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Digital Transformation to Accelerate Indonesia's Hydrocarbon Exploration from Data to Discovery

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Abstract - **Exploration data are the forefront and the driving force of exploration activity in the upstream oil and gas sector. The accessibility and quality of the data are the deciding factor to de-risk the exploration. Data have not been properly managed in the past despite its potential to accelerate hydrocarbon discovery. Government has initiated attempt to liberate Indonesian's subsurface data through Migas Data Repository (MDR). However, the current functionality of the MDR is yet to attract investor and increase the exploration activity. This research proposes a business solution through digital transformation to elevate MDR functionality into a National Upstream Gateway (NUG). The solution is derived from system thinking which was built based on the internal and external factor of the industry. NUG requires a self-sustaining business model powered by collaboration building block which enable investor and existing contractors to access Indonesian exploration data virtually in an intuitive manner. NUG is expected to break silos and improving the performance of the exploration program. The system allows licensing round marketing to penetrate global audience and ultimately accelerate Indonesia's hydrocarbon exploration.**

Keywords - **data liberation, digital transformation, hydrocarbon exploration**

I. INTRODUCTION

The oil and gas industry has experienced significant volatility in the last decade. Geopolitics and global economy play a significant role to drive the sensitivity of oil prices. According to the PwC Oil and Gas Investment Guide, 2019 [1], the declining oil production and increased consumption have resulted in Indonesia being a net oil importer since 2004. This factor along with high oil prices before 2015, led the Government to gradually but substantially scale back the domestic fuel subsidy during 2009-2014.

Investment in the oil and gas industry was around US$ 10.9 billion in 2018 [2], as the rise in oil and gas prices triggered some investment interest from the previous US$ 10.3 billion in 2017, which was the lowest in decades. Indonesia is facing problem of a lack of new reserve discoveries and reserve depletion; as SKK Migas noted [3], investment in exploration areas was a mere US$ 122 thousand in 2018, compared to the US$ 10.92 billion invested in exploitation areas. These factors also contracted from the relinquishment of numerous oil and gas working areas from the 312 working areas in 2015 to 216 working areas in 2018.

The enabler of exploration activity is data. Data will increase the chance of discovery to some extent that it can offset the risk. At the end of the second quarter 2019, Indonesian energy and natural resources (ESDM) ministry release a new regulation for oil and gas data management and access, Regulation 07/2019 [4] which amend Regulation 27/2006. The new regulation supposedly make ease to the data access as mentioned in article 5 paragraph 6. However, the current infrastructure is insufficient to realize this objective. Data liberation has to be managed sophisticatedly so that it encourages investor to come and thus triggering exploration activities. Article 21 paragraph 1 stated that data management can be performed through sole management by Pusdatin ESDM or through collaboration between Pusdatin with PT Pertamina (Persero) or with other service provider under a collaboration contract with the ministry. Paragraph 2 of article 21 mentioned that the collaboration contract is based on efficiency, transparency, antitrust, and in accordance with the regulation.

There are many issues contributing to the decline of the investment in the Indonesian upstream oil and gas exploration. The research is focused on the access for exploration data and its quality which remain unattractive to the investor and led to the decline of the exploration investment in the Indonesian upstream oil and gas. The objective of this research is to propose a digitally centralized national data management and marketplace in a self-sustaining business model. The system is expected to ultimately trigger exploration investment and achieving an overall increase of business activity in the upstream oil and gas. Meanwhile, the scope is established around the Government attempts to revamp data management for exploration activities in Indonesia and how the proposed business solution can elevate the existing platform to accelerate the exploration from data to discovery.

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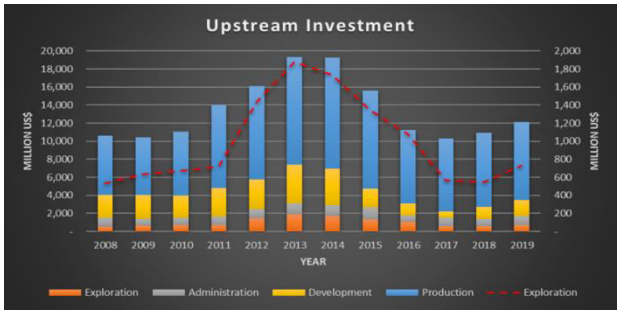

Fig. 1. Indonesia Upstream Investment (Source: BP statistical review, 2020)

II. LITERATURE REVIEW

A. Hydrocarbon Exploration in Indonesia

SKK Migas [5] mentioned that Indonesia's crude oil production declined over the last decade due to the natural maturation of producing oil fields combined with a slower reserve replacement rate and decreased exploration and investment. During 2018, Indonesia's gas production represents 60% of total oil and gas production in the country. This portion is estimated to increase to 70% in 2020 and 86% in 2050. However, as with oil, the gas reserves are predicted, slowly but surely, to decline following the depletion of some major fields, e.g., the gas-rich Mahakam block.

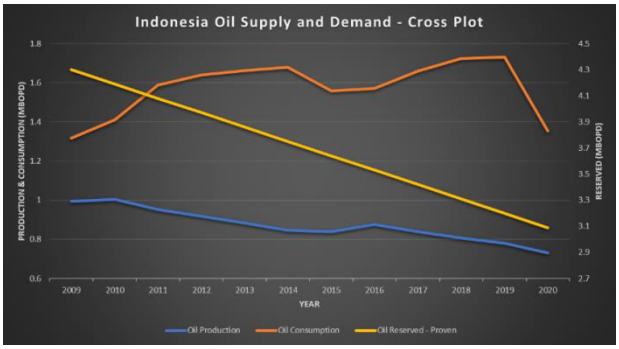

Fig. 2. Indonesia Oil Supply and Demand (Source: BP statistical review, 2020)

At the end of the second quarter 2019, Indonesian energy and natural resources (ESDM) ministry release a new regulation for oil and gas data management and access, Regulation 07/2019 which amend Regulation 27/2006. The new Regulation was one of the government initiatives to increase exploration and exploitation investment in the country.

Regulation 27/2006 [6] mentioned that all oil and gas data are owned by the country. However, if there is a company interested in a particular block, they can propose to have a production sharing contract (PSC). Under PSC, the data is exclusive to that particular company for a time period. The time period, depending on the contract, can span up to 30 years. Should the company opted to relinquish the area, the data is returned to the government and other company may access the data. The data access come with an access fee which booked under non-tax revenue for the country. This activity is performed by ESDM ministry under Pusdatin (Pusat Data dan Informasi) and subcontracted to Pertamina.

B. Migas Data Repository (MDR)

Pusdatin launched Migas Data Repository (MDR) in 2019 [7] as an attempt to trigger the exploration investment. MDR is an online upstream data repository that allows member to browse, download, and order the open area dataset. MDR is supported by membership fee with different level of access.

TABLE I
MDR ANNUAL FEE (source: datamigas.esdm.go.id)

	Member type	Annual Fee (US$)
1	Entity with more than 5 working areas	50,000
2	Entity with =< 2 and <= 5 working areas	40,000
3	Entity with 1 working areas	20,000
4	Non-mandatory member	35,000

Pusdatin invited upstream service providers both nationals and multinationals to collaborate in developing MDR and to take it beyond [8]. Pusdatin acknowledged the challenge of inviting multinational investors back to Indonesia, therefore, Pusdatin would like to collaborate with the service providers that owns an international reputation and the technical knowhow. The service providers are welcome to propose their business model as long as there is no vendor lock, meaning that the service offered will use an open-source or universal data format that allows a connectivity between vendors and avoid a monopoly of a single vendor. The anticorruption commission (KPK) was tasked to supervise the process. Pusdatin emphasized that there will be no budget available to fund this project but there will be opportunity to monetize the data within the regulation corridor. Hence, potential partner/s were encouraged to offer a self-funded project. The effectiveness of the system at the times of writing is remain to be seen.

C. Digital Transformation in Oil and Gas Industry

In 2020, Yu et. al. [9], published their findings for digital transformation in multinationals oil and gas companies around the world namely Chevron and ExxonMobil (US), Eni (Italy), Equinor (Norway), and Shell (Netherlands). The type of the digital transformation varies among these companies however the ultimate goal is to streamline their business process, increase efficiency, and reduce cost.

SKK Migas introduced its long-term plan (RENSTRA – Rencana Strategis) [10] to achieve one-million-barrel oil per day (BOPD) in 2030. The plan includes 10 pillars and among these pillars are digitalization and collaboration through technology and innovation as the enablers.

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III. METHODOLOGY

The methodology presented in this research includes identification the industry regulatory framework and the current business practice that contributes to the decline of the exploration investment through political, economic, sociocultural, technological, ecological, and legal analysis; assessment of industry competitiveness, the involved stakeholder, and supporting elements that construct the system of the upstream oil and gas exploration activity for the identification of the driving forces and its outcome. Based on these elements and feedback from dependency analysis of the infrastructure, business model formulation is established. Figure 3 below illustrates the conceptual framework used in this research.

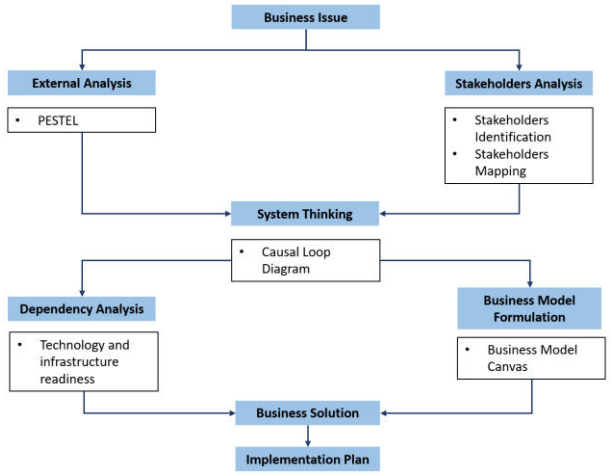

Fig. 3. Conceptual Framework

A. PESTEL Analysis

PESTEL analysis is employed to scan, monitor, and evaluate the external factors (Rothaermel, 2017) [11] that affect the decline of Indonesia's exploration investment. The segments are listed below:

1) In the political segment, the issuance of regulation 07/2019 indicates government attempts to support the increase of exploration investment. This is strengthened by SKK Migas' target to achieve 1 million BOPD by 2030.
2) For the economical segment, eastern province exploration without sufficient data yields a high-risk investment. However, there is a possibility of data monetization through collaboration contract.
3) Sociocultural segment contribution is the COVID-19 pandemic hit that force remote working. Digital solution offers an online collaboration space with minimized disruption.
4) The technological segment is related to the readiness of infrastructure to host the existing MDR system and the lack of local talent for digital solution knowhow. However, service provider's technology can be implemented to fill the gap.
5) Paradigm shift of renewable and clean energy to replace oil plays factor from the ecological segment. Although, contribution from fossil fuel remain substantial to the state budget.
6) Data residency regulation prevents global expert utilization and ample computing resources. Having said that, regulation 07/2019 open the opportunity for collaboration to manage exploration data. These are from the legal segment.

Recent adoption of a national upstream gateway by Egypt provides the country a platform to promote its oil and gas bid rounds through a seamless online access to the exploration data. This was endorsed by its minister in 2021 (offshore-energy.biz, 2021) [12]. Indonesia may follow Egypt's footstep in exploration data management in order to increase the exploration activity. The issuance of the ESDM regulation 07/2019 with emphasis on collaboration, data liberation, and improved data management is the initial step for the endeavor to increase the exploration activity through a revolutionary data management.

SKK Migas' campaign to achieve 1 million BOPD by 2030 is followed by Government support for exploration program through the newly acquired 30,000 line kilometers of 2D seismic data across Indonesia including the eastern province [13]. Coupled with SKK Migas' strategic plan to develop exploration potential with digitalization as an enabler, Indonesia offers potential for the next giant discovery.

B. Stakeholder's Analysis

The upstream sector involves multiple stakeholders and they are interdependently connected to one another. Each stakeholder has to be identified and analysed in order to understand the building block of the upstream activities and the driving forces of an investment. The stakeholders' analysis is focused on the MDR as the backbone of data liberation to accelerate upstream investment. The stakeholders of the MDR are identified as follows:

- The ministry of Energy and Mineral Resources (ESDM)
- SKK Migas
- PT. Pertamina
- Komisi Pemberantasan Korupsi (KPK)
- Industry Associations

Using the foundation laid out by the PESTEL analysis, a stakeholders mapping is designed to encapsulate the moving parts of using data as a gateway for exploration. There are two maps showing a different information. The first map (Figure 4) showing the stakeholders orbiting the MDR as the center of the system

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whilst the second map (Figure 5) showing the stakeholders relative position according to its interest against the influence/power.

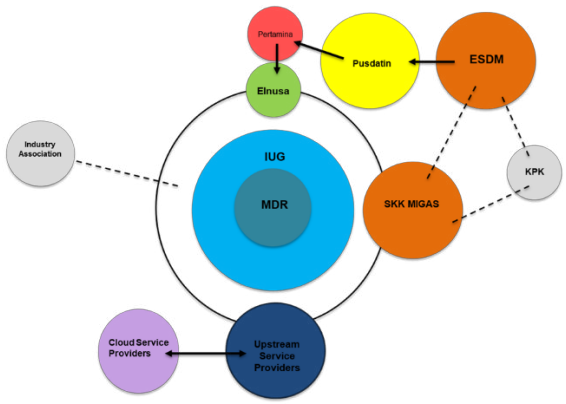

Fig. 4. MDR Stakeholders

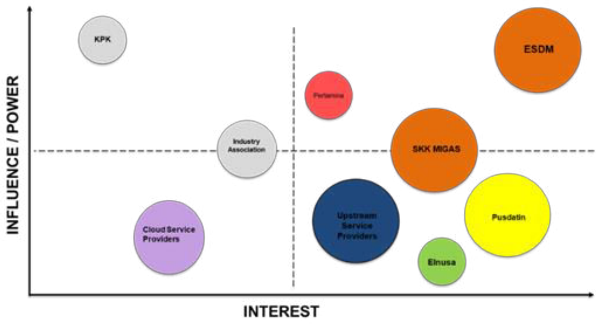

Fig. 5. MDR Stakeholders Mapping

MDR in the inner circle acts as a backbone of the system where the data is stored in a digital format and accessible online. In the situation where the suppliers and buyers force are strong, a new landmark that leverage data potential has to be established. Therefore, a National Upstream Gateway (NUG) is proposed. NUG is more than an online data repository. Further detail of this proposal is elaborated in Section III.

The outer circle consists of an active and passive stakeholder that support MDR. Practically, there are only ESDM, SKK Migas, and upstream service providers that engage the system in a direct manner. The stakeholder mapping shows that ESDM is situated in the top right corner of the matrix indicating party with the most interest and power.

C. System Thinking

In order to have a better comprehension of how the element interact with each other as well as to identify the driving forces of these elements, a holistic approach of system thinking is used. The objective of having system thinking in this research is to identify the interrelationship of each element thus enabling a derivation of the drivers and the outcomes as an integral part of the system. According to Anderson et. al., 1997 [14], Causal Loop Diagram (CLD) as one of the system thinking tools is used to understand the system structure, identify the emergence of the unintended consequences, explore the consequences of the proposed action, recognize the impact of time delays, and identify possible leverage points for actions The CLD is depicting the current situation of the industry and highlight at which location the system 'gear' stops grinding. The idea is to have this part of the 'gear' lubricated with the solution to keep it moving. In this diagram, COVID-19 outbreak and new energy initiative serve as the external factor with substantial impact.

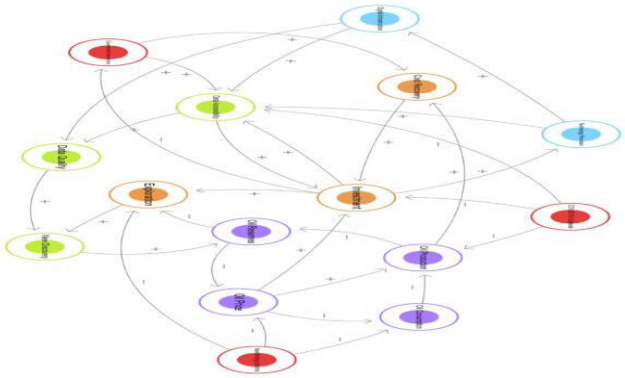

Fig. 6. Indonesia Upstream Sector CLD (https://bit.ly/3r6Cse6)

The CLD illustrated in Figure 6 indicates that data accessibility is the driving forces for the investment. The relationship between data accessibility and investment in the CLD occurs under two circumstances, the first one is through a direct reinforcement loop and the second one through a more complicated route passing data quality, new discovery, oil reserves, and oil price. The first circumstance has been identified by the Government through the issuance of ESDM Regulation 07/2019 and currently it is at its infant stage. The second circumstance is the route that this research is focused on and aimed to be the tip of the spear for Indonesia's endeavor to increase upstream investment and accelerate exploration from data to discovery.

III. RESULTS

A. Exploration Data Acquisition

Data quality plays an important role to increase the success ratio for the exploration activity. Most of Indonesian basin have been explored to various extent both onshore and offshore. These data were acquired, processed, and interpreted through a conventional proprietary procurement from the work area operator at a given time. When the said operator decides to abandon the work area, these data have to be returned to the government for the next investor to start with, these are commonly called as legacy data. In the realm of exploration, under-processed or conversely, over-processed data could increase the risk of exploration

failure. The new investor has to decide whether they choose to use the legacy data either directly or reprocess it with the latest technology, or start the exploration program from scratch. The whole exploration program from data acquisition to drilling can cost up to US$ 80 million depending on the complexity of the area by the recent standard. Approximately 10% of that budget would go for data investment.

There is an unconventional approach for data gathering through joint study or a multiclient business model. This model enables every interest party to perform a data acquisition from an open area and offer it to multiple parties since dataset from open area is free to be marketed. Should the buyer of the dataset decide to invest in the area, they are able to put in the offer to Government to open the block tender or negotiate for a direct award. In this case the data provider is commonly a service provider companies which are able to acquire, and process the data at their own cost. This investment scheme is a high-risk investment from the service provider, though conversely, it will lower the risk for the potential contractor.

The most recent scheme came from the Government initiative to boost exploration activity through the issuance of ESDM Regulation No. 03/2019 [15]. *Komitmen Kerja Pasti* (KKP) or firm commitment is an investment that must be performed by the contractor for the awarded work area within the first 5-year period of the JCC. Article 13 of this regulation mandated that the investment can be proposed to be spent in an open area regardless of the awarded work area based on SKK Migas recommendation. The firm commitment fund for the open area typically occurs in a situation whereby there is an expiration of the existing JCC and the incumbent contractor wishes to extend the JCC. In this case, if SKK Migas decides that the current area has been thoroughly explored then the fund should be transferred to an under-explored basin.

Essentially, there are three main routes to access the upstream dataset as explained above which are:

- Contractor procures own dataset (Route 1)
- Service provider offers to multiple potential contractors (Route 2)
- Government procures the dataset (Route 3)

To further understand the differentiation of the three alternatives, a simple matrix is designed highlighting the cost, risk, and benefit for each route.

TABLE II
COST, RISK, AND BENEFIT OF DATA ACQUISITION

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	Cost			Risk			Benefit		
	Contractor	Service Provider	Government	Contractor	Service Provider	Government	Contractor	Service Provider	Government
Route 1	High	Low	Low	High	Low	Low	High	Moderate	Low
Route 2	Moderate	High	Low	Low	High	Low	High	High	Moderate
Route 3	Low	Low	High	Low	Low	High	High	Moderate	High
Route 4*	Low	High	Low	Moderate	Low	Low	High	High	High

Table 2 shows that there may be another route yet to be discovered as marked by an asterisk (Route 4). This route should offer a high benefit to all parties yet generally low risk and low cost. In order to build a cost-conscious system, digital transformation is proposed by bringing in the cloud service provider as the resource owner to elevate MDR functionalities. This is enabled by the expertise of the oilfield service providers through a joint collaboration contract with the Government. The service provider is expected to fill in the following points:

- Global experience, this is required to attract multinational investor.
- Access to in-country digital infrastructure, either by self-procurement or a third-party lease.
- State of the art technology portfolio, beneficial for data evergreening.
- Usage of vendor-neutral data format.
- Allow integration of the existing MDR to the new platform.

B. Building Block

The following diagram is proposed to include the oilfield service provider/s in the collaboration of the existing MDR and to take it further to the National Upstream Gateway (NUG).

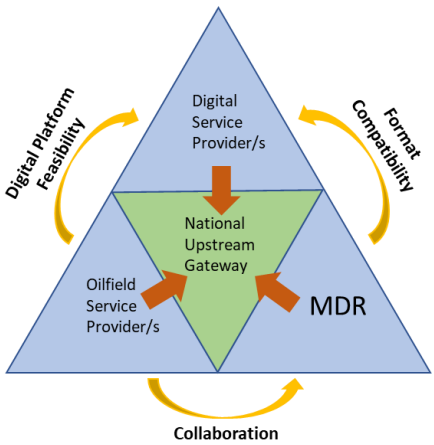

Fig. 7. NUG Building Block

Ideally the oil service provider must have a pre-defined collaboration with reputable worldwide digital service provider such as Google Cloud, Amazon Web

Service, or Microsoft Azure to name a few. the oilfield service provider/s which have the commercial digital platform that runs on the mentioned digital provider is preferred. This is beneficial as the collaboration will not be funded by Government; hence, investment has to be made if an oilfield service provider/s were to develop their platform from scratch. In terms of cloud-based, vendor-neutral data universe and ecosystem.

There is various form of data format used for exploration data. These format sometimes are not interchangeable nor transferrable from one software to another. This has been a pain point in the search of data from explorationist perspective. In order to avoid a vendor lock, Pusdatin confirmed that the collaboration is preferred to use an open data format. MDR is currently using some form of open data format hence the NUG will have to use similar data format that is compatible with the cloud environment. There are several service providers offering this solution in the market.

The last dependency of the NUG building block is the collaboration of the oilfield service provider with the Government. From the point of view of the investor of the scheme, which in this case, is the oilfield service provider, a self-sustaining business model is required. The cost structure of the NUG mainly comes from investment and operational cost meanwhile the revenue stream includes membership fee, commission and pre-committee fund for data evergreening. In this case the oilfield service provider can propose the existing membership scheme of the MDR to maintain the NUG. However, this will not be sufficient to support the platform. Hence, the following schematic proposal is put forward.

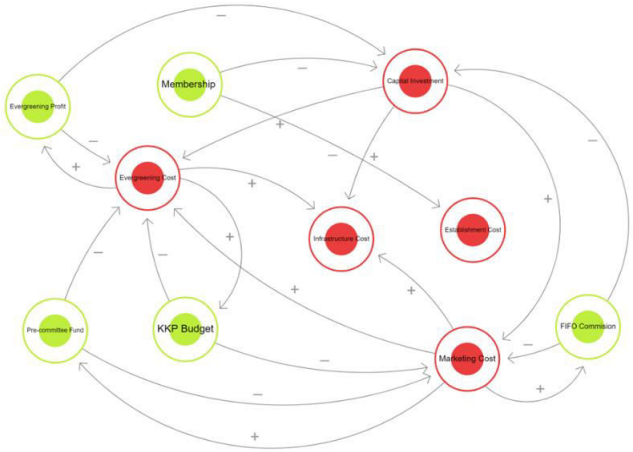

Fig. 8. Causal Loop Diagram for NUG business model (https://bit.ly/3vUQJO0)

The above diagram shows cost as red circle and revenue as green circle. Although the NUG requires considerable amount of capital investment upfront, according to the diagram, the collaboration model will be paid off over time by a continuous evergreening and membership fee and assuming the investment level to increase which subsequently increase the Farm-In/Farm-Out commission.

C. Upstream Digital Marketplace

NUG is intended to be an upstream digital marketplace. The marketplace is illustrated as an upside-down multilevel pyramid. The level indicates different membership rate. The pyramid is designed not only to mimic a tiered based membership scheme but also to be more focus on the investor engagement as well as the exploration endeavor. This is aimed to accelerate the exploration process from data to discovery.

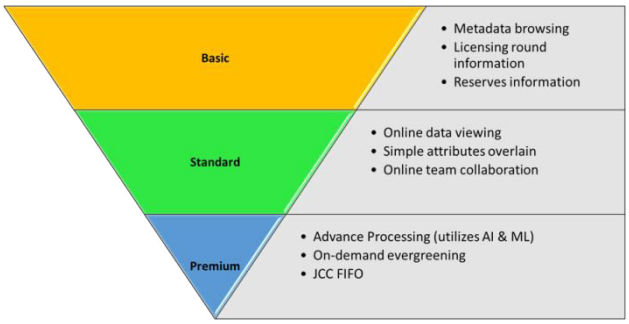

Fig. 9. Marketplace Level in NUG

The user experience starts from the marketing portal. This layer includes general information on the ongoing licensing round, JCC performance dashboard, executive level information on the existing reserves at basin level, and the available upstream metadata (seismic, well, derivatives, infrastructures, geology, etc). At this level general user with basic membership access can explore the exploration opportunity and specified the area of interest. User may order an open area dataset at this level access on agreed terms and conditions.

The next level can be called a standard membership access, at this level the user can go to their area of interest to see the seismic data (2D and 3D) interactively via a web browser and scan for the data quality. Derivative products such as simple attributes, velocity field, geological interpretation can be overlain with the seismic volume. The access level also allows user to collaborate within their exploration team in real time. The complex rendering is made available by the advance GPU on the cloud infrastructure. User can select a subset of the data to perform advance processing in the next level.

The last level, a premium membership access, allows a more advance processing to be taken using the full potential of the platform. Given the collaborative space and the increase of Artificial Intelligence (AI) and Machine Learning (ML), user can produce advance derivates such as re-interpretation, attribute generation, and basin modelling (provided data completeness) in a short turn-around time. Alternatively, user may select to perform on-demand evergreening to the oilfield service provider with an extra cost. The following figure illustrates the solution offered by the NUG. Intuitively,

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user with premium access can access the prior level. Membership level can also be customized on a given period of time during the licensing round for tender participant of the tendered block dataset.

One of the key elements that differentiate NUG from MDR is that the data hosted inside will not be limited to the open area dataset only but also including all dataset from the active Joint Collaboration Contract (JCC). This will break down silos of operation across JCC as well as diminish the overlap of data hosting between SKK Migas and ESDM.

IV. DISCUSSION

This research proposes a model that embrace collaboration between Government (ESDM and SKK Migas), existing JCCs, technology providers (oilfield service and cloud service), and potential investor. Partners would be granted the privilege of data access of the open area and require to invest using its own fund for the establishment and maintenance of the NUG. However, the return for this investment can be achieved through various stream. The data access privilege can be used to improve the legacy data quality through evergreening. The profit from this activity, combined with farm-in/farm-out commission, and NUG membership fee can be used to fund the platform.

Considering the current situation where investment is a challenge, NUG will only be feasible through a collaboration coupled with the employment of a self-sustaining business model. The proposed business model described in this research offers the solution to these challenges and is expected to accelerate exploration from data to discovery. In order implement the NUG, the following process is required; (1) gap analysis, (2) dependencies assessment, and (3) technology adoption. The following figure illustrated the implementations flowchart in adopting the business solution.

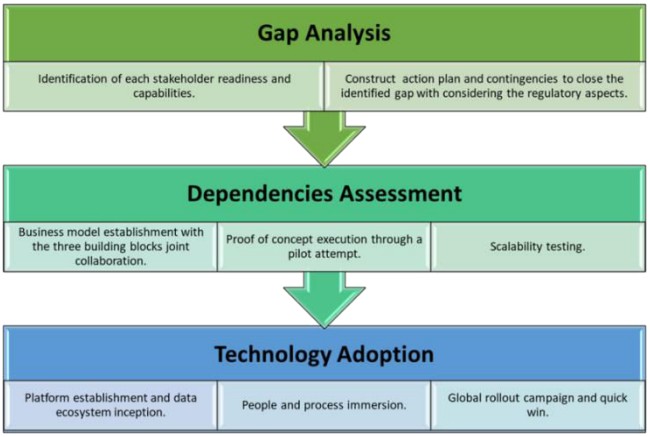

Fig. 10. Gap Analysis

Given the current circumstance around MDR platform, regulations, and the availability of digital and service provider, NUG can be implemented in 2 to 3 years. This is laid out in table 3.

V. CONCLUSION

Digital transformation is proposed to elevate MDR functionality into a National Upstream Gateway (NUG). NUG is an upstream digital marketplace in which data liberation plays an important role. NUG enables investor and JCC to access Indonesian upstream data online in an intuitive and collaborative manner. This will allow them to increase their efficiency of working since the time spent on data searching in the past is diminished. NUG allows Government to stay on top of their data, breaks silos, and to monitor the performance of the exploration program. Marketing of the offered work area during the licensing round could also be improved and packaged to be more attractive to penetrate wider market. The platform also makes use the advance technology from the service provider to ensure the data stays relevant and evergreened.

There are four recommendations which can be concluded from this research.

1) Data liberation can help the investment for the upstream oil and gas sector in Indonesia.
2) The collaboration for data liberation requires a self-sustaining business model within the regulation corridor.
3) The proposed business solution needs to generate quick win in order to start the global campaign by launching its first licensing round.
4) NUG evaluation and continuous improvement is required to ensure relevancy.

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TABLE III
IMPLEMENTATION PLAN TIMELINE

Task	First Year				Second Year				Third Year			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Gap Analysis												
Proof of Concept												
Dependencies Assessment												
Data Ingestion												
Data Evergreening												
People and Process Immersion												
Alpha Test - Internal Stakeholders												
Beta Test - Non-Commercial Release												
Platform Feedback												
Commercial Release & Global Rollout Campaign												
First Digital Licensing Round												

TABLE III
IMPLEMENTATION PLAN TIMELINE

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