Management Barriers in Implementation of Integrated Operations Solutions in Indian Upstream Companies

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Abstract—The Upstream Oil and Gas industry in India was quick in embracing new technology and digital innovation even back in 1980s. Scholar’s first Upstream Oil & Gas (O&G) job back in 1990 as the Offshore Complex Shift In-charge managing Oil & Gas operations through partly automated DCS (Distributed Control System) is a personal testimony to it. Integrated Operation (IO) term was coined by Norwegian Upstream company Statoil around 2005 which was based on combined use of Data Integration based on open standards / Predictive Analytics / IIOT sensors, going beyond DCS (Distributed Control System), PLC (Programmable Logic Controller) and any data historian or point software systems. IO solutions were developed as the customized solutions for Upstream company with an intelligent real time (or near real time) system helping decision makers to take quicker decisions with online monitoring of various work processes impacting revenue or cost performance of the organization. During last one decade, after Statoil, various global upstream companies coined newer names for such IO initiatives and did get benefits but Digital Oilfield (DOF) was another widely accepted name for IO in Upstream. Indian upstream companies had been trying to adapt this second wave of IO / DOF but have not yet taken full advantage of using data integration and analytics in a meaningful way. As per the survey, Cairn Energy has been one of the leader in Digital Oilfield space in India but majority of the effort had been towards incremental performance improvements only through selective use of digital technologies.

Motivation for this research was to understand the precise barriers faced by Indian upstream companies in adopting Integrated operations / IO / Digital Transformation despite so many foreign players entering India because of NELP (New Exploration Licensing Policy) implementation after 90s with sole focus on bringing in new technology partners to increase the O&G production.

In this paper, we have examined the management decision-making barriers for implementation of Integrated Operations solutions in Indian upstream companies based on Factor Analysis with the objective to expedite decision making beyond 4 categories of IO barriers resulting in improved organizational efficiency parameters. A survey questionnaire was conducted to collect data from 141 participants.

Confirmatory Factor Analysis (CFA) has been deployed to identify dominant barrier. Despite their belief in the present and future efficiency of these smart Integrated Operations solutions, research shows that stakeholders are showing considerable reluctance on account of lack of education about IO and lack of IO drive across the organization.

Keywords—Integrated Operations, Digital Oilfield, Industrial Internet of Things, Digital Transformation, Predictive Analytics

I. INTRODUCTION

Integrated Operations / Digital Transformation / Industrial Internet of Things: Need for Digital Transformation for operational excellence has always been there even in the first digital wave in India, when Upstream Oil and Gas companies in India had also started adopting digital technologies like SCADA (Supervisory Control & Data Acquisition), DCS (Distributed Control System), PLC (Programmable Logic Controller) as early as the 1980s with clear focus on better field operations control, better understanding of reservoir and production potential, improving safety, and boosting marginal operational efficiencies at oil fields. However, the upstream companies in India have not taken advantage of the second wave of digital oilfield initiatives in 21st century that derive from using data and technology with analytics and data integration in a meaningful way. As an example, a single drilling rig at an oilfield can generate terabytes of data every day, but only a small fraction of it is used for decision-making. Adopting analytics based technology solutions linked with IIOT (Industrial Internet of Things) sensors / devices on top of DCS / ERP / other software application allows Upstream companies to become more proactive and less reactive thus optimizing on the overall productivity. Integrating systems and streamlining the flow of data from field to boardroom with various stages of IO, shown in Fig 1 below, is the only solution for removing the management barriers for a Smarter Oil & Gas company. Even other capital intensive industries (such as aviation, automotive and downstream refiners) in India have revolutionized their business and operating models through a holistic application of digital technologies, the opportunity for the upstream companies in India to leverage the transformational impact of Integrated Operations has become more evident.
Another reason for embracing IO is how global Upstream companies have been improving their topline and bottom line business performance while upstream industry has been witnessing one of its worst downturns, driven by a supply-side disruption and fall in crude oil prices compared to June 2014 levels.

As per World Economic Forum, IO adoption is increasing, and this new era of automation will add significant value to upstream globally.

II. LITERATURE REVIEW

Already proven globally, IO is the technological leap that is allowing upstream companies to become more proactive and less reactive in managing their business. As per the literature survey, adoption of IO is recognized as a key factor for running a safer and more profitable business by making quicker decisions. Many experts predict that more than 20 billion connected devices will be there by 2020. Upstream companies will take advantage of this technology evolution to improve the stakeholder’s user experience by getting all the information on ongoing operations remotely.
Various stakeholders in different departments, be it Operations or Maintenance or Reservoir or Drilling or Subsurface or Supply Chain, everyone will see the same universal truth of operations from their own domain perspective. Stakeholders will take quicker decisions with Integrated Operations rather than spending time on managing data coming from siloed systems requiring manual intervention.

A. Research gaps
In spite of the successful history of Integrated Operations in Nordic countries, the same has not been replicated by companies in Asia due to various unidentified management barriers. Following are major research gaps prioritised by scholar based on the literature survey:
1. Indian upstream companies have not formulated Integrated Operations implementation strategy.
2. Barrier to seamless information flow to people not identified for Indian upstream companies.
3. Information barrier affecting HSE not identified for Indian upstream companies.
4. Barriers for remote operations with Integrated Operations not identified for Indian upstream companies.
5. Indian upstream companies have not mapped the efficiency parameters for evaluating likely impact of Integrated Operations.
6. Indian upstream companies have not analyzed impact of implementation with selective layers of Integrated Operations.
7. Indian upstream companies have not estimated likely potential opportunity loss with Integrated Operations implementation.

B. Research Problem
Identify management barriers and develop a customized solution for implementation of Integrated Operations solutions for capturing the potential opportunity loss for Indian upstream companies.

C. Research Design & Methodology
Three objectives were identified to come up with Research design and methodology for the Research Problem but in this paper, research is confined to:

C1. Research Objective
To identify the management decision-making barriers for implementation of Integrated Operations solutions in Indian upstream companies.

C2. Sampling
Since adoption of the Integrated Operations is fairly recent in India, upstream companies do not have any dedicated department around Digital Transformation or Integrated Operations in contrast to global upstream companies who even now have Chief Digital Officer (CDO) in addition to Chief Information Officer (CIO) and Chief Technology Officer (CTO). Research company Econsultancy tracked the use of the chief data officer title on LinkedIn for two years. In April 2016, there were 2,899 people who identified as chief data officers; by February 2018, there were 11,418. And this trend has started globally in upstream as well while Indian upstream companies are lagging behind. Mostly, Operations Excellence group is looking into digital improvements in India with help from Information Technology (IT) colleagues while both groups lack understanding about complimentary roles each of them play for improving production throughput or lower costs (as evident from the survey). Our preliminary list contained 400 target respondent but only 141 participated and majority of the participants preferred to be anonymous considering Integrated Operations as a confidential business initiative of the organization. As a prerequisite for pre-processing, missing responses were eliminated and the final sample was composed of 141 respondents. Among the sample obtained, 46% were from Operations & Maintenance (O&M) background and 54% were from Information Technology (IT) side, which corresponds approximately to the distribution of the actual population. The Specific O&G domain details of our sample are presented in Table 1.

C. Research Design & Methodology

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>25-35</th>
<th>36-45</th>
<th>Above 45</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>O&amp;M</td>
<td>12</td>
<td>42</td>
<td>11</td>
<td>65</td>
<td>46%</td>
</tr>
<tr>
<td>IT</td>
<td>28</td>
<td>31</td>
<td>17</td>
<td>76</td>
<td>54%</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>73</td>
<td>28</td>
<td>141</td>
<td>100%</td>
</tr>
<tr>
<td>%</td>
<td>25%</td>
<td>53%</td>
<td>20%</td>
<td></td>
<td>100%</td>
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</tbody>
</table>

Convenience Sampling technique was used under Purposive Sampling in Nonprobability sample category considering the limited number of people with expertise in Integrated Operations area being researched. In this survey, stakeholders were asked to assess twelve different IO focus areas with total 36 measured variables categorized in these 12 categories. The questionnaire was based on survey with 5 point Likert scale about these factors.
This survey was carried out to cover three research objectives, however this paper is limited to finding out the factors affecting decision making on the IO investment decision with only 12 measured variables.

C3. Sources of data

Data from this study are obtained through a questionnaire distributed to participants from Indian upstream companies that are producing oil and gas and have scope for adopting Integrated Operations based technological solutions. The primary data was collected from various stakeholders from ONGC, Oil India, ONGC Videsh, Cairn Energy, BG, HOEC, Essar etc. The secondary data was collected from DGH, OLF, Society of Petroleum Engineers, World Oil, BI Norwegian Business School, Norwegian University of Science and Technology, Purdue university and other Research Journals.

C4. List of parameters

Based on author’s decade long experience working in IO field, 36 IO measured variables were categorized under 12 IO focus areas; with only 12 measured variables (Please refer Fig 4) for researching the Research Objective in this paper.

C5. Research Method for Objective 1

Significant management barriers are identified using Factor Analysis with the objective to expedite IO investment decision resulting in improved efficiency parameters. Other 2 objectives shall be researched further.

For Objective 1, survey focused on 12 measured variables under eight categories affecting decision making on the IO investment decision. As the result of factor analysis, first 12 measured variables were grouped into fours barrier categorizes – IO Education barrier (B1), IO Social drive barrier (B2), IO Cost barrier (B3), and the IO Adoption barrier (B4) – measuring barriers faced by Indian upstream companies in spending money on Integrated Operations aspirations. And four perspective categories highlighted the IO perspective of Indian Upstream companies.

Barrier#1: IO Education in Organization
(Q1.1- IO inclination; Q1.2- IO curiosity; Q1.3- IO learning ability)
Barrier#2: IO Social drive
(Q2.1- Track global IO; Q2.2- Enterprise wide IO; Q2.3-4.0 benefit)
Barrier#3: IO Cost
(Q3.1- Pay market Price; Q3.2- Savings with IO; Q3.3- IT Maintenance cost of IO)
Barrier#4: IO adoption
(Q4.1- Business Performance; Q4.2- Functionality needs; Q4.3- User friendliness)

Following 12 measured variables were used to verify the research
Perspective#1: IO Optimism
(Q9.1- IO tech capability; Q9.2. Open to risk; Q9.3. Embrace Ind4.0 change)
Perspective#2: IO Innovation
(Q10.1- New use case; Q10.2- Try pilot; Q10.3- Replicate across Enterprise)
Perspective#3: IO Wait & Watch
(Q11.1- New solution; Q11.2- Proven cases; Q11.3- Ind4.0 compliance)
Perspective#4: IO Pessimism
(Q12.1- Doubt IO; Q12.2- IT complications; Q12.3- Lack domain expertise)

IO Education barrier measured three variables around how curious and inclined are users on using IO technology and what is their learning ability perception of IO technology solutions.

IO Social drive barrier measured how keenly organization is tracking development in IO space globally and how well organization is trying to create awareness about IO across the organization alongwith quantified benefits possible with IO technology solution.

IO cost barrier is expected to be one of most influential factors of the acceptance of IO technology. The term “Cost” here means money, time and effort to achieve the IO technology from the market. This barrier measured how willing is organization to pay the prevailing market price for IO solutions and how much saving potential can be realized with such investment. Cost-benefit ratio is considered as an important factor in deciding to buy and use of IO technology.

IO adoption barrier measures the user friendliness is considered very important for every stakeholder plays in deciding to buy and use IO technology. Therefore wider functionality needs of IO solutions and a belief that business performance can be improved with IO adoption are important factors affecting the acceptance of IO technology.
Confirmatory factor analysis is a method to model the population covariance matrix of a set of variables using sample data. Common variance is sometimes referred to as “communality,” and the specific variance and error variance are often combined and referred to as “uniqueness.”

C6. Overall Model Fit

CMIN of 3.159 is quite lower than upper threshold of 5. P value is significant which means we have poor fit for a sample size of 141. GFI of 0.853, AGFI of 0.761, CFI of 0.882 and PCFI of 0.642 are tolerable but not great. P Close of .000 is not acceptable, it should be above 0.05 ideally. Similarly RMSEA of 0.124 is also not good, it should have been less than 0.1.
III. EMPIRICAL ANALYSIS AND RESULTS

Removed Q3.2 variable as values were going above 0.4. Other covariances could not be influenced, and can be attributed to the nature of technical survey with limitations mentioned later in this paper.

Table 4. Final Standardized Residual Covariances

<table>
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<tr>
<th></th>
<th>Q4.1</th>
<th>Q4.2</th>
<th>Q4.3</th>
<th>Q3.1</th>
<th>Q3.2</th>
<th>Q2.1</th>
<th>Q2.2</th>
<th>Q1.1</th>
<th>Q1.2</th>
<th>Q1.3</th>
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<tr>
<td>Q4.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Q4.2</td>
<td>.957</td>
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<td>Q4.3</td>
<td>.003</td>
<td>.751</td>
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<td>Q3.1</td>
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<td>Q3.2</td>
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<td>.000</td>
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<tr>
<td>Q2.1</td>
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<td>.000</td>
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<td>Q2.3</td>
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<td>Q1.3</td>
<td>.000</td>
<td>-.163</td>
<td>-.221</td>
<td>.446</td>
<td>.215</td>
<td>-.466</td>
<td>.572</td>
<td>-.367</td>
<td>-.024</td>
<td>.486</td>
</tr>
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</table>

Table 5. Final Model Fit Indices after removing Q3.2

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<tr>
<th>Fit Index</th>
<th>Recommended Critical value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \chi^2/D.F. )</td>
<td>≤ 3</td>
<td>3.623</td>
</tr>
<tr>
<td>GFI</td>
<td>≥ 0.9</td>
<td>0.853</td>
</tr>
<tr>
<td>AGFI</td>
<td>≥ 0.8</td>
<td>0.745</td>
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<tr>
<td>CFI</td>
<td>≥ 0.9</td>
<td>0.880</td>
</tr>
</tbody>
</table>

IV. CONCLUSIONS

Based on our findings, one can mention that the surveyed respondents are somewhat ready for the use of IO technology provided they are educated in the first place about IO technology and its specific use cases. With Q3.2 about Potential Savings with IO removed during CFA, it was realized that in India, Education and Adoption are biggest barriers as compared to the Cost or Organization wide IO drive because Indian upstream companies are still at an earlier stage where educating users and management is a bigger challenge towards IO.

Analysis of the management decision making barriers for implementation of Integrated Operations solutions in Indian upstream companies shows that except the correlation between IO Education and IO Cost, all other barriers are reasonably correlated with each other with value of more than 0.35. IO Education barrier (B1) and IO Org Drive Barrier (B2) are strongly correlated with IO Adoption barrier (B4) with highest value of 0.36.

The rank of all 12 variables (Q1.1 to Q4.3) of each factor is displayed clearly above indicate that the variable, “Price of IO technology” is least important barrier in adoption of IO by various organizations.

Based on our findings, one can mention that the surveyed respondents in Indian upstream sector are somewhat waiting to be educated for exact use of IO technology. Benefits of the IO technology are probably not well understood in India due to lack of specific use cases.

A. LIMITATIONS OF THE STUDY

Primary limitation is the understanding of the potential dollar impact of Integrated Operations solutions by the stakeholders / decision makers, thus lowering the possibility of identifying all the management barriers. Secondary limitation is due to Purposive Sampling method in Nonprobability sample category considering the limited number of people with expertise in Integrated Operations area being researched, nonprobability sampling does not allow estimation of sampling errors.
B. Significance of the Study

Importance of scholar’s proposed research is based on the fact that Statoil is the only company in Norway which could successfully implement Integrated Operations initiative with $50bn saving potential over during 2005-2013 period but it could not be replicated in India due to management barriers involved in taking IO investment decisions.

C. Conflicts of Interest

The author declares no conflicts of interest. Names of survey participants and their organizations have been kept confidential to avoid any conflict.

Acknowledgements

Acknowledging contribution from :

(i) IO / DOF community members in India without whose help this research would not have been possible.

(ii) Also want to acknowledge motivation and guidance provided by Dr. Prerna Gaur (Professor and Head, Department of Instrumentation and Control Engineering, Netaji Subhas University of Technology, Director and Member Secretary, NSUT-IIF (Technical Business Incubator), Chair, IEEE Delhi Section, Fellow-IEI, Fellow- IETE, LMISTE, Senior member IEEE (USA) to undertake this formal research back in 2013.

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