment, culture change, education and training, communication, employee involvement and establishing a link between Lean method and the strategies of businesses were the topmost CSFs for the implementation of Lean in the manufacturing sector.

Table 3 presents a compilation of 48 success factors based on the literature review from 23 published journal papers on CSFs across various industries. A total of 71 success factors were identified and subsequently reclassified into 48 CSFs. The rationale is to establish the

frequency of application of each of the 48 success factors identified. The illustration shows that Top Management Commitment and Support is the highest-ranked factor, followed by education and training and management leadership. Admittedly, the majority of Lean initiatives assume a top-down approach. Thus, management commitment and support and management leadership play a pivotal role in providing focus and direction for Lean projects. Undoubtedly, and admittedly so, the importance of employees with the requisite knowledge and skills to execute Lean initiatives cannot be overemphasized.
This approach has been adopted from a similar survey-based approach in which 76 empirically validated TQM factors were analysed(Sila and Ebrahimpour, 2003).

Table 3: Critical Success Factors from Literature

Frequency of occurrence	Critical Success Factors
01	1. Site management and supervision, 2. Overall managerial actions, 3. Cash flow, 4. Contractor experience, 5. Project team experience, 6. Project delivery system, 7. Project team monitoring, 8. Physical environment, 9. Regulatory/legal environment, 10. Social environment, 11. Economic environment, 12. Political environment,13. Client Goals and objectives, 14.project uniqueness and complexity,15.project organisation,16.Requirements management, 17.Contractual aspects,18.Project characteristics,19. Institutional factors,20.Client knowledge and experience, 21.External challenges,22. Increase diversification of customer base, 23. Professional staff productivity,24. Corporate image and market share, 25. Long term plan
02	1. Commit to, lead and take active part in lean programmes, 2. Project risk management, 3. Competence of project manager/project team,4. Experience of project manager/project team 5. Shop floor management
03	1. Process management, controls and audits,2. Link to Business strategy,3. Selection and Prioritization
04	1. Well-defined project goals, 2. Capacity to make and carry out decisions,3. Allocate resources and share gains,4. Continuous Improvement
05	1. Apply Lean tools and techniques,2. Measurement framework,3. Organisational culture/change management
06	Financial capability
07	1. Link to customer/customer satisfaction,2. Cooperation and trust with contractors and suppliers,3. communication
09	1. Employee involvement and empowerment, 2. Project Management and Quality planning skills, 3. Skilled cross-functional working teams
10	Management and leadership
12	Education and Training
16	Top Management Commitment and support

METHODOLOGY

Previous studies have used survey-based approaches to evaluate existing CSFs and propose appropriate CSFs for adoption across various sectors(Achanga *et al.*, 2006b, Brun, 2010, Singla Nitin, Khanduja Dinesh and Singh Tejinder Paul, 2011, Antony *et al.*, 2012a, Taner, 2013, Netland, 2016a, Pearce, Pons and Neitzert, 2018). Therefore, this study adopted a survey-based approach to design data collection, analysis and to propose a set of CSFs for Lean implementation in the upstream petroleum sector. For this research a 5 point Likert – Scale questionnaire was adopted on the basis that questions are easy to answer, self-explanatory and increase precision(Kitchenham and Pfleeger, 2002, Antony *et al.*, 2012a).

A total of 115 survey questionnaires were sent to three categories of employees: (i) operational staff, (ii) junior, and (iii) middle level managers within the upstream petroleum sector in Ghana. Seventy-five (75) questionnaires were returned. After screening and cleaning the data, 3 questionnaires were eliminated due to various inaccuracies. Thus, responses from seventy-two (72) questionnaires were analyzed. Data analysis was completed using the Statistical Package for Social Sciences (SPSS) with Spearman correlation and Chi-Square tests performed to determine the relationship between Critical Success Factors and Lean Implementation Guidelines. Based on the Cronbach's alpha value of 0.81, the internal consistency of the survey questionnaire is high.

RESULTS

The results of the analysis indicated Lean awareness among the target population. From the analysis, four valuable insights can be adduced.

Based on literature review on TQM, Lean and Lean Six Sigma, 14 CSFs were identified and used as the basis for the design of the survey instrument. The results of the analysis show the ranking of the CSFs suitable for adoption in the upstream petroleum sector include: Management Commitment (MC), Active Leadership (AL), Management Support t(MS), Communication (C), Organizational Culture(OC), Sustainability(S), Training and Skills Development(TSD), Shared Vision(SV), Financial Capability(FC) and Work Environment(WE), Continuous Improvement Culture(CI), Measurement Framework(MF), Supplier Benchmarking(SB) and Lean Readiness(LR). The results show little or no significant disparity from many prior researchers in TQM, Lean and Lean Six Sigma in which similar findings were obtained(Worley and Doolen, 2006, Singla Nitin, Khanduja Dinesh and Singh Tejinder Paul, 2011, Antony *et al.*, 2012a, Müller and Jugdev, 2012, Taner, 2013, Almajed and Mayhew, 2014, Lean Enterprise Institute, 2014, Thanki and Thakkar, 2014, Sisson and Elshennawy, 2015, Netland, 2016a, Chen *et al.*, 2018). Figure 2 presents the success factors identified and ranked in order of frequency of applicability.

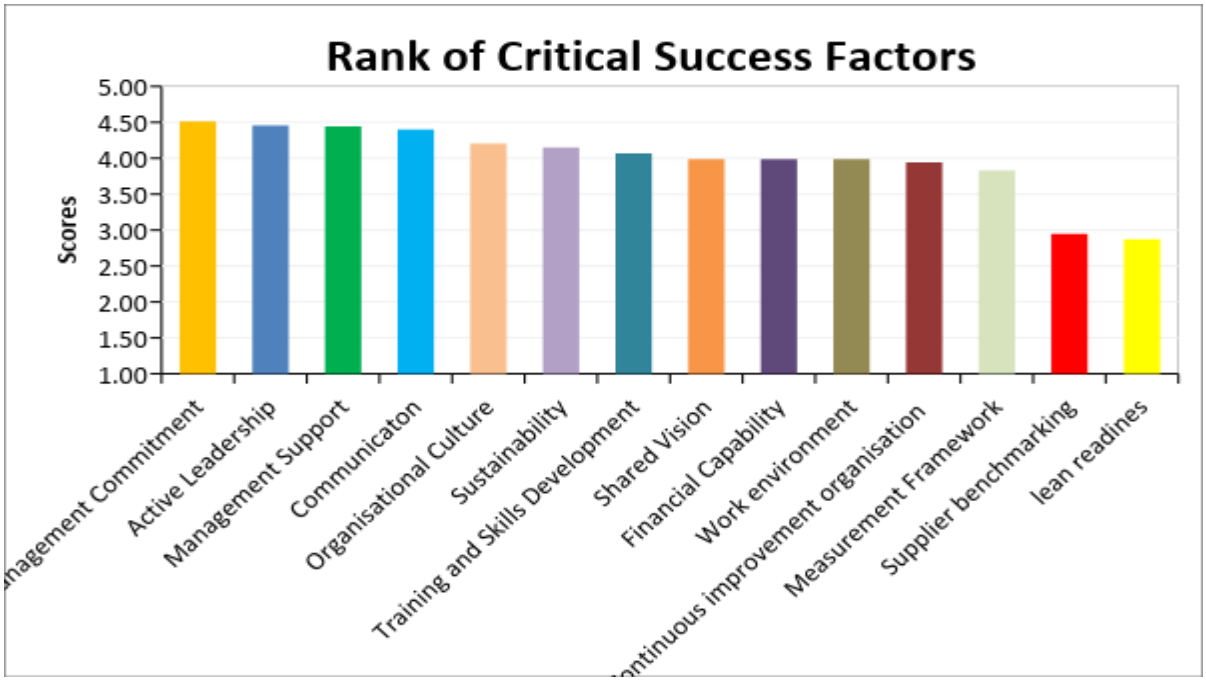

Figure 2: Ranking of success factors.

Distribution of Critical Success Factors

The ranking of the success factors (Figure 2) provides guidelines for managers and practitioners desirous of implementing Lean within the upstream sector. Nonetheless, this is not cast in stone; hence the organizational requirements and context may significantly influence the selection of critical success factors suitable for adoption in the upstream petroleum sector.

Knol et al (2018) questions the universality of critical success factors and proposes the adoption of company-specific success factors. Tsiga et al (2017) explored critical success factors for projects in the petroleum industry and established that project risk management and requirements management as well as some soft aspects of risk management play a pivotal role in achieving project implementation success in the petroleum industry.

The second objective of this paper is to establish the extent to which identified CSFs depend on/are independent of lean implementation guidelines. Lean implementation guidelines form the basis of any successful any lean initiative. Figure 3 is a representation of proposed lean implementation guidelines that have been developed. Implementation guidelines provide the direction, support and methodological approach that will enhance Lean implementation success. Stated differently, a list of appropriate success factors without guidance on "how to" implement will not yield desired results. This research was limited to the identification of the critical success factors for Lean implementation only. Future studies should consider the barriers to Lean implementation within the petroleum industry. Also, a qualitative approach should be adopted to conduct future studies since this study was purely a quantitative one. Future studies should also consider replicating the study in other countries to obtain comparison in research findings.

International Journal of Petroleum and Gas Exploration Management
Vol.6, No.1, pp.11-32, 2023
Print ISSN: 2515-0863 (Print)
Online ISSN: 2515-0871 (Online)
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

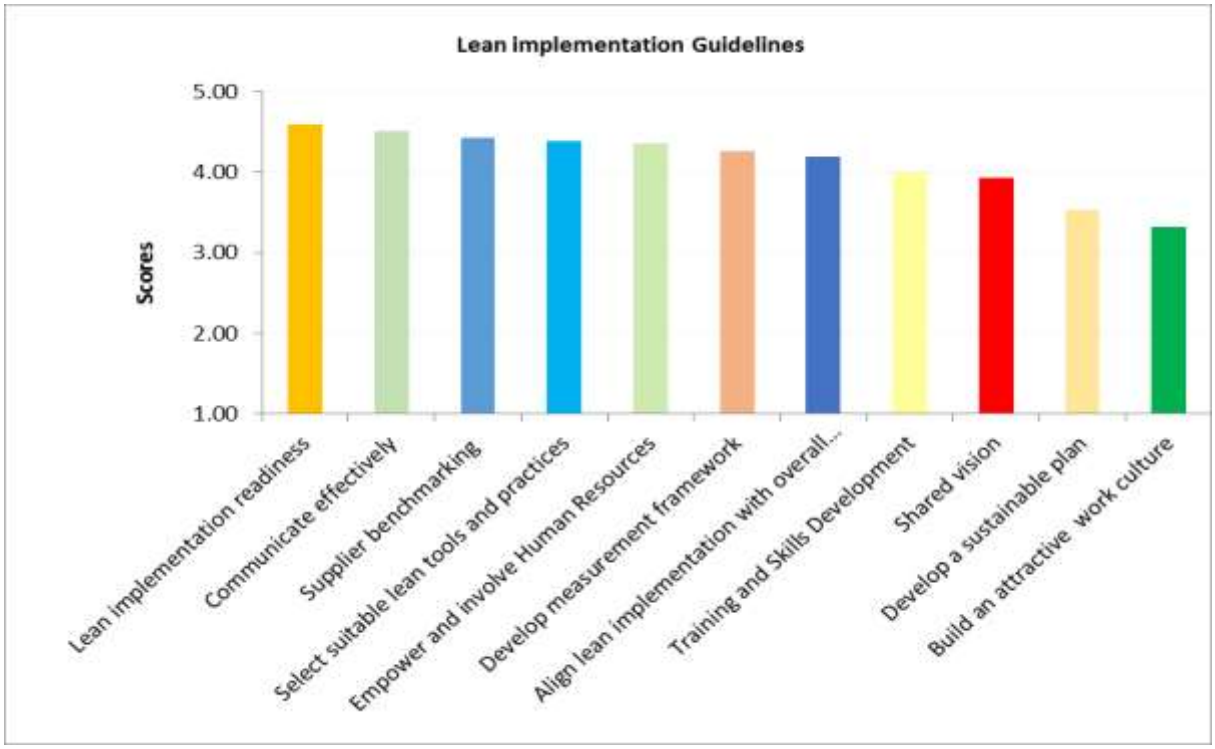

Figure 3: Ranking of Lean Implementation guidelines.

Descriptive Analysis:
To achieve the overarching objectives of this paper, relevant descriptive analyses were conducted.

First, a cross-tabulated analysis showing years of professional service of respondents, and their corresponding opinions on CSFs was conducted. The results show that 31% of respondents between 1 to 5 years of professional service agreed with the identified CSFs whilst 11.1% of respondents within the same length of service strongly agreed. Conversely, 4.2% of respondents with 1 - 5 years of professional experience strongly disagreed, whilst another 4.2% were undecided. All other categories had marginal response rates.

Secondly, the study tries to establish the relationship between employment status and corresponding views on proposed CSF. The results presented show an average of 61.1% of respondents across various employee categories agreed with the CSFs, while 19.4% strongly agreed. However, 8.3% of respondents strongly disagreed whilst 11.1% of respondents were undecided. Specifically, 20.8% of junior managers, 20.8% of middle managers and 19.4% of operational staff agreed with the proposed CSFs. Besides, 9.7% of middle managers, 4.2% of

junior managers and 5.6% of operational staff strongly agreed with the proposed CSFs. On the flip side, 2.8% of all employee categories strongly disagreed while 4.2% operational staff, 2.8% of junior managers were undecided.

The analysis further draws a comparative view between the core business operation of surveyed and the corresponding level of agreement with the proposed CSFs. The results indicate that 22.2% of respondents in the production organizations agree with the proposed CSFs compared to 18.1% in the Exploration organizations, 12.5% of organizations within the Engineering services organizations and 8.3% of respondents in the Improvement Consultancy Services organizations. Similarly, 12.5% of respondents in Production strongly agree, compared to 5.6% in Exploration and 1.4% in engineering services.

Furthermore, an analysis was conducted to determine the relationship between years of professional service and the level of agreement of lean implementation guidelines. It is evident from the results that 25% of respondents with 1-5 years of professional service agree with the Lean implementation guidelines compared to 9.7% of employees between 16-20 years and 8.3% for those with 6-10 and 11-15 years of professional service. Also, 18.1% of respondents within the 1-5 years' category strongly agreed with the proposed Lean implementation guidelines compared to 4.2% for 11-15 years' category and the 2.8% of respondents for the 21-25 years' category.

DISCUSSION

The paper hypothesized that CSFs are independent of Lean implementation guidelines. The Chi-Square test at 95% Confidence level, the Approx. Sig. (P-value) of 0.00 is less than the significance value of 0.05(Table 4). Hence, based on sample evidence, the hypothesis of independence is rejected. This implies there is a relationship between CSFs and Lean implementation guidelines. To buttress the test of hypothesis and provide further insight into this study, a Spearman Correlation analysis results with the r- value of 0.586 indicate a moderately linear relationship between CSFs and Lean implementation guidelines (Table 4).

Table 4 Symmetric Measures

	Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Spearman Correlation	.586	.091	6.046	.000[c]
N of Valid Cases	72			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

The results of the ranking of the CSFs show that overall, 81% of respondents agreed with the proposed CSFs compared to a marginal 4.2% of respondents who strongly disagreed with the

proposed CSFs. Furthermore, regarding employee status, 61.1% of respondents agreed with the proposed CSFs compared to 19.4% who strongly agreed and 8.3% strongly disagreed.

The paper discusses successful lean implementation through the identification of industry-specific critical success factors in emerging economies. Contextually, not only are emerging economies characterized by lack of adequate resources, but the socio-cultural nuances peculiar to developing economies may impact lean implementation initiatives. Also, the paucity of research on CSFs for lean implementation within the upstream petroleum sector in emerging economies leaves a significant gap in the implementation process. Thus, the importance and contributions of the paper to knowledge cannot be overemphasized; first, the paper does not only identify CSFs, but discusses lean implementation process and outlines the importance of identifying the most appreciate industry-specific CSFs to enhance lean implementation success. Secondly, because there is no consensus on any specific set of CSFs for lean implementation(Netland, 2016; Knol et al., 2018; Abu et al., 2019; Antony and Gupta, 2019;), provides sufficient justification for the conduct of the research and also places the CSFs identified in context. Thus, the identified CSFs reflect requirements within the upstream petroleum sector in emerging markets, and notwithstanding the fact that some research on CSFs have been conducted within the petroleum sector(Tsiga, Emes and Smith, 2017a; Rachman and Ratnayake, 2019), this paper complements extant literature with special focus on CSFs implementation in emerging economies.Undoubtedly, evidence abounds to suggest that the continuous evolutionary transformation of Lean remains pivotal for Lean adoption. Consequently, proper evaluation and identification of the most appropriate CSFs are critical for successful Lean adoption. The proposed CSFs for the upstream petroleum sector do not only enhance Lean adoption within the sector but also serves as a foundation for further research and practice within the upstream petroleum sector.

Future studies should consider the adoption of a qualitative approach to the study of critical success factors for Lean success in the upstream Petroleum sector to generate more insights. The study should be replicated in other sectors to achieve comparative findings. Researchers should also consider developing variables that moderate or mediate the relationship between Critical Success Factors and the implementation of Lean to identify more variables that apply to Lean success in the upstream petroleum sector. Suffice to reiterate that while several authors have explored the application of CSFs in various sectors (Alhurais, Robledo and Kobi, 2017; Raja, Vijaya and Raja, 2018; Caiado et al., 2020; Yuk Ming Tang et al., 2021), the paper provides a different perspective to the lean implementation discourse and how CSFs could underpin the lean implementation process.

CONCLUSION

CSFs are the foundation of any successful Lean implementation initiative. The extent to which CSFs are selected and implemented depends on an organization's culture, philosophy, strategic intent and geographical context.

Akin to the findings of (Pay, 2008, Scherrer-Rathje, Boyle and Deflorin, 2009, Antony *et al.*, 2012b, Kundu and Manohar, 2012, Kolberg and Zühlke, 2015, Lodgaard *et al.*, 2016), successful lean implementation is significantly anchored on identification and selection of appropriate constellation of success factors aligned to business requirements and organizational culture. Thus, this research found that appropriate CSFs, supported by Lean success guidelines are pivotal to Lean implementation success. Stated differently, this research finding indicates that CSFs affect Lean implementation success guidelines (Shank, Boynton and Zmud, 1985).

This paper also evaluates existing CSFs across various sectors and proposes a set of CSFs suitable for adoption in the upstream petroleum sector. The top ten ranked success factors CSFs include Management Commitment (MC), Active Leadership (AL), Management Support (MS), Communication (C), Organizational Culture (OC), Sustainability (S), Training and Skills Development (TSD), Shared Vision (SV), Financial Capability (FC) and Work Environment (WE). Other success factors pertinent to this paper among the CSFs include Continuous Improvement (CI), Measurement Framework (MF), Supplier Benchmarking (SB) and Lean Readiness (LR).

Acknowledgements
The authors would like to thank the Scottish Development International (SDI) for Sub-Saharan Africa led by Andrew Monaghan for participating in this research.

Funding
This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

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