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Integrated Operations another Tool for Achieving Operational Excellence in the Oil and Gas Sector

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Abstract: ***Activities of the oil and gas sector operations are highly complex, from oil rigs to refining and transportation. It is against this backdrop that companies opt for operational excellence to control the complexities, of which failure to manage the situation, assets, peoples and profit could be lost. This paper is aimed at determining how integrated operations influences operational excellence in the oil and gas sector. This is with a view to help in facilitating effective operational excellence implementation in the oil industry. Quantitavive survey research approach was adopted, questionnaire was used to collect data from 120 respondents. The result shows that all the postulated integrated operations factors have significant effect on operational excellence. It concludes that integrated operations are the way forward for condition monitoring and maintenance of oil sector assets, people and process for optimising production, operational efficiency, reduced health and safety risks and environmental performance.***

Keywords: ***Health and safety, Integrated operations, Monitoring, Oil and gas, Operational excellence***.

I.INTRODUCTION

The oil and gas sector accounts for over 30% of the global energy source, and this has made oil the cash cow of many economies [1]. Eccentric processes characterise the operations of the oil and gas industry for hydrocarbon extraction, which are usually done in environments that are remote and with harsher conditions [2]. These processes and the environmental condition has made the operations of the sector more complex and risky. As a result, companies are experiencing issues related to safety and health, efficiency and asset reliability which are key to oil and gas operations. Also, the discovery of new oil blogs and pressure mounted on the oil firms to optimise the production and recovery of hydrocarbon by their stakeholders increases their operational complexity. These have made them adopted operational excellence (OpEx) strategy to remedy the situation [3].

It is a known fact that an effective OpEx program improves the production yield of organisational assets and people, reduces the cost of production, improves quality and flexibility of operations [4]. There are still issues on health, safety and environment (HSE), also problems related to cost and process efficiency and above all assets and process reliability are another challenges facing the oil sector in Malaysia. According to [2] and [5], one approach available for operators in the oil and gas sector to overcome most of these challenges is the adoption of the digital oilfield, also known as integrated operations (IO). This according to Bigliani would enhance reservoir recoverability, increase production, reduce environmental, health and safety risks. Specifically, it has also been projected that IO solutions boost oil recovery by 3-4%, speed up production by 5-10% and bring down operational costs by 20-30% [6].

IO is the current strategy that is widely adopted in the oil and gas industry that promotes continuous monitoring and optimisation of oil wells, overall reservoir, and refining and transportation performance [1,7]. As an emerging trend in the global oil production, IO enables and enhances coordination and cooperation amongst various operating units in the firm in real time. Most establishments see the concept of integration as a system of a sharedworkstation that allows the use of video conferencing technology to interact with onshore and offshore personnel in real time [8]. According to [7], the interactions between say, operators and maintenance, engineering, production management as well as suppliers instigates a streamlined operation.Thisis possible by maintaining and integrating real-time data emanating from the oil field in the chain of business management processes.

Notwithstanding OpEx implementations in the oil sector, issues related to facilities failure, explosion due to pipeline burst and corrosion, accidents and health issues, increase in the cost of operation and other risk incidents kept on occurring [9]. It therefore means there is need for improvement. Studies doneonOpEx focussed on the effects of risk management, change management, leadership, organisational culture, efficiency. Studies like these of[4] [10]and [3].The persistence of the current situation risks the loss of revenues, environmental pollution, assets wear and tear, increase in the cost of operation, disabilities and fatality among staff and loss of profit [9]. These failures if continued, there would be no way National Oil Companies (NOC) could compete with integrated oil companies.

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Considering the operational benefits derivable from OI in the oil and gas production value chain, this article is therefore aimed at highlighting and explaining some of the contributions of IO to OpEx in the oil and gas sector and ICT capabilities required to achieve that. The practical relationship between IO and OpEx as found by scholarswas discussed,a proposed conceptual framework wasdeveloped for conducting an empirical study to scientifically test such a relationship in Malaysian oil and gas industry. The independent variables are IO components (People, Process, Technology and organisation) and the dependent variable remainsOpEx (Health and safety, Operational efficiency, assets reliability and environmental performance). An underpinning theory was also adopted to further explain such relationship among the postulated variables.

II. LITERATURE REVIEW

Integrated Operations

Integrated operations (IO) are often adopted and implemented for the reason that they bring down the cost of production, increase in revenue and growth in oil and gas fields productivity [11]. IO is the combination of activities of the oil firm that are controlled holistically by a particular unit. According to[12] and [13], IO is the practice of combining people, process, and technology in an organisation for optimal production, [5] better and timely decision making. Oil firms across the globe viewed the concept of IO in their unique ways as regards the purpose to which it is used in the firm. Oil companies like BP see IO as a field of the future, Shell called IO a smart fields, Chevron considered IO as I-field, Halliburton referred to IO as real-time operation, and Schlumberger sees it as smart wells [14]. Today there seems to be a consensus amongst oil firms as to what IO is all about and what it intend to achieve.

Majority of the industry players have adopted IO as a tool used for condition monitoring and smart processing. [15, 16, 17] posit that IO means those work processes that enable offshore and onshore integration between personnel, operators as well as service providers in the industry. It is a system that bridge the distance between operators and vendors in oil production and processing. In the same vein, the Norwegian oil industry association [6] considered IO as a real-time data onshore from offshore fields and new integrated work processes. IO became the way forward for efficient operational performance in Norway since 2012.

The Norwegian Ministry of Petroleum and Energy [18] see IO as the art of using information technology to facilitate an improved decision-making process for a smoother performance that guaranty remote controlling of firm's processes and assets. [17] opined that IO is the beginning of new work procedures driven by technological innovation that permit the sharing and communication of real-time data between the different field of expertise, remote locations and organisational settings. IOprovides a flexible approach to oil firms that address a wide range of risks (operational and financial) or threat to assets and process safety, employees' health, quality of outputs and environmental performance [19]. This provision has made IO a factor to reckon with in achieving OpEx in the oil industry because it addresses issues related to health, safety and the environment, quality of process and output which are the concerns of OpEx.

ICT Capabilities

The complexity and the volume of activities in the oil and gas operations require certain capabilities in IT for IO effectiveness and efficiency. According to [2], ICT capabilities like cloud computing, big data, and mobility and smart instrumentation are critical for an integrated information management. This information management as put by[20] is done remotely to improve the efficiency of assets. In the occasion of HSE and other operational risk mitigation across upstream, midstream and downstream activities in oil and gas, IDC Energy Insights, according to [2] developed five critical IT capabilities areas as follows:

1. Enterprise-wideinformation management and intelligence. Information regarding oil and gas explorations, regulatory compliance and other correspondences has to be stored, processed and reviewed for proper decision making.
2. Consistency and mobility of contextualised and integrated information.
3. Collaboration of technology tools which facilitate sharing of technical expertise and resources across the industry and geographical regions.
4. Information security is needed to identify,analyse and prevent breaches of security.
5. Enterprise governance, risk and compliance (eGRC).

Operational Excellence

Operational Excellence is the goal set by the industry for operational best practice in performance metrics. In the oil and gas industry,OpExis seen as a strategy for continuous improvement in health and safety, the reliability of assets and process, efficiency (cost and output) and environmental performance [3]. Operational activities involve all forms of upstream and downstream activities, from construction to decommissioning, all through the value chain of oil and gas production [19]. Although there are differences as to what OpEx is in different industries. In the manufacturing sector, as put by [4] OpEx is a system that ensures attainment of reduced cost, optimised output, flexible operations, improved quality and minimised wastage. OE is regarded as a tool that brings into line and integrates process that helped business organisations overcome difficulties in operational performance [21].

Upstream OpEx can be defined as the implementation of value-driven performance in an efficient, best-in-class, combined method across the upstream value chain [22]. The steps to achieving this excellence starts with people's current dealings in their roles, such as acquaintance with business processes in decision-making framework; ascertaining strengths and weaknesses based on performance measures and industry's best practices; and redesigning processes as needed to align with corporate strategic goals, which typically incorporate relevant best practices and lean concepts [22].

Integrated Operations and Operational Excellence

It is evident that IO had improved the operational performance of so many oil firms across the globe. IO generally improves oil production operation; it derives recovery, brings down cost and optimises efficient work processes that eventually translate into productivity [13].

Table. 1 IO Relationship with OpEx

Scholars	Contributions
[24] Kapteijin (2002), [25] Bogaert*et al*. (2004) [26] Henderson (2005)	above 10% improvement in production of old and new oil fields, 5% Greenfields recovery and 2% rise in reserves of the Shell Corporation
[27] Edward, Mydland&Henriquez, (2010) [28] Dickens *et al*., (2010)	improves oil production by 0.5 – 2.0% when implemented
[25] Bogaert*et al*. (2004)	IO assisted in reducing time lost and ensures accurate flow estimation
[26] Henderson (2005)	reduction in operational cost by 20%, cycle and extraction times, and exploration risks
[29] Crowford, Hoefner and Oakes (2008)	ExxonMobil surveillance system indicated saving 44% of the time ought to have been wasted for gathering data on plots and report
[30] Oran, Brink and Ouimette (2008)	In Chevron IO led to the establishment of steam operation, 12% growth in plant capacity optimisation, improvement in environmental performance, and general improvement in efficiencies and reliability of assets and processes, and predictive maintenance
[31] Ahuthali*et al*. (2012)	Saudi Aramco saved 429 days for gathering information to be used in defining above 100 oil well's rate of production, reservoir pressures and injectivity in a shutdown situation
[32] Lejon, Hervic and Boe (2010)	efficient collaboration facilitation of IO system led to continuous improvement in oil well production with minimal safety and health risk incidents
[33] Moore-Cernoch (2010)	many losses and unplanned shutdowns were avoided in the Gulf of Mexico and the North Sea by BP due to collaborations managed by IO
[34] Howell *et al*. (2002) [15] Hjellestad (2006)	IO aids every decision on engineering and operations. It helps develop information, minimising lead time on the design, quality enhancement and cost reduction

Several scholars are of the view that pointed out and discussed the contributions of IO in the operational performance in the oil sector. The contributions are presented in Table 1,which is related to OpEx. These contributions, affectedOpEx positively because productionimproved, health, safety, environmental performance (HSE) improved, reduced cost of production, and reliability issues due to IO. Looking at enhancements in efficiency, and reliability of assets and people in Chevron and BP and improvement in operational performance because of IO, one could argue that when it is fully implemented, problemrelated to such areas would be a thing of the past; as such OpExwould be achieved.

However, other views negate such contributions and kicked against it, that without IO such an OpEx could be achieved [23]. IO exposes the firm to cyber risk or system crashing in spite of its contribution to the reduction in HSE incidents [11].Their arguments are that IO is highly capital intensive and therefore requires huge investment in new technology, which will mean more cost to the firms.

Lead-time reduction, quality improvement and cost reduction are some of the major constructs of OpEx as argued in the work of [3] and [4].

Their position and the points put by Howell on IO have further strengthened the argument of IO having a positive relationship with OpEx. It enables the monitoring and tracking of personnel in remote and vulnerable locations on a daily basis.

The concept of IO is quite interesting, as it allows collaboration and exchange of expertise amongst various disciplines and speciality in the organisation so as to centrally control operational activities in the firm. In the article, some of the benefits of IO seemed to have improved work processes in the oil industry. Issues related to health and safety, environmental performance, productivity, quality, cost and process efficiency, assets and process reliability could improve with integrated operations in place.IO had assisted oil firms like Shell, BP, Chevron,

Statoil, Saudi ARAMCO and so many to mention a few achieved continuous improvement and efficiencies in productivity, cost reduction, reduced lead-time, product quality and health, safety, and the environment (HSE).

However, most of the positive results were not empirically supported by any scientific findings, which is why this article proposed a conceptual and theoretical framework to carry out a study on the relationship. It is concluded that for IO to be effective and devoid of the raised issues, the IT capabilities, controllability, operability, reliability and security of the system must be ensured at all time by the firm and its collaborating partners.

III.CONCEPTUAL FRAMEWORK

The proposed conceptual framework depicts how integrated operations relate to operational excellence and to be moderated by management commitment, as shown in Figure 1. The moderator variable was used in a study by [4] on the relationship between change management and operational excellence. The finding indicated that the variable moderates such a relationship.

Integrated Operations (IO)

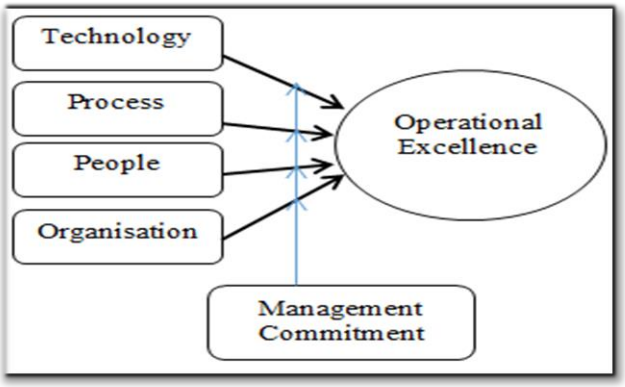

Fig. 1 Conceptual Framework

IV.THEORETICAL FRAMEWORK

Two theories have been reviewed for consideration in the current study.

Balanced scorecard (BSC)

Balance Scorecard (BSC) is a management tool for measuring and enhancing performance in organisation by exploiting intangible assets in the organisation's value development for its stakeholders [35]. The concept develops ways firms could improve performance by integrating intangible assets into organisation's management system [36]. According to [37]BSC is a structured management methodology with focus resource on set performance goals achievement bymodifying policy direction. Profitability, market share, productivity, product leadership, public responsibility, personnel development, employee attitudes and the balance between short-range and long-range objectives were the basis of BSC[38]. The BSC is a tool that guides how organisation's strategic objectives are aligned with performance indicators in the areas of finance, customer, internal business processes and organisational learning and growth [37, 39]. BSC provides feedback from internal processes and organisational outcome for continuous improvement in performance and results [39]. [40] Posited that BSC is an instrument that drives smooth business operations geared for the achievement of organisational objectives.

Resource Based View (RBV) Theory

The resource-based view (RBV) theory is a widely held theory used a lot when it comes to organizational resources that are under her control. So the application and a mixture of a lot of valuable resources possessed by an organization are vital to its competitive advantage [41, 42]. The theory is about internal resources that are comprised of people, technology and machinery employed for operation in the organization. The ability of an organization to deploy such resources into productive functions within the firm increases efficiency in the organization [43]. The RBV theory stresses on harnessing internal resources as a vital element in achieving an improved performance, which suggests RBVs fitness to explain operational excellence [44, 4].

The RBV highlights the firm as a unique collection of resources [45, 42]. [46]however, emphasizes that not all resources provides the firm with a sustainable competitive gain. RBV literature hadbeenfocusing on resources as an established ideals that can be recognized at a point in time and will be sustained over time[47]. RBV focus on strategic context, presenting resources and capabilities as essential to gaining a superior performance [46, 48].

This article has adopted the RBV because it consolidates about the organisation as resources, which means both tangible and intangible resources are important in the development of an organisation. Therefore, the RBV seems to be more encompassing unlike the BSC that focusesmore on intangible resources. Again, the RBV have been used to explain operational excellence in studies by [4] and [10].

V.METHOD AND MATERIAL

A quantitative survey research design was used in the current study. Eight oil and gas companies were surveyed, and 100 respondents were selected purposively from the firms' management staff. A five point likert scale and closed ended questionnaire was the tool used for data collection. Data were collected, screened and treated for reliability and normality before analysis.

Statistical Package for Social Sciences (SPSS) was used for data analysis, multiple regression test was conducted to show the model summary, ANOVA and coefficients of the significance of the effect of independent variables on the dependent variableusing two models. A correlations test was performed to show the level of relationships among the study variables.

VI.RESULTS

The findings as presented in Table 1 shows the model summary. In the table the R^2 was .506 in the first model, which indicated that collectively the variables of the study specifically IO (people, process, organisation and

technology) as independent variables have 50.6%. predictive power on OpExand the 50.6% variation on OPEX was found in the first model in Table 2. The Durbin-Watson was good at 1.593 coefficient and significance of F change was .000. The result indicated that IO as whole influences OpEx in the oil and gas sector.

On the other hand, the second model shows a significant change in the effect size of the independent variables on the dependent variable. When management commitment was introduced into the second model, the R^2rose to .533 compared to .506 obtained in the 1st model. It indicated a change of .027. Similarly the F change Sig. was .005, which means that management commitment could moderate the relationship between IO and OpEx in the oil and gas industry.

Table. 2 Study's Models Summary

Models	R^2	Adjusted R^2	Sig. F Change	Durbin-Watson
1	.506	.493	.000	
2	.533	.516	.005	1.593

The ANOVA and correlations statistics are presented in Table 3 and 4 below. Table 3 indicated the ANOVA result of the sum of squares are the same for both models, and mean square 1452.141 for the first model and 1222.533 for the second model. The F values are 37.392 and 33.036 respectively for first and second models. The ANOVA values are significant in both the two models in the study.

Table. 3 ANOVA

Models	Sum of Squares	Mean Square	F	Sig.
1	11478.490	1452.141	37.392	.000
2	11478.490	1222.533	33.036	.000

The correlations test measures the relationship among variables of the study. It indicates the level, nature and significance of such relationships, which specifies the influence or effects each could have on one another, especially on the dependent variable. In Table 4, the 2tailed Pearsoncorrelation statistics shows that people, process technology and organisation are significantly related as independent variables. The highest coefficient .608 was found in the relationship between OpEx and PPL, followed by .604 between TEC and OpEx, then .565 between OpEx and MGT, which indicated a strong relationship with dependent variable (OpEx). Other relationships that are strong but did not amount to colinearity case were the relationship among the independent variables. All the correlations are significant at .01.

Table. 4 Correlations among study variables

	OPEX	PPL	ORG	PRC	TEC	MGT
OPEX	1					
PPL	.608	1				
ORG	.403	.378	1			
PRC	.452	.255	.387	1		
TEC	.604	.482	.280	.440	1	
MGT	.565	.481	.281	.330	.571	1

A coefficient was determined to show the effect of individual factor of integrated operations on operational excellence, and the significance of such relationship as presented in Table 5.Technology (TEC) effect on OpEx was beta .366, t-value5.457 and significance level at .000, which means it has significant relationship with OpEx, as the variable also explained 36.6% variance in OpExin the oil and gas sector. Similarly, People (PPL) with beta .309, t-value 4.565 and significance level at .000, explains 30.9% variance in OpEx. The result indicated that TEC and PPL explained major variance in OpEx, as they cause change by 67.5%. Other variables, organization (ORG) with beta .148, t-value 2.271 and sig. .025 explained 14.8% variation in OpEx, while process (PRC) had beta .143, t-value 2.169, and sig. .032 caused variation in OpEx by 14.3%.

The general findings indicated that ingrated operations significantly influence variation in operational excellence because all the factors as independent variables are significantly related to OpEx and they also caused variation in the dependent variable.

Table. 5 Coefficient statistics

Variables	Beta	t-value	P-value (sig.)
PPL	.309	4.565	.000
ORG	.148	2.271	.025
PRC	.143	2.169	.032
TEC	.366	5.457	.000

VII.DISCUSSION AND CONTRIBUTION

The field of operational excellence is still nascent in academic research. There are very few studies in the area and majority of such studies were concentrated in the manufacturing and service sector. [4] employed and used change management (culture, human resource andleadership) as variable to explain variation operational excellence. [10] exploitedleadership style, human resources practices,operations strategy and involement culture in Jordan. factors to determine change in operational excellence. [49] employed technology development and domestic manufacturing on operational excellence. Similarly [50] used change management factors as independent variables and management commitment to change as moderator to explain variance in operational excellence. [51] used six sigma tools, process monitoring to predict operational excellence in India. [52] utilised risk management determinants (information technology, staff capacity, regulatory framework and firm characteristics) as independent variables and mediated by enterprise risk management implementation to explain variation in operational excellence in the nigerian oil and gas industry.

The current study found that Integrated Operations could significantly influence operational excellence in the oil and gas sector. As people, process, organization, and technology as dimensions of integrated operations had significant effect onoperational excellence. Equally, management

commitment was found to have positively altered the relationship between IO and OpEx. Therefore it could be argued that majority of the reviewed earlier studies on OpExdiscussed and utilised various variables in their frameworks across manaufacturing, service, and oil and gas sector. There was rarely any study that engaged integrated operations (IO) to predict operational excellence. Although [49] used new technology but did not utilised IO to explain operational excellence. This article had taken an entirely new perspective by adopting IO as a tool to improve operational excellence in the Malaysian oil and gas sector.

The theoretical contribution of the proposed framework was the adoption and utilization of IO factors to explain and moderated by management commitment. The practical contribution would be the enhancement in the health safety and the environmental performance, improved efficiency (cost and process) and improved assets reliability as seen in some of the intergated oil firms like Exxon Mobil, Chevron, Shell BP and Saudi Aramco [30, 31, 33].

Although the initial investment required for IO is huge and it will take strong decision to venture into it, but the long term benefits to oil and gas firm is equally enormous.

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