Futuristic Drilling Organizations Under the Changing and Emerging Industry Models

May 2021

Author:
J. Muthu Kumar, iWells Integrated Management Consultants DMCC, Dubai
+ 36 years of experience upstream oil and gas industry with core expertise in drilling project management, well delivery process, risk management and cost optimization.

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1.0 Drilling Industry In 2021 And in the Future

The shock received by the upstream business of the oil and gas industry in late 2015 with the sudden drop in oil prices from US$ 100+ to below US$ 35 is still reverberating in the industry today. The industry was gradually crawling back to the pre-2015 business model from early 2017 due to the prolonged strategy of OPEC+ countries to cut oil production by 7.7 mm bopd that allowed the oil prices to sustain above US$ 55+ per bbl. However, the impact of dual shock of COVID-19 on humanitarian crisis, global economy and low oil prices in 2020 has proven to be completely different from the earlier two shocks of the 21st century which occurred in 2008-09 and 2015-16.

Although by May 2021, the oil prices are hovering above US$ 60 per bbl due to forces that are not fundamental, the volatility in the oil prices is still high and hence a sustained long term oil price range above the current level is highly uncertain.

The dual shock of 2020 was unprecedented in the industry with a huge demand drop, high supply stock and a globally impacted humanitarian crisis. The economic meltdown, lockdowns and border closures have shaken the industry's financial foundations that has led to a large number of bankruptcies and a significant drop in investment structure. In 2020, most of the investment bankers, institutions and HNI had put a red card for oil and gas investments and the drop in stock prices of almost all the oil and gas companies including IOCs, NOCs and Super Majors indicate the loss of confidence in the once very attractive industry.

The future, without a doubt, will be a period of intense combat to overcome the forces working against the oil and gas industry and in general fossil fuels ("Forces") using resilient methodologies of project execution enhanced by the technology driven digitalized infotech models. Some of the effective components of the Forces are:

(a) Demand for sustained growth of crude oil with governance, control and compliance;
(b) large investments to compensate the loss of natural decline of the reservoirs;
(c) lowering enthusiasm for investment to oil and gas industry;
(d) widening gap of talent and skill sets;
(e) inadequacy of resources;
(f) dwindling service resources due to lack of investments, research and innovations;
(g) rising value for renewables and alternate sources of energy; and
(h) raising pressure against fossil fuels on climate and environment issues;

Another major factor that will govern the upstream oil and gas industry in the future is carbon emissions and carbon footprint. Drilling operations require large amounts of energy to drill a well and hence emit significant amount of carbon into the atmosphere. Furthermore, the impact of drilling discharges and waste disposals on carbon footprint is also sizeable.

Under pressure of climate emergency declaration and energy transition demands that were initiated by the Paris Agreement that came in to force from November 2016 (legally binding international treaty on climate change), several major oil companies are already launching alternate energy ventures as a hedge against an uncertain future of fossil fuel-based energy matrix. As per the Paris Agreement, the goal of all participating 196 countries is to reduce the global warming to well below 2 deg C (preferably below 1.5 deg C) compared to pre-industrial levels (defined as 1850-1900 period). With pressure mounting against fossil fuels to achieve this goal and for climate change, the carbon footprint of drilling operations will also come under the radar. Although no norms or regulations or limits to carbon emissions from drilling rigs exist today, some rules and laws might be imposed soon. As no oil or gas can be produced without drilling, carbon footprint reduction technologies and best practices will be needed to achieve optimized solutions.

With all of the above, the only option left to the industry today is to expedite and embrace the already ongoing transformative changes and emerging strategies in an urgent fashion. Without some fundamental changes and a paradigm shift to establish a new platform to combat the growing Forces, the industry cannot return to its attractive business model of the past.

While developed rich countries and those with smaller population of the Western world may push for renewables, most of the emerging, developing and poor nations and those with huge population will need time to adapt and scale up alternate energy technologies. Further, the power generated by solar and wind are intermittent and hence they are unreliable to integrate them into the power grid for uninterrupted supply to the consumers as per demand. Unlike oil and gas, solar and wind power cannot be stored for use when needed. The technologies to achieve the transition for energy without oil is not available as of today but significant focus and investment are being added every year to develop them in the future.

Hence, despite all the challenges, oil and gas will remain a strong force in the energy matrix contributing at least one third of the energy demand for the next three decades as none of the alternate renewable energy sources have the ability to scale up and be as affordable as oil and gas.

However, that does not mean that oil can be produced without adequate measures to improve efficiency and reduce carbon emissions. Hence, the biggest challenge for both the oil and gas companies and the service sector is the creation of value through sustainable operating models against all the challenges to oil. Such models require bold steps to make some fundamental changes to the performance culture, creativity and innovation, discipline in finance engineering, risk management and robust project delivery technologies.

The industry is struggling today to safely operate the assets amidst the threat of the pandemic that continues to impact with limited signs of containment despite the ongoing vaccinations and continuing restrictions in air travels and border controls. This will continue to have significant and unprecedented impact in the industry which will reverberate for a long time. With looming uncertainties of the future, the only way the industry can sustain is by accelerating the steps to achieve a transformative change.

All major service players are moving away from conventional models towards emerging strategies and automized models. With layoffs up to 20-40% of personnel in 2020, several highly experienced and qualified experts are retiring from oil and gas industry or switching to other business portfolios. The young talent does not see oil and gas as an attractive business model due to better avenues that are available in the growing sectors of infotech and cyber world. The expanding gap in talent created by the lack of successor development and skill development strategies and with the growing complexity in sustaining the model due to regional and local regulations, the industry (both the oil and gas companies and service providers) is modifying their working model to reduce costs and improve efficiency.

Several oil and gas players are also prudently shifting towards the emerging technologies to ensure that the changing face of the industry is merged in to their existing systems.

2.0 Futuristic Drilling Organizations

The drilling process is very complex and the complexity increases multifold when the wells become more complex. The advances that were achieved in the technology of process plants (like refineries, petrochemicals, fertilizers, manufacturing etc) made them much safer and efficient in the last five decades. However, despite being an industry of more than hundred years, every day, at some part of the world, drilling problems occur. Despite all the advancements made in the last three decades in drilling technology, even today at least 20% of the wells that are currently drilled face some kind of challenges. Considering that nearly 50,000 wells are drilled per year globally, the 20% relates to nearly 10,000 wells. At least 10% of those wells (1,000 or so) get in to major problems while around 5% (around 500) end up in side tracking and/or lost. This level of failures have been reduced significantly in process establishments like refinery, petrochemical and power plants but in drilling, it could not be reduced due to its complexity, high level of uncertainties and extensive dependency on skilled and talented personnel and the need for effective integration of nearly 30-40 services.

Fundamental reasons for such problems and failures in the drilling projects are:

1. Lack of a robust and well defined drilling project delivery technology and processes.
2. Gaps in understanding subsurface risks and uncertainties.
3. Excessive dependence on strict procedures and formalities that restrain the execution within tight boundary conditions.
4. Lack of tolerance for drilling risks, uncertainties and complexities with low degree of freedom for creativity and undefined or restricted delegation of authority.
5. The model of one design/strategy/approach fits all does not apply in drilling because even after drilling a large number of development wells in a field, a new well could spring a major surprise unexpectedly.
6. With the current technology, drilling projects are extensively dependent on talented and highly skilled personnel but the talent gap is expanding due to lack of recruitment, coaching and mentoring and inadequate succession planning especially in the last ten years or so.
7. Resource constraints and inadequate time for planning and preparation for readiness to execute.
8. The complex nature of managing 20-40 services (depending on the drilling environment) and lack of effective integration or co-ordination required to drill and complete a well.
9. Improper and inappropriate selection of rig and services and their poor performance due to lack of the required processes to manage their performance effectively.
10. Inadequate percolation of appropriate technology and recommended practices in developing and under developed countries

The success of a drilling project is heavily dependent on having a well-defined and robust project delivery technology (PDT) and a strong and highly qualified core team that has the capacity to implement, execute and deliver. Foremost of all, the combination of the robust PDT and strong core team will reduce the effects of the other failure causes listed above and work towards delivering the wells successfully.

Drilling costs are highly capital intensive and are close to 40-60% of the field development costs and hence, drilling contributes majorly to project economics. Under the current conditions and uncertain future of oil prices and industry growth, it is extremely critical for the oil and gas companies to achieve performance and cost efficiency in drilling and completions to return and sustain a robust project economics.

As the industry is going through major transformational changes and emerging strategies, a great opportunity that exists today for oil and gas companies to grab and adapt to create a futuristic drilling organization that will not only enhance operating standards, increase value, minimize costs and reduce risk but also will achieve effective drilling project delivery process on a holistic scale. Oil and gas companies who are reluctant to shift towards the emerging models are at a risk of lagging behind under the heavy burden of conventional execution process and the loss of the value driven by the future strategies of drilling.

Today, drilling is not just about drilling and completing a well as an independent activity. It is an integrated process with clearly defined deliverables that are much beyond accomplishing just the drilling targets. A summary of well deliverables is provided in Fig. 2.1 and Fig. 2.2 and associated risk prevention in Fig. 2.3. Accordingly, every well must be designed and executed to evaluate risks, develop mitigative measures and deliver by managing the risks effectively. Conventional approach to drilling is inadequate to achieve such expectations. Low cost drilling to reduce cost is not to be cheap with ignorance to the law of the land but it is defined as the lowest cost of drilling without compromising the objectives, safety and quality.

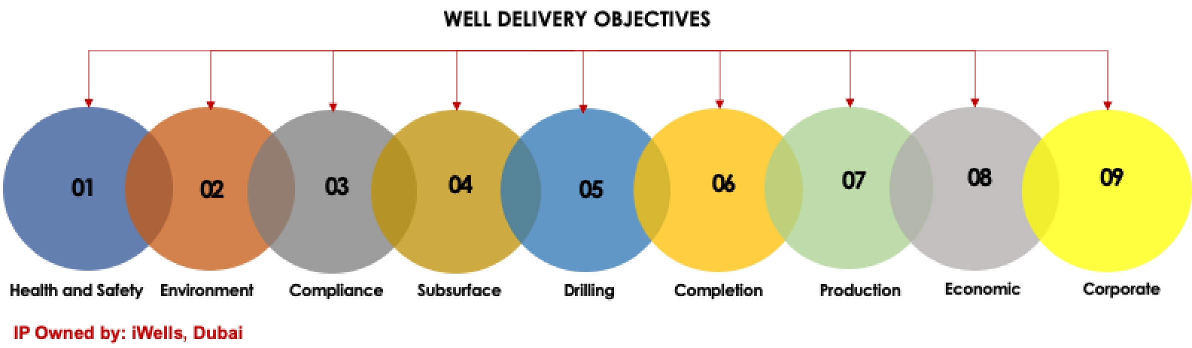

Fig. 2.1: Drilling and Completion – Well Delivery Objectives

Another critical objective that needs to be added to the objectives presented in Fig. 2.1, is the Reduction of Drilling Carbon Emissions as part of the actions to be taken by the oil and gas industry to respond to the Climate Emergency Declaration. Future drilling operations will be required to establish practices and implement technologies to reduce carbon emissions.

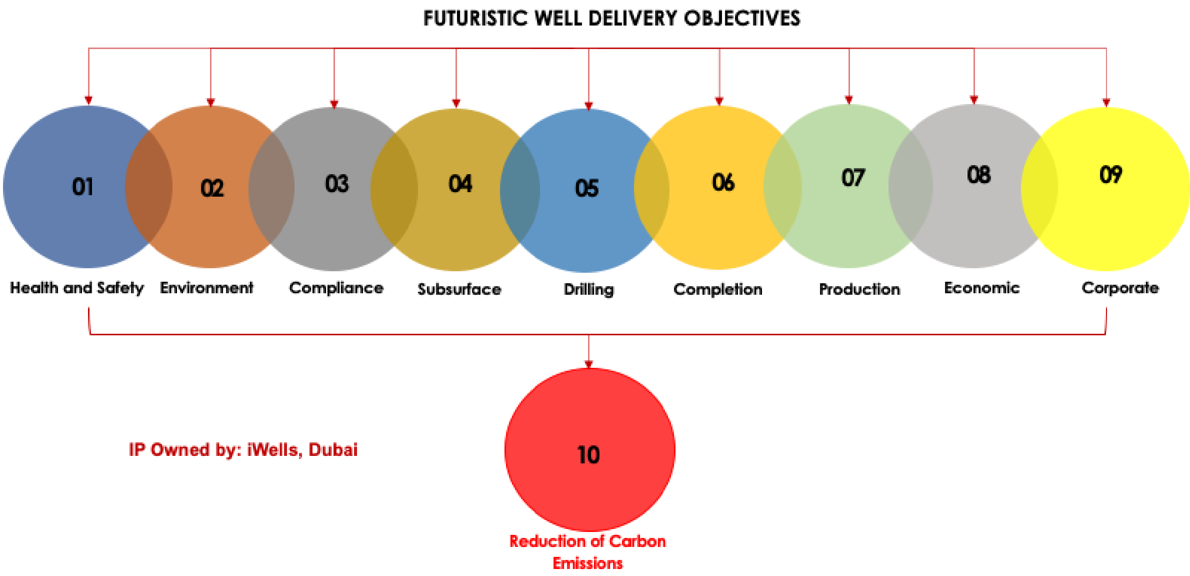

Fig. 2.2: Futuristic Well Delivery Objectives

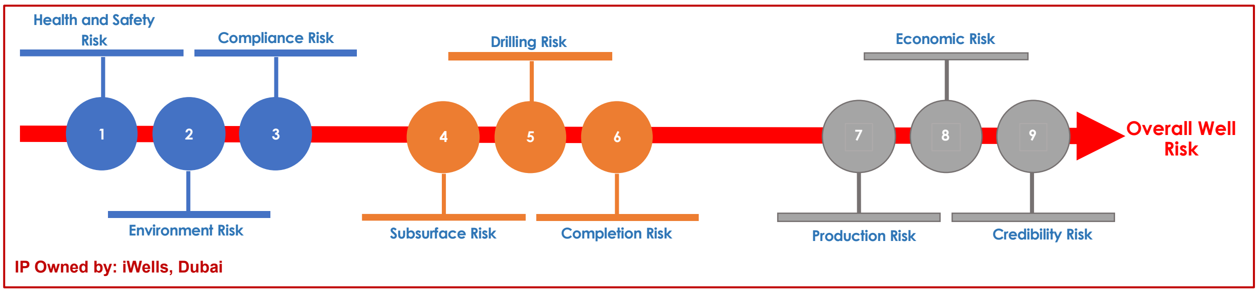

Fig. 2.3: Drilling and Completion - Major Risk Prevention Objectives

3.0 Future Challenges to Drilling Organization

The goal of every oil and gas company is to optimize the cost, reduce the risk and maximize the value of drilling operations ("Goals"). Reducing carbon footprint will become mandatory going forward in a world that is growing against fossil fuels. Drilling deliverables of the future are multi-fold as shown in Section 2.

The pressure to deliver these goals is mounting under the current scenario of high volatility and uncertainty of the future of oil prices. With the transformational changes and emerging strategies occurring in the industry, the oil and gas companies will face new challenges to adapt to the changing environment. Some of them are:

3.1 Digitalization and Automation in Drilling

While some of the existing drilling automation systems have demonstrated their ability to provide significant and consistent improvement in efficiency, the sustained implementation of automation in the drilling applications faces few challenges. The primary challenges faced are:

(a) The existing automation is isolated and lacks collaboration and integration

(b) Lack of alignment of goals and expectations between Operators, Service Providers and Drilling Rig Contractors, especially if the automation manufacturer or inventor is different from any of them

(c) Natural human resistance to change the already established working habits

(d) Complexity in measurement of performance due to the utilization of technology

(e) Failure to sustain the expansion of technology (stagnancy between growth)

(f) Reducing manpower as the first line of cost optimization rather than improving operational efficiency and minimizing risks

At the same time, in this changing scenario of the industry, the digitalization model may reduce the value of certain jobs.

Let us take for example a Drilling Project Engineer and that his/her job is to monitor the project progress against the schedule and alert the decision makers on growing gaps and potential delays. This job requires skill to make subjective judgements from the digital data about the reality of the situation before creating reports to the top. With the digitization process, this job can be replaced by a Bot which will be managed by few minimum wage people who will not require extensive training or skill sets for subjective judgements. They would be expected to follow certain policy guidelines with decision trees handed over to them by the system.

While this will allow organizations to save money on expensive professionals in the long term, however it will produce unskilled robotic type of personnel who will ultimately become obsolete when the full AI automation occurs. The organizations would turn into a head heavy model with few highly experienced and qualified professionals managing projects with Bots and people of lower skills.

Probably some oil and gas service providers are already following this model or in the verge of moving towards that culture. This model of service companies may or may not enhance the operating efficiency of the oil and gas Operators unless they truly understand the merits and demerits of the digitalization process.

The biggest challenges for cost optimization in the drilling industry are:

1. Flat times: Flat times, many of them are repetitive tasks and they occupy more than 40-60% of the overall drilling time.

   Application of appropriate automation and digitalization technology with skilled personnel and advanced real time coaching using a qualified performance consultant on the rig can reduce the flat times by 20-40% (not associated with technical limit).

2. Drilling efficiency: Drilling time contributes 40-60% of the well time depending on the type of well and underlying geology and subsurface complications.

   Using big data analytics, drilling optimization systems and real time data analysis applications, drilling performance can be improved to reduce well times by at least 10% by achieving optimal ROP, maintaining directional control with improved automatic downlinking, minimizing stick-slip oscillations and vibrations, reducing trips to those essential, increasing on bottom time, reducing operational inconsistencies, and efficiently managing well complications.

3. Delivery effectiveness: Invisible lost time (ILT) and inadequate risk understanding (IRU) cause nearly 10-30% of excess time (black swan incidents and surprises excluded).

   Understanding well delivery difficulty index through an integrated drilling project risk identification process is essential to apply advanced optimization techniques and integrating established practices, digitization, big data and real time data analysis to reduce the impact of ILT and IRU.

The challenge in drilling is to segregate the random and non-random risks. It is important that non-random risks are identified and mitigation measures are put in place. Unfortunately, many in drilling do not recognize that non-random events can be identified and mitigated. Hence, most risks are treated as random and hence mitigations are mostly on paper but not in practice because if every risk is treated as random, then the scope and cost of mitigation readiness becomes excessive.

4. Selection of the rig technology, contractors and services: The major obstacles in achieving this goal are:

   (a) in general, the first line of approach by Operators world wide, except few, is to negotiate the costs of services as low as possible without discrimination between value and routine service;
   (b) service companies, except few, knock down the prices to beat the competition or to stay in business with low margin at unsustainable levels, while value driven highly qualified services may turn down low price demands;
   (c) regulations on local content are essential to promote and protect the economy, national resources and talent but lack of proper implementation and governance lead to inadequate growth of the sector and imbalanced competition;
   (d) while governance and control of the tendering process are a must to ensure compliance and conformance to the standards of the company, partners and governments, the process shall not become a bottleneck or an excuse for improper selection of the right contractors and technology or create extended delays in the process;

(e) Collaboration Models: Lack of integration between the four pillars of a drilling project (Operator, Drilling Rig Contractor, Service Providers and Regulatory Bodies) leads to wasted time, efforts and costs. While the wastage can be quantified for specific projects, the critical fact is that growth in execution efficiency is negatively impacted by the lack of integration between these four pillars.

Hence, digitalization and automation require a holistic approach to ensure the balance between data analysis, human skills that require high level of judgement and cognition abilities, selection of the right technology and contractors, and optimized processes to achieve efficient drilling operations.

3.2 Carbon Footprint Reduction in Drilling

Reducing carbon footprint in drilling is still at a very conceptual stage in the industry and requires significant investments and resources to innovate and develop new ideas and strategies for effective applications. The primary challenges in reducing carbon footprint in drilling are:

(a) More than 95% of rig power generation is through fossil fuels with diesel as the most commonly used fuel

(b) The entire gambit of logistics requires significant fossil fuel consumption for land transport by trucks, offshore transportation by vessels, shore base activities for cranage, helicopter flights for personnel movements

(c) The impact of drilling discharges and waste disposals on carbon footprint is also sizeable

(d) The carbon foot print caused by humans during the entire drilling project

Changing or modifying the energy resources from fossil fuels to renewables or low carbon emission technologies require huge investments, time and training. It is not an easy task and hence the industry needs to adapt highly efficient practices that would reduce the carbon emission while appropriate cost effective technologies are developed.

The business model of drilling rig contractors is complex, especially if the industry is volatile without assured long term contracts. In that scenario, with Oil and Gas companies squeezing to reduce the contract rates of drilling rigs, the quality of maintenance, sustaining high level of HSE standards and qualified rig crew are already under tight operating conditions. Adding low carbon emission technologies, especially when the rigs are operating in short term contracts, will be expensive and this needs to be addressed between the operators, drilling rig contractors and regulatory.

Further, Regulatory Bodies and Governments need to allow carbon credits or tax credits for oil and gas companies and drilling contractors for reducing carbon emissions or capturing/storing carbon ("CCUS" or "Carbon Capture Use and Storage") to encourage the huge investments and capital required to convert and modify the existing systems through innovative technologies.

3.3 Way Forward

Hence, going forward, due to the imminence of the emerging strategies and transformative changes in automation, digitalization and cyber-tech models, it is imperative that the drilling industry find a new emergence to become futuristic.

For effective application of emerging technologies based on digitalization and automation and reduction of carbon footprint in drilling, it is critical that an alignment is achieved between the four pillars ("Four Pillars") of drilling which are:

Pillar 1: Operator
Pillar 2: Drilling Rig Contractor
Pillar 3: Service Providers
Pillar 4: Regulatory

Without the alignment between the Four Pillars that govern the execution of a drilling project complementing to each other, paradigm shifts cannot occur in the industry. Only such alignment will allow course corrections and real time management of deviations to result in a sustained long-term change. Improving efficiency of the drilling operations with reduced energy will also contribute substantially to reduce carbon emissions and hence an efficient drilling project delivery technology becomes much more important in delivering not only the well objectives but also the climate emergency requirements.

While the regulatory is not considered to be a part of the day-to-day operations, engagement of other three pillars are crucial for ensuring and to impose a positive impact to convince regulators to adapt modern optimization principles and become flexible for policy modifications.

Despite the alignment of the Four Pillars, the human effect cannot be ignored as it has the power necessary to fail any project despite high level of commitment and management approvals. Hence, futuristic drilling organizations need to establish a robust and efficient drilling project management teams with the right talent and skill sets suitable to execute the futuristic drilling models.

4.0 Talent and Culture in Drilling

The talent gap in the oil gas industry has widened especially after the oil shock of 2009 due to the worldwide economic meltdown created by the subprime crisis. The volatility and tough work-life combination in the drilling industry had made lot of talented and highly skilled people to pursue other careers in infotech, digital and technology venues. Highly talented professionals of the older generation are in the verge of retiring or shifting away from the oil industry. In the last 12 years, the recruitment, training and coaching of new talent had reduced significantly and due to this, today it is rare to find truly talented young professionals for drilling at the middle management levels.

The future model for the industry requires an organization integrated both in talent and technological skill set. Conventional management structures, processes and systems will not return value to the organization. A new model to integrate talent, skill and processes through agile or resilient strategies is needed.

4.1 Strength and Performance = Potential – Interference

Irrespective of the size and established systems of an organization, its success arises from commitment to deliver by best efforts through personal commitment, passion and fulfilling expectations. The rules played by IOCs, NOCs or Oil Majors may not apply at the same degree to small and mid-size independents due to the fundamental difference between them in the project objectives including funding structure, timebound monetization to service debts and commitments to the stakeholders. However, both type of organizations will fail when an inspirational leader and talented/skilled project teams are absent. The history has shown that despite the level of systems, procedures and policies in an organization, the ability to be reliable, consistent and uniform throughout the lifecycle emerges only if there is an inspirational leader at the top with the cascading leadership, management and execution skills at every level.

Hence, potential alone is inadequate and immaterial. The interferences that affect the performance efficiencies must be eliminated or reduced to achieve robustness.

- Strength and performance emanate from resilience of the organization and that can be achieved through:
  - simplification of policies, processes and procedures;
  - integration of interface, collaboration and competency through unified approach;

- The organization must follow a learning culture and not performance culture. There is no such thing as the ultimate. So best practices are best only at the current context and cannot be generalized forever as it actually restraints creativity and enhancement.

- Organizations that demand performance culture using best practices without tolerance for creativity, learning and adapting, will tend to fail at some point of time as such organizations are restrained by closed boundary conditions.

- The peripheral challenges to mobilize resources in the midst of still ongoing border closures, travel restrictions and pandemic response protocols need to be managed through an integration of local talent and remote based operations using high tech digitalized solutions.

- The supply chain model needs significant orientation to eliminate the delivery challenges elevated by the current pandemic related crisis and to ensure that the conventional burden of competitive bidding is modified to strategic integration and technology driven model to reduce costs.

4.2 Efficiency = Potential + Effectiveness

It has been proved beyond doubt that potential alone is inadequate to deliver efficiency.

- It is not uncommon that some high potential organizations deliver lower efficiency due to lack of the culture of learning, adapting, innovating, and integrating.
- Potential needs to be supplemented and augmented with effectiveness. The effectiveness is achieved by inculcating a culture that overrides all the obstacles in deliverables. The culture must also be adaptable to changes to drive strength and resilience.

However, to achieve that dream, the drilling organization must become agile and resilient by establishing the necessary foundation and platform to merge into the emerging strategies and philosophies of the transforming industry.

The current phase of the industry provides an excellent opportunity to oil and gas companies to develop, coach, prepare, implement and be ready to execute the new model in all their future drilling operations.

5.0 Drilling Project Delivery Process (or Technology)

In order to become futuristic, drilling organizations need to avoid getting caught into the traditional / conventional management models that are on the way to their extinction. Some of the fundamental changes needed to achieve that are:

(1) a resilient drilling project delivery technology that eliminates the gaps of the traditional project management systems;

(2) the rules of engagement of the resilient technology must be complementary to defined existing systems;

(3) the rules of engagement to become futuristic must be inculcated as a habit in the drilling organization;

5.1 Traditional Stage Gate and Agile Project Management

The first step towards achieving a futuristic drilling organization model is to evaluate the appropriateness and suitability of traditional project management technologies and their application to the organization’s business model and principles.

Conventional and traditional project delivery technologies like the stage gate are not always successful in drilling due to its complexity and in general the upstream oil and gas industry.

Before we engage with the proposed project delivery technological model, it would help to understand some of the demerits of the conventional model for drilling applications.

The traditional Stage Gate process is a waterfall (sequential) management while the second most commonly applied model, the Agile Project Management is an adaptive technology.

Both the Stage Gate and Agile processes were primarily developed for large software developments but gradually they were being adapted by other industries.

Stage Gate process has been used in the oil and gas projects with mixed success. The success depends on several factors including fundamental changes to an organization's business philosophy and execution principles from board room to the field levels.

Agile method is not adapted as formally as Stage Gate in the oil and gas industry but several organizations, especially small and mid-size independents use an adaptive model successfully without naming it formally as Agile. In an informal way, Agile has been in existence in the oil and gas industry in different forms even before the Stage Gate was formally introduced.

Traditional gating process is designed to bring a disciplined approach to a project execution by breaking down the process into discrete stages from concept to completion. Each stage incorporates:

(a) defined practices;
(b) checks and balances;
(c) reviews and challenges;
(d) effective front-end work where changes if any will cost lesser;
(e) establishing a cross functional team; etc

It also provides defined deliverables to the project objectives and a platform to confirm compliance to the current stage before moving to the next stage. Stage Gate process also allows evaluation of investments, especially incremental investment which allows mitigation and minimizing of risk.

Agile is another project management method that is based on agility, flexibility, adaptability and a fast-track approach to project delivery. Agile consists of short sprints that produces a demonstratable work/task which gets integrated into the project process with specific approvals (if required). Each such sprint is planned relatively in real time without a master plan on critical path for the entire project which provides the adaptability and flexibility. Agile is applicable in organization cultures that responds to change (rather than the order and stability demanded by Stage Gate).

However, both Stage Gate and Agile models are not successful as a standalone Project Management Technology ("PMT") for drilling applications due to the level of complexity, impact of risks and high uncertainties.

The reasons for failures and problems in implementing the Stage Gate and Agile to drilling project management is multi-fold but primary of them are:

(a) Most firms assume one size fits all and implement the same style of stage gate and/or agile process for all projects despite varying,

- *business cultures and drivers;*
- *asset type and levels;*
- *JV partnership agreements;*
- *petroleum license models;*
- *size, model and project drivers of the company;*
- *management structure, capabilities and decision making cultures;*
- *portfolio management philosophies;*

- *reverse engineering or copying of another company's procedures;*
- *pressure on teams to follow the same road map for all projects;*

(b) *often, companies miss the opportunity to create a high impact value during project framing phase that leads to costly changes during execution;*

(c) *stage gate process has limited tolerance of leadership expectations and hence does not allow project alternatives, critical path activities and collaborating proposals;*

(d) *project teams will be forced indirectly to develop advocacy models to adhere to the limiting conditions of the stage gate process resulting in un-exploring alternate perspectives with the risk of missing a better alternative;*

(e) *in traditional project management systems, the functional management biases become rampant exerting influence on decision making which creates a conflicting spider web of contradicting and inappropriate role distributions between project and functional managements;*

Finally, An aggressive organization that believes in fast track acquire-exploit-monetize model cannot implement the process of an international super major oil company without undergoing some fundamental and major changes to the organization's operating model.

The Hybrid system provides the combination of agility and discipline by containing the Agile principles within each Gate. In the Hybrid system, the Stage Gate stays as designed at macro level while Agile brings value with its micro principles. Several drilling projects run on this hybrid model practically without a formal code for the underlying hybrid principles. However, the Hybrid method is not yet widely adapted as a formal system in drilling project management.

5.2 Resilient Drilling Project Delivery Technology – RDPD^T

As no project in the world is an extreme, a balanced approach is preferred. Irrespective of the project management system followed, in order to adapt to the emerging strategies and transformative changes, every system requires some fundamental changes to the business model of an organization that applies to all from board to field levels.

Establishing a futuristic drilling organization requires radical changes to the traditional operating practices. The first step is to modify the existing traditional Stage Gate or Agile or Hybrid project delivery process to produce a more powerful, highly practical and robust model to execute a drilling project under tight operating conditions.

The application of the innovative project delivery technology must encompass the existing operating model instead of alienating it. It is extremely critical because any major change to the existing project delivery technology will invite resistance as the natural reaction for change. Unless the entire drilling organization and all the interfacing disciplines within the organization are integrated with a total buy-in, any new technology will become ineffective. Hence, any such new model needs to encompass and integrate the existing systems while at the same time firmly establishing its footprint to avoid misrepresentation and failure.

A futuristic model to engage and adapt to the transformational changes occurring in the industry was developed by iWells Integrated Project Management Consultants DMCC, Dubai ("iWells"). The "proof by contradictions" analysis model was used to eliminate the major gaps existing in the traditional systems when applied in complex drilling projects. This model complements the Hybrid (Stage Gate-Agile) project management system with a new innovative Resilient strategy. The Integrated Resilient-Agile-Stage Gate Project Delivery Technology "RDPD^{T}", encompasses the whole gambit of drilling complexities, uncertainties, risks and variance and is developed to deliver drilling project management as a holistic model.

Fig. 5.1 presents the RDPD^{T} model.

There is an opportunity available today in the industry to implement the RDPD^{T} drilling project delivery process. It will enable the integration of the transformational changes and emerging strategies that are happening in the industry and the application of digitalized and cyber-tech models to effectively and efficiently deliver drilling projects.

There is no risk in formally using the RDPD^{T} as it is an amalgamation of the Hybrid (Stage Gate-Agile) with Resilient part that consists of few innovatively created critical, strategical and effective optimization processes. RDPD^{T} will enhance the value of an oil and gas company's drilling projects in terms of, but not limited to:

- (a) A robust well delivery process with a dynamic management of change process
- (b) A dynamic application to effectively manage risks, uncertainties, and potential difficulties in drilling a well
- (c) Real time robust and well defined decision making process
- (d) Allows appropriate application of technologies and modern digitalization processes
- (e) Dynamic and robust process for real time governance in monitoring, reporting, and controlling
- (f) Seamless integration of drilling with interfacing disciplines within and outside of the organization

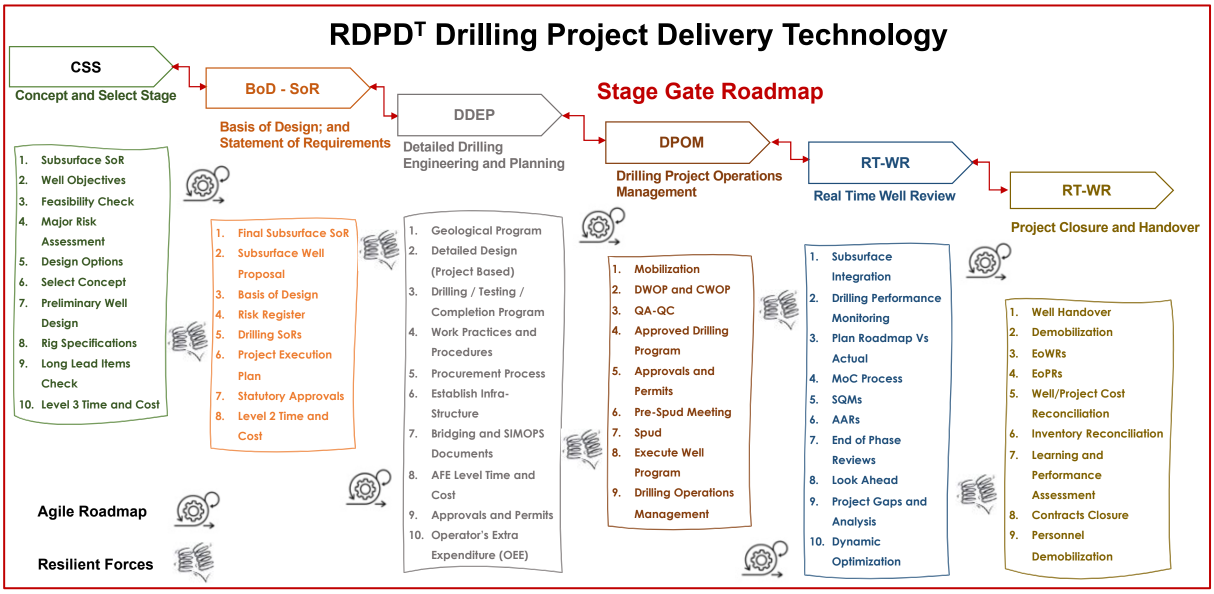

Fig. 5.1: Resilient Drilling Project Delivery Process

Please write to admin@iwellsmc.com for a poster of the RDPD^{T} process that is designed for various sizes from A2 to A0.

Application of RDPD^{T} through "Well^{OPT}" is being developed by iWells as the world's first fully integrated specialty drilling project management software. Well^{OPT} is expected to be launched in Q1-Q2, 2022.

However, all the components of RDPD[T] are available in different forms for application today from iWells.

6.0 Drilling Project Costs – Complexity and Difficulty Index

6.1 Drilling Cost Model and Effect of Complexity Levels

Drilling cost model is a complex process due to various factors that create multiple layers of uncertainties and risks. Most of the optimistic drilling cost estimates ends in a cost overrun that impacts the funding/cash flow while pessimistic approach results in overestimated budget that impacts the conditions for optimal execution.

Although termed as P10, P50 and P90, both the time and cost estimates are mostly deterministic using only one constant variable or limited impacting conditions are applied to extrapolate them from a most likely estimate.

Composite well times are used to create technical limit time estimate but they are comprised of unaccounted uncertainties and inadequate application of cause and effect scenarios and hence generally applies only to a set of large number of wells.

A well-defined drilling cost estimate is difficult to achieve due to varying:

(a) Inadequate definition of drilling project objectives (refer to Fig. 2.1);
(b) inadequate planning and design inputs and failure to capture possible gaps between design and objectives;
(c) lack of understanding of type of distribution or correlation between input parameters;
(d) insufficient understanding of subsurface risks and hazards;
(e) inadequate mapping of level of complexity, expected uncertainties, surprises and unplanned problems, delays and operational constraints;
(f) failure to capture random and non-random risks properly into the cost models;
(g) fear of rejection leading to advocacy models (prepare cost to suit management expectations or project economics);
(h) pressure to reduce cost for creating robust economics or pressure to increase cost to avoid amendments in situations where changes are not appreciated;
(i) capability and capacity of the drilling project teams and efficiency matrix;
(j) several others that are discussed elsewhere in this document;

The cost of a drilling project commences from the concept stage and completes at the end of project closeout and handover.

Please refer Fig. 5.1 to the elements of a drilling project cost model.

The major cost centers of drilling project operations are:

A well (technically) and its cost are governed by three major categories:

(a) the Periphery,
(b) the Core, and
(c) the Product.

The Periphery is defined as all activities that relate to prepare for drilling a well. Please refer to the sections 1 (CSS), 2 (BoD-Sor) and 3 (DDEP) in Fig. 5.1.

The Core is defined as all activities that relate to execute drilling operations. Please refer to sections 4 (DOPM) and 5 (RT-WR) in Fig. 5.1.

The Product is defined as all activities that relate to deliver the well successfully and hand over to production. Please refer to section 6 (PCHO) in Fig. 5.1.

Note 1:

Individual well costs need to be segregated from the over drilling project operations cost if there are multiple wells in a campaign.

Note 2:

Operator Extra Expenditure ("OEE") Insurance, listed in Section 3: Detailed Drilling Engineering and Planning (DDEP), is essential for well blow out insurance, restoration/re-drilling and pollution liability plus all the critical endorsements that are needed.

Note 3:

In the future, a new cost element for reducing carbon emissions of drilling operations will have to be added.

Note 4:

iWells has developed a holistic drilling time and cost management software called T^{OPT} and C^{OPT} respectively. The models are highly cost effective, efficient in time and cost modelling and real time monitoring, reporting and optimization.

6.2 iWells Publications on Well Cost Optimization

Please refer to the links below for iWells publications on cost optimization:

1. http://iwellsmc.com/well-cost-optimisation.pdf, published in 2016
2. http://iwellsmc.com/well-cost-optimisation-may2020.pdf, published in 2020

6.3 Well Cost – Cost Vs Complexity

A well (technically) and its cost are governed by three major categories, (1) the Periphery, (2) the Core and (3) the Product. Please refer to Section 6.1 for details.

Prudent organizations understand that the well cost increases by a factor or in a steeper slope whenever a threshold of difficulty level is crossed. However, this fact is not formally applied widely in the industry because of the complexity in estimating the threshold values. The general considerations used by the industry for benchmarking well costs are parameters like the depth, well type, environment, temperature and pressure etc, but there is no formalized index to benchmark and evaluate well costs from a holistic approach.

Without a clear distinction between difficulty levels at defined threshold values, determining a drilling time and cost would only lead to failures as one design does not fit all levels of difficulty index.

In general terms, the industry has several drilling difficulty index models such as:

(1) JAS – Joint Association Survey, probably the earliest and oldest in the industry, developed to deduce the cost of an unreported well using offset wells data

(2) MRI - Mechanical Risk Index developed to compare the performance of offset wells

(3) DDI - Directional Drilling Index, to represent directional drilling complexity rather than the overall well delivery process

(4) DI – Difficulty Index, to represent difficulties in ERD wells

(5) MSE – Mechanical Specific Energy, that quantifies the energy required to drill a volume of rock.

Each of the above listed difficulty index models are limited to certain boundary conditions and hence are not fully holistic to a well delivery.

iWells has been working on developing a difficulty index model that encompasses all the possible elements that define, contribute and govern a well cost. The output of such work, after nearly two years of research and development, is the Well Delivery Difficulty Index ("WDDI"). The WDDI attempts to remove the gaps and limiting boundary conditions that exist in other difficulty index models. The WDDI encompass all the three major categories of the well (1) the Periphery, (2) the Core and (3) the Product.

The WDDI integrates the Level of Complexity (LoC) and Delivery Difficulties (DD) into a single matrix. While the LoC governs the Peripheral boundary of a drilling project, the DD governs the Core and the Product.

The WDDI Index follows a scale based on Fibonacci Sequence of 1, 2, 3, 5, 8, 13 and 21, with 1 being the lowest risk and relative cost. Fibonacci Sequence is a better factor to define the risk and cost of every subsequent order because it clearly demonstrates the relative difference between two orders.

Most of the indexes in the world use a scale of 1 to 10 but this scale is inadequate to capture the relative difference between two subsequent sequences. As an example, if two subsequent orders are rated as 5 and 6, it is difficult to register the significance of the difference between them and hence might be ignored as subtle. However, in reality, there is a 16.7% difference between 5 and 6, which is significant but it will not be seen that way.

Hence, iWells' WDDI model was developed based on Fibonacci Sequence.

Fig. 6.1 provides a representative model of the well cost and risk levels due to WDDI.

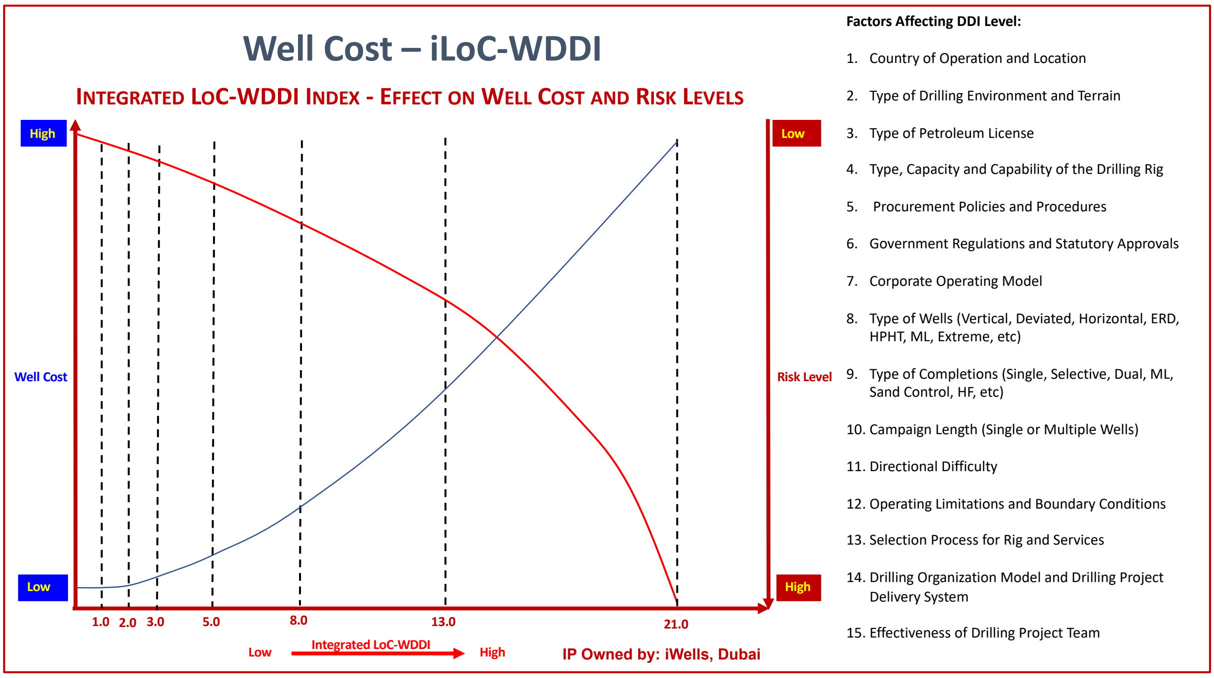

Fig. 6.1: Drilling Cost and Risk Vs LoC-WDDI

The WDDI model can be applied to distinguish and identify the threshold levels for well time and cost estimates. For details of the application, please refer to section 9 for contacts.

7.0 Drilling Project Management Team

7.1 Principles that Govern a Reliable Drilling Project Management Team

A Drilling Project Management Team is much more than having a team of competent personnel working together. The principles that govern the drilling discipline, apart from knowledge, qualifications and experience, are primarily trust, reliability and understanding within the members of the team.

Often drilling problems do not allow extended period of time to search for solutions and hence faster decisions are needed to prevent further escalation of the problems. Despite all the digital information available real time, the reliability of information received from the project team is vital for taking right decisions using proper judgement and logical reasoning.

The digital data alone, while good for analysis, is inadequate for good decision-making process. Similarly, one cannot make a right decision based on information received by project personnel only.

One of the major challenges in drilling decisions is the advocating or biased views of an individual based on their expertise and experience rather than using the right data and appropriate information to evaluate a situation. Due to this, the info given to the drilling project leadership may become biased and skewed to justify one's decision (advocacy model). This needs to be seriously avoided in drilling teams because in several instances, decisions are to be made in a short time.

Hence, it is important that the right information based on actual facts using both data and project team's report are considered for evaluation. If the decision making process is based on only one of, either the digital data or information narratives by personnel, then decisions may go terribly wrong sometimes. A good decision making process will require to integrate and combine both the digital information and firsthand reports by the project personnel so that a properly analysed, informed and educated decision is made.

In an expanded operating environment, the requirement of a team that can work together without conflict of interest is extremely critical for the success of the projects. While the views and experience can differ, it is healthy to have a multi-national multi-cultural environment that allows decisions to be taken through effective communication, discussions, deliberations or even debates.

It is also extremely important to remove any complacency, familiarity bias and comfort bias in the drilling team.

7.2 Cost of Drilling Personnel – Cost Vs Complexity

The cost of drilling project team is significant in a drilling project. The cost of personnel commences from the concept stage of the project and completes at the end of project closeout and handover. A typical drilling project personnel cost model is provided below:

The cost of drilling personnel in the overall drilling cost vary significantly with a wide range, between 6% to 14% of the total well cost, depending on the Level of Complexity ("LoC") of the drilling project. Fig. 7.1 provides the cost matrix against complexity in pictorial form.

WDDI of iWells incorporates the drilling personnel cost as a major input to the WDDI matrix estimation.

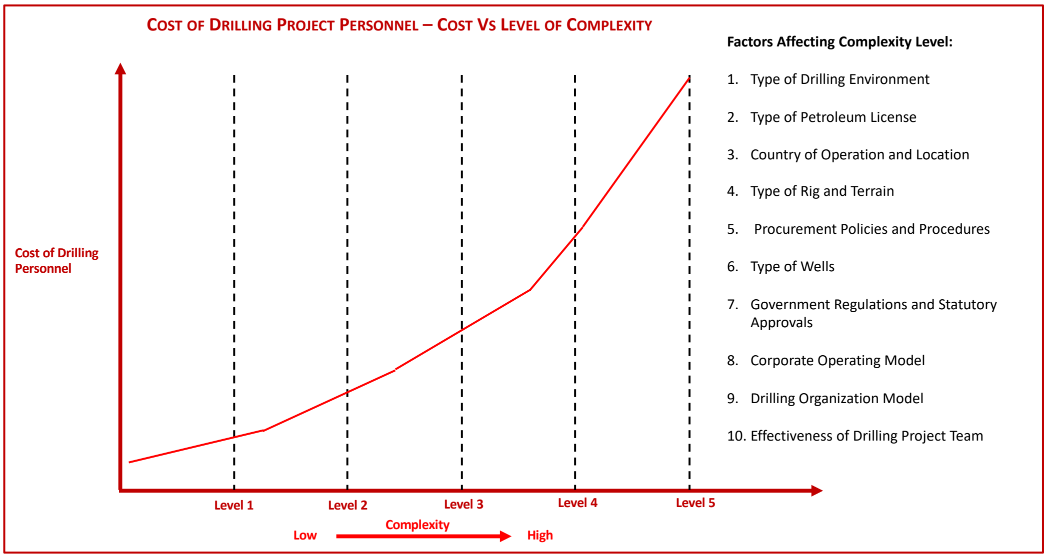

Fig. 7.1: Drilling Cost Vs Level of Complexity

7.3 Drilling Project Team of the Future

The goal of such changes is to achieve "Frictionless Efficiency in Drilling".

With the imminent advent of digital revolution, emerging strategies and cost effective models in the drilling industry, the drilling operations management of the future will also need to undergo a change to establish new fundamentals.

Conventional models of full inhouse team (from base office to the rig) or complete drilling IPM from a 3rd party service provider may not be sustainable in the future.

7.3.1 Full Inhouse Team

A complete full inhouse team has traditionally always been possible only by IOCs, NOCs and Majors due to their extended long term drilling campaigns in multiple countries and their affordability. Unless the drilling programs are justifiably long, this model is unsustainable by others like small and mid-size independents. While this model worked well in the past for companies who could afford it, future would be different.

In most cases of permanent inhouse staff team, a significant portion of the team exhibits inherent risks of complacency, familiarity bias, comfort zone attitudes with lack of ambition for growth, prolonging the engagement for retirement benefits, compartmentalization affected by internal dynamics and a natural resistance to change. A model of this kind with only a portion of the inhouse team having the attitude for true growth, improvements and changes will not allow the companies to establish a futuristic drilling organization successfully and efficiently. As discussed in Section 4.0 above, having established systems, policies and procedures are inadequate without a cascading leadership that drives value and excellence in performance.

7.3.2 Complete 3rd Party Provided IPM Team

Small and mid-size independents, due to short term drilling projects on project basis, could not afford expensive full inhouse drilling teams for extended periods. Hence, the industry has been working on various models of drilling organization structure. One such model is the complete drilling project management provided by a 3rd party service provider ("IPM").

The IPM model that was prominent in the past for small and mid-size independents may not be sustainable in the future. The IPM model is the most expensive model for an Operator with least control on the project. The success of an IPM depends on the quality of IPM leadership, nature of engagement, defined deliverables, drilling complexity and environment factors including execution dynamics and effective performance monitoring. Although expensive, many oil and gas companies utilized this model as the high oil prices of the past returned a robust economics. When the oil prices are high, north of around US$ 70 per bbl, the efforts towards true cost optimization naturally drops off except in few companies who practice optimization as a habit.

Further, drilling IPM Organizations require a very strong and robust senior core team in every discipline of well construction. Beyond the core team, other personnel must also be highly qualified in respective disciplines. Head heavy concept with mediocre middle and lower-level management teams does not work for an IPM. The core team is extremely expensive to sustain without regular and running projects. The entire success philosophy of a drilling IPM organization arises from the strength of such a core team without which they would invariably fail.

A drilling IPM organization cannot be run by picking up and collecting people from market as and when needed as irrespective of the experience and ability of each individual, the central philosophy of an IPM organization with strong fundamentals cannot be achieved without a robust and highly experienced integrated core team.

Hence, the expensive and independent model of IPM may not be applicable for a futuristic drilling organization due to conflicting interests.

The dual shock of 2020 due to (a) Coronavirus effects and (b) low oil prices to less than US$ 30 per bbl from March 2020 has created a massive blow to the drilling projects globally and several drilling IPM organizations have lost ground to sustain. Most of them had dismantled the IPM model or merged with a bigger company to survive or converted the model to manpower supply. Only a few unique drilling IPM organizations exist today globally with all the capabilities and capacities to justify the IPM model due to their strong fundamentals and endurance. However, most of them are restricted to their own territory of boundary conditions due to increasing local content regulations in many countries.

Fundamentally, the concept of a complete Drilling IPM model is not suitable for futuristic drilling organizations due to:

1. Inability to maintain a strong and robust core team which is the heart of an IPM model
2. Inability to assure continuity due to high personnel turn over
3. Inability to adapt to the technological changes, digitalization, automation and cost optimization solutions due to conflict of interest
4. Unwillingness to understand the changing industry landscape and inflexibility to modify the model for hybrid platform
5. Inability to manage cash flow to endure potential delays in the realization of accrued revenue

7.3.3 Drilling Project Team of the Future

It is hence imperative that Oil and Gas companies while integrating the emerging strategies and transformative changes, must also establish robust operating models for project execution with a radical shift to enhance and elevate the business execution, performance, compliance and conformance applications.

Under this scenario, four major changes must occur in the execution model of futuristic oil and gas companies for efficient and effective drilling project management.

They are:

1. A strong and competent in-house core team, consisting of senior decision making leaders in drilling project management, engineering, operations and logistics, with all other personnel sourced from a network of talent pool that are available from outsourced platforms at affordable costs.

2. A hybrid collaborative working model that combines physical and virtual environment through advanced cyber-technology and innovative networking which reduces the human foot print in drilling operations significantly.

3. Digitalized and automated platform for well delivery process that reduces human intervention to the lowest practically possible levels to increase efficiency substantially.

Practices to optimize execution and improve performance using big data (where available) for structured and activity based detailed analysis.

4. An innovative and robust project delivery technology that is designed for managing the futuristic applications of drilling projects that are capital intensive, complex, risky, prone to high uncertainties and high level of difficulty index.

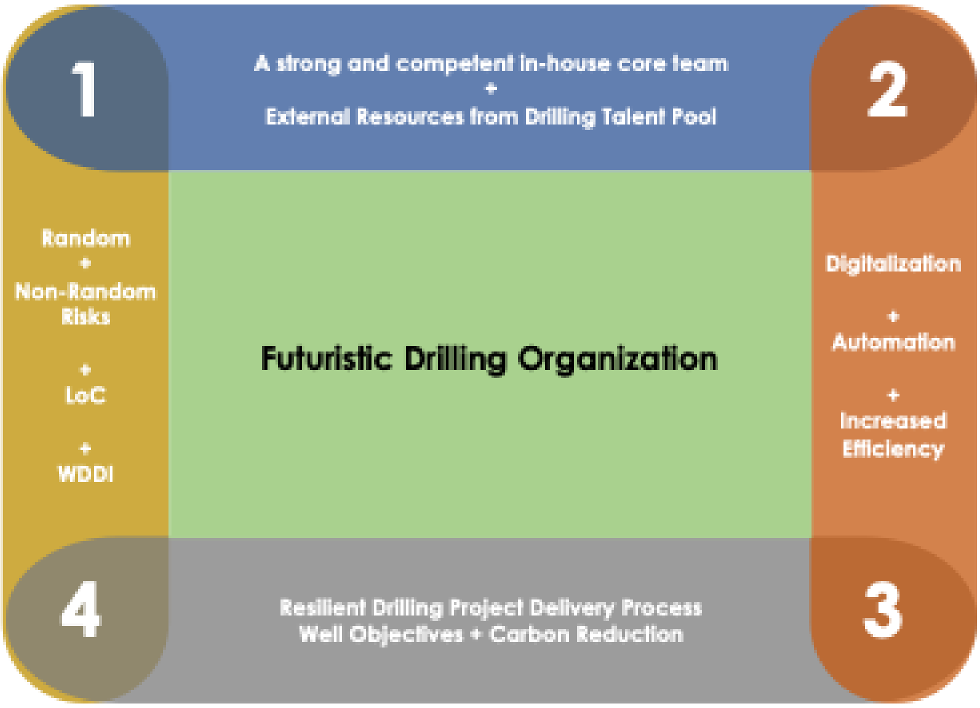

Fig. 7.2: Drilling Project Management of the Future

iDrilling Technologies ("iDT") Dubai (through iWells) had launched the world's first model of complete online engineering consultancy firm for well delivery process at www.drillersdesk.com. The model is the first step towards establishing the digital platform of drilling management for futuristic landscape of drilling. Further details of the drillersdesk platform is available at the web portal.

iWells is currently developing a drilling carbon footprint efficiency tool to measure, estimate, report, monitor and control carbon emissions from drilling operations.

8.0 Conclusions

1. The landscape of drilling of oil and gas wells is changing rapidly, and it is imperative that drilling organizations become futuristic to adopt the ongoing transformational changes and emerging strategies in the drilling industry.

2. Unlike in the past, today drilling is a holistic well delivery model with ten different objectives (refer to Section 2.0) including reduction of carbon emissions from drilling operations. Hence, well delivery must be planned and executed with optimized and effective solutions.

3. The traditional stage gate or agile models as standalone applications are not suitable for a successful drilling project delivery. While the hybrid model (stage gate-agile combination) works better, the industry needs a much robust resilient

drilling project delivery technology, refer to Section 5.0, to achieve the integration necessary to the changing industry scenario.

4. Drilling projects must be designed and executed with a full understanding on random and non-random risks, level of complexity and well delivery difficulty index. The time and cost estimates must be based on the threshold values of difficulty level index to ensure a highly practical and executable model (refer to Section 6.0).

5. A hybrid collaborative working model that combines physical and virtual environment is essential through advanced cyber-technology, digitalized and automated platform that reduces human intervention and foot print in drilling operations significantly and to increase efficiency substantially.

6. The conventional/tradition models of drilling project teams may not be sustainable in the future and must undergo rapid changes as discussed in Section 7.3 to establish a strong platform to deliver drilling projects effectively and efficiently.

9.0 Further Contacts:

For further discussions or presentations or materials, please contact:

jmk@iwellsmc.com
vignesh@iwellsmc.com
admin@iwellsmc.com

Website: www.iwellsmc.com

iWells Management Consultancy: iWells is specialized in drilling oil and gas wells with focus on well delivery optimization, technical and operational integrity, effective drilling execution strategies, risk mitigation and prevention, resilient well delivery process through RPDP[T], continuous improvement to reduce drilling carbon emissions and establishing Integrated Project Management concepts in the industry.