A Research Proposal: Understanding the Business Analytics Capability and Impact on the Upstream Oil and Gas Surface Facility Performance.

Agung Prasetya
Candidate Doctor in Science Management
School of Business Management
Bandung Institute of Technology (SBM ITB)
Bandung, Indonesia
agung_prasetya@sbm-itb.ac.id

Yos Sunitiyoso
Associate Professor
Decision-Making and Strategic Negotiation Interest Group
School of Business Management
Bandung Institute of Technology (SBM ITB)
Bandung, Indonesia
yos.sunitiyoso@sbm-itb.ac.id

Meditya Wasesa
Assistant Professor
Office Location: Faculty Room-5th Floor,
Labtek XIX-Freeport Building, SBM-ITB, Bandung, Indonesia
meditya.wasesa@sbm-itb.ac.id

Abstract

Upstream Oil and Gas (O&G) companies that operate brownfield assets with aging surface facilities experience challenges in managing their base-business operations. Companies must manage the increasing challenges of maintaining equipment reliability, integrity, and operational safety. The high quality and timely decision to take necessary action for the operation and maintenance of the aging facilities becomes very critical. The support from the comprehensive analytics approach to drive the decision-making capability also becomes very important. The Digitalization and the adoption of Business Analytics (BA), such as Digital Twin, Computerized Maintenance Management System (CMMS), Big Data (BD), Artificial Intelligent (AI), Machine Learning (ML), Deep Learning (DL), Decision Support Centre (DSC), become the option which is commonly growing in line with the increase of the investment in the BA adoption. There is a need to have a thorough evaluation or lookback to review whether those efforts on BA adoption have produced the promised solution, and returned the benefits of the investment that has been allocated. This paper is a research proposal that provides the introduction and background, the state-of-the-art and research gap identification, and the proposed methodology for the operationalization of the research. The research background and objectives are described, many previous studies are summarized and compared and finally, the methodology is proposed.

Keywords
Business Analytics; Adoption; Impact; Capabilities; Oil and Gas Industry; Upstream; Surface Facility; Aging; State of The Art Review; Research Proposal

1. Introduction

The Upstream Business of the Oil and Gas (O&G) Industry can be categorized into 3 large processes, namely sub-surface, Surface, and Drilling & Completion, besides some other supporting processes. Recently, O&G Industry faced several major challenges, including cost efficiency, operation excellence, reliability, environmental friendliness, security challenges, and changes in consumer preferences (US Energy Information Administration, International Energy Outlook 2019). In upstream surface processes, the biggest challenge is operation safety and operational excellence including ensuring the reliability of facilities and equipment.

The Challenges to O&G Surface Facility Management

Oil and gas (O&G) companies that operate brownfield assets with most of their aging surface facilities (ASF) experience challenges in managing their base-business operations.

With aging equipment and facilities, operators must manage the increasing challenges of maintaining equipment reliability, integrity, and operational safety. It involves not only hardware but also human and organizational factors. Factors include corrosion, erosion, fatigue, equipment obsolescence, normalization of deviance (accepting degraded conditions as being normal), changes in codes and standards, and lack of data to forecast future risks (Khan et al. 2020).

ASF is commonly described as a system that has reached its design lifetime and is considered obsolete. It also does not meet the current capacity demand and it requires improvement or upgrade to avoid system capacity constraints. The aging facilities and equipment will eventually bring natural consequences such as performance degradation, reliability challenges, and lack of integrity. Importantly, aging effects may propagate through different levels, from the physical up to the system level, to ultimately have a deleterious impact and degrade the reliability of the entire system (Amrouch & Henkel 2016).

ASF presents increased challenges in maintaining equipment integrity and hence, will need to be managed accordingly. These could be because of a cumulative degradation and risks over time, which includes: Degraded materials of construction due to corrosion-related mechanisms; Erosion, wear, fatigue, or cracking mechanisms; 'Slow burn' degradation mechanisms; Obsolescence of equipment leading to potential lack of spares, high cost of spares, etc.; Normalization of deviance associated with human factors (i.e., accepting degraded conditions as being the new normal); Lack of data trending to forecast future risks to safety and business continuity; Failure to record the accurate status of safety-critical elements (SCE) over time; Changes to engineering codes and standards; Loss of technical competence (qualifications + training + experience) in the industry; Introduction of foreign materials into the production systems (e.g., Chemicals for Enhanced Oil Recovery (EOR), downhole sand consolidation, chemical tracers, off-spec water injection, etc.)

Safety and Environmental Compliance

To extend asset life and push the design envelope, operators must prove to themselves and often their regulators that the assets are safe to operate with limited and controlled risks. In a scenario like this, the integrity management of aging assets has become a key issue for the O&G Industry (Carvalho et al. 2015). Due to this scenario of uncertainties regarding the asset integrity condition, the operator shall better understand its degradation condition before deciding to extend an asset's life.

The risk matrix presented is primarily used as a screening tool and typically it is suggested that there are at least three-color regions representing three potential courses of action. Three color regions are usually sufficient to provide guidance on the risk tolerance criteria, and many organizations tend to use them.

- Green to represent Risk Scenarios that are considered tolerable.
- Yellow (or orange) to represent Risk Scenarios that are tolerable providing reasonable mitigating actions have been applied.
- Red to represent Risk Scenarios normally considered intolerable and must be mitigated.

	Severity	Consequence Category		Increasing Probability →		
		Containment (C) (Safety / Environmental)	Operability (O) (Availability / OPEX)	(1) Low	(2) Medium	(3) High
Increasing Consequence	A	No external leak, or minor internal leaks	Minor maintenance activity	(1) Low	(1) Low	(2) Medium
	B	Small external leak, unacceptable internal leak, or unacceptable cross leak to secondary barrier	Longer shut down and significant repair cost, implications for system reliability	(1) Low	(2) Medium	(3) High
	C	Full bore rupture and well blow-out	Permanent shut-in of well	(2) Medium	(3) High	(3) High

Figure 1. Risk Matrix of Assets Condition

This safety and environmental compliance aspect is a major factor in the management of the upstream O&G aging surface facility. There is a lot of knowledge, skills, information, and data that must be considered, processed and reviewed to decide a facility can still be operated safely and comply.

Operation and Maintenance (O&M)

Operation and Maintenance (O&M) shall mean all activities required to operate, maintain, and monitor the effectiveness of the asset as specified in the SOW. Routine maintenance means activities to keep an impervious surface as near as possible to its constructed condition. These are inclusive, but not limited to, the following:

1) Actions focused on scheduling, procedures, and work/systems control and optimization; and
2) Performance of routine, preventive, predictive, scheduled, and unscheduled actions aimed at preventing equipment failure or decline with the goal of increasing efficiency, reliability, and safety.

O&G producers know that reliability in operations is required to maintain production level requirements, to prevent unscheduled maintenance and repair work, as well as to avoid costly accidents, and to prevent environmental damage. Not only is safety a top concern for workers, consumers, and the community, but oil and gas professionals recognize that safety and reliability are intertwined and vitally important. And that both directly impact not only profitability but also company standing and reputation.
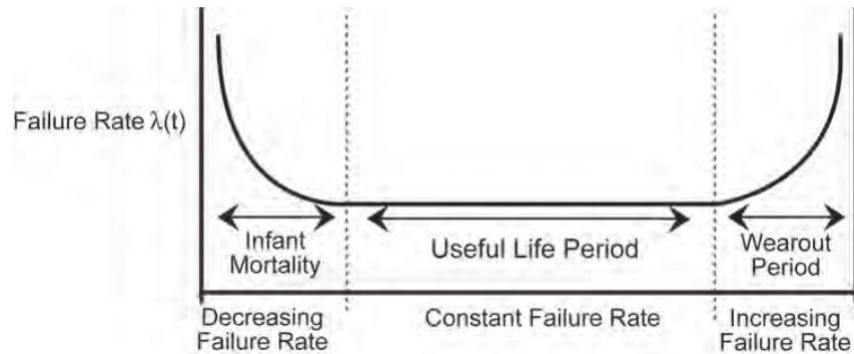
Figure 2. Component failure rate over time for the component population

Operational Efficiency represents the life cycle, cost-effective mix of preventive, predictive, and reliability-centered maintenance technologies, coupled with equipment calibration, tracking, and computerized maintenance management capabilities all target reliability, safety, occupant comfort, and system efficiency.

The complex of maintenance activities, methodologies and tools aim to obtain the continuity of the productive process; traditionally, this objective was achieved by reviewing and substituting the critical systems or through operational and functional surplus to guarantee an excess of productive capacity. All these approaches have partially shown inefficiencies: redundant systems and excess capacity immobilize capitals that could be used more profitably for the

production activities while carrying out revision policies very careful means to support a rather expensive method to obtain the demand standards (Bevilacqua et al. n.d.).

The complex of maintenance activities is transformed from a simple reparation activity to a complex managerial task whose main aim is the prevention of failure. An optimal maintenance approach is a key support to industrial production in the contemporary process industry and many tools have been developed for improving and optimizing this task. The need for maintenance is predicated on actual or impending failure – ideally, maintenance is performed to keep equipment and systems running efficiently for at least the design life of the component(s). As such, the practical operation of a component is a time-based function. If one were to graph the failure rate of a component population versus time, it is likely the graph would take the "bathtub" shape shown in Figure 1. In the figure, the Y-axis represents the failure rate, and the X-axis is time. From its shape, the curve can be divided into three distinct: infant mortality, useful life, and wear-out periods.

The evaluation of components reliability is a fundamental aspect for proper maintenance execution; existing reliability evaluation methods are based on the availability of knowledge about component states. However, component states are often uncertain or unknown, especially during the early stages of the development of new systems. In such cases, it is important to understand how uncertainties will affect system reliability assessment. The reliability of systems often depends on their age, intrinsic factors (dimensioning, quality of components, material, etc.), and conditions of use (environment, load rate, stress, etc.) - (Corvaro et al. 2017).

Preventive Maintenance is done before a failure occurs and consists of maintenance types like Time Based Maintenance, Failure Finding Maintenance, Risk-Based Maintenance, Condition Based Maintenance, and Predictive Maintenance. Corrective maintenance is done after a failure has occurred either as Deferred Corrective Maintenance or as Emergency Maintenance.

Business Analytics (BA) Adoption

In general, there are three major activities and processes of the surface facility management program in the O&G Industry which are integrated facility optimization, comprehensive maintenance, and reliable operation. These three activities and processes require careful planning, prompt decision-making and disciplined and purposeful execution. Therefore, the ability and speed in managing and analyzing information and data is key in this program. These three processes and activities include enormous amounts of data and information, with very wide variations, fast process needs, and high value. Therefore, the Big Data approach in the management of information and data will greatly help this process and activity.
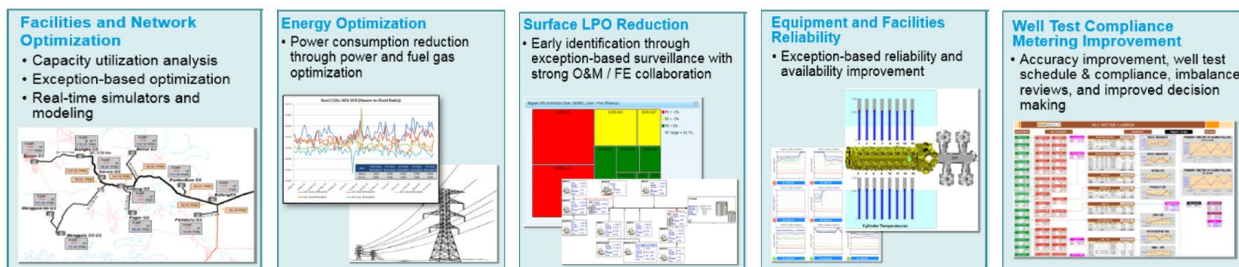

Figure 3. BA Adoption to Support Upstream O&G Surface Facility Management

Figure 5 shows some examples of implementing business analytics to support O&M processes on O&G Upstream, especially for surface facilities. Some examples of these are First Facility Network Optimization, capacity analysis, Exception-based optimization, perform real time simulation and modelling. Second Energy Optimization, reduce operating costs by reducing the use of fuel gas and electricity. Third Surface LPO Reduction, Early identification using exception-based monitoring methods on surface equipment and facilities and intensive collaboration with operations, maintenance, and engineering teams. Forth Equipment and Facility Reliability, Smart Online Condition Monitoring and Modelling.

Analyze the work time, reliability, and availability of critical equipment on an exception-based basis and provide recommendations for improvements/ improvements. Fifth Well Test Compliance Metering, Improved metering quality and in-balance metering review.

And there are many other examples of BA adoption to support decision making and organization capability on Upstream O&G Surface Facility Management.

The above examples shows that the investment to build BA approach is quite high these days. Quite a lot of resources are allocated in this implementation, both in the form of funds, people, and technology. With the growing adoption of BA, investment firms need to understand how business value is created from investments (Krishnamoorthi & Mathew, 2018). The BA adoption can be a BD analytics utilization as an emerging trend, in O&G Industry, the upstream and downstream. Analyzing seismic and micro-seismic data, improving reservoir characterization and simulation, reducing drilling time and increasing drilling safety, optimization of the performance of production pumps, improved petrochemical asset management, improved shipping and transportation, and improved occupational safety are among some of the applications of Big Data in O&G industry (Mohammadpoor & Torabi 2020).

1.1 Objectives

The purpose of this research is to explain the impact or influence, or contribution of BA adoption on the O&G Industry to support the surface facility management program, which consists of integrated facility optimization, comprehensive maintenance, and a reliable operation program. The research will be a case study and based on the data and information from a certain number of projects and programs of BA adoption in a working area of PT XYZ.

The research is important to better understand and explain how the BA (Descriptive, Prescriptive, Predictive Analytics) adoption will impact O&G Industry performance through facility integrated optimization, comprehensive maintenance, and reliable operation program, and assess the BA capabilities readiness to support the adoption. Having a better understanding of those two areas will benefit the development of a framework of BA Adoption.

With the background of information and problems that have been explained before, the objective of this study is at least four, namely:
1. To explain the key element and correlation (model) of BA adoption in the O&G Industry.
2. To describe the impact, influence, or contribution of BA adoption to the success of surface facilities management program in the O&G Industry.
3. To assess the BA capabilities (people, process, technology) readiness for the BA adoption.
4. To describe a framework of BA adoption for future development and implementation reference in the O&G Industry.

In achieving the four objectives of the research, some research questions are raised and need to be elaborated, deep-dived, reviewed, accessed, and answered.

The first objective is to explain the key element and correlation (model) of BA adoption in the O&G Industry, has the followings research question:

RQ1: How does the analytics element (prescriptive, predictive, descriptive) and capabilities element (people, process, and technology) correlate? How does the model lookalike?

The second objective is to describe the impact, influence, or contribution of BA adoption to the success of surface facilities management program in the O&G Industry, has the followings research question:

RQ2: How does BA adoption influence, impact, or contribute to O&G Industry performance (especially in supporting surface facility management programs)?

The second objective is to conduct the assessment on the BA capabilities (people, process, technology) readiness for the BA adoption, has the following question:

RQ3: How important and why are the BA capabilities for the success of BA adoption in Oil and Gas Industry?

The fourth objective is to describe a framework of BA adoption for future development and implementation reference in the O&G Industry, has the following question:

RQ4: How the step and framework will ensure the success of BA adoption in the O&G Industry?

2. Literature Review

Underlying Theories

Several theories have been brought forward to elucidate business analytics adoption and its impact on firm performance. The research will adopt the perspective of technology affordances to theorize the organizational uses and implications of BAs in the game industry. The concept of affordances originates from Gibson, (1979) work in the field of ecological psychology. First, developed the concept of affordances to explain the possibilities an object affords for action.

Scholars then introduced the concept of technology affordances in the recent decade to capture the action potentials of technological objects (Majchrzak 2013). Specifically, technology affordances refer to "what an individual or organization with a particular purpose can do with a technology".

Business Analytics

In general, conventional views of BA are concerned with operating on data, to support business activities (e.g., decision making). The operations may involve an examination, calculation, or inference.

Analytics is "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions" (Thomas Davenport, n.d.). While the concept of BA has a long history, its functions and applications have been re-defined over the years to reflect technological evolution and emerging applications (Holsapple et al. 2014).
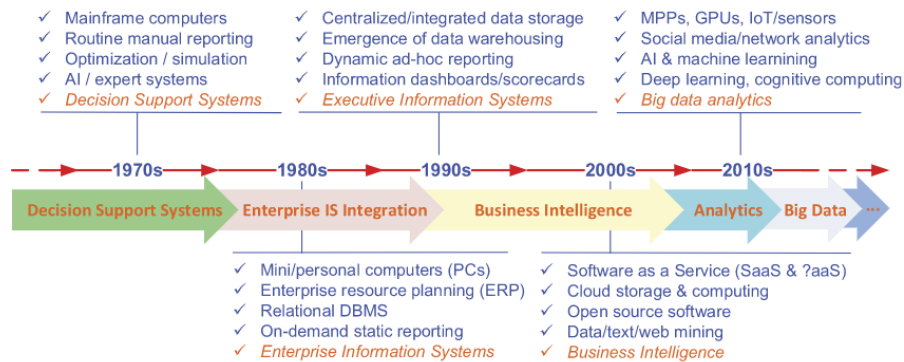

Figure 4. A historical view to the evolution of analytics terminology (Delen & Ram 2018)

The concept of business analytics is still evolving. There is no single, widely known, authoritative definition of BA. The field of BA has matured since 2012, but much more needs to be done to address the questions they raised. BA does involve Information System (IS), but it is a cross-disciplinary area of research and practice that has evolved rapidly (Power et al. 2018).

The literature show that BA has been classified in several ways based on its application domain, evolution process, or key functionality. BA's application domain may include, for example, learning analytics, web analytics, marketing analytics, customer analytics, etc. BA refers to the skills, technologies, and practices for continuous iterative exploration and investigation of past business performance to gain insight and drive business planning. BA focuses on developing new insights and understanding of business performance based on data and statistical methods.

In contrast, business intelligence traditionally focuses on using a consistent set of metrics to both measures past performance and guide business planning. In other words, business intelligence focuses on the description, while business analytics focuses on prediction and prescription. Briefly describe the domain of the four major fields of business analytics: databases and data warehousing, descriptive, predictive, and prescriptive analytics.

Descriptive analytics is the entry level in analytics taxonomy. It is often called business reporting, because of the fact that most of the analytics activities at this level deal with creating report to summaries business activities, to answer the questions of "What happened?" or "What is happening?".

Diagnostic analytics (as a natural extension of descriptive analytics) examines the data to answer the question of "why did it happen?". It employs exploratory data analysis of the existing data using tools and techniques like visualization,

drill-down, data discovery, and data mining in order to identify / discover the root causes of a given problem (Delen & Zolbanin 2018).

Descriptive analytics (and diagnostic analytics) are also called BI, and the other two (predictive and prescriptive analytics) collectively called Advanced Analytics. The logic behind calling a part of the taxonomy advanced analytics is that moving from descriptive to predictive and/or prescriptive is a significant shift in the level of sophistication and there-fore warrant the label of "advanced."

Predictive analytics comes right after the descriptive analytics in the three-level analytics hierarchy. Organization that are matured in descriptive analytics move into this level where they look beyond what happened and try to answer the question of "What will happen?".

Figure 5. Simple Taxonomy of Analytics (Delen & Ram 2018)

Prescriptive analytics is the highest echelon in analytics hierarchy. It is where the best alternative among many that are usually created/identified by predictive and/or descriptive analytics–courses of action is determined using sophisticated mathematical models.

Business Analytics Capability and Framework

BA capabilities can potentially provide value and lead to better organizational Performance (Cosic et al. 2015)(Cosic et al. 2015). BA systems benefit organizations by enabling improvements to business processes, firm Performance, and creating competitive advantage (Thomas Davenport, n.d.). In the resource-based view (RBV), a capability is conceptualized as utilizing resources to perform a certain task. It is produced from the interaction between IT assets and other organizational resources. In line with this, a BA capability was defined as: 'the ability to utilize resources to perform a BA task, based on the interaction between IT assets and other firm resources.

The BA capabilities were grouped into four capability areas based on similarities. These are:
- Governance: A Mechanism for managing BA resources and the assignment of decision rights and accountabilities to align BA initiatives with organizational objectives (Weill & Ross, n.d.).
- Culture: Tacit and explicit organizational norms, values, and behavioral patterns that form over time and lead to systematic ways of gathering, analyzing, and disseminating data (Leidner & Kayworth, 2006).
- People: Individuals who use BA as part of their job function (Thomas Davenport, n.d.).
- Technology: Development and use hardware, software, and data within BA activities (Negash & Gray 2008).

3. Methods

Discussion on research methodology will include philosophical research, approaches taken, whether it is deductive, abductive, or inductive, strategies and methods that will be carried out. The research philosophy will underlie how the research will be conducted. The selection of deductive or inductive approaches will be based on problems and research gaps that have been planned based on literature review. The research strategy will be adjusted to the conditions on the ground, ensuring that practically this research can run well, get the necessary data and information, and produce the expected contribution. Discussions on data retrieval and analysis methods, are still in the early stages and will continue to be matured in accordance with the maturity of the research stage and the readiness of the research infrastructure.

This research tends to use Positivism as a research paradigm, with a deductive approach. This research will be operated with a multi (comparative) case study, where data and information collection or collection will be carried out using a mixed method (a combination of qualitative and quantitative). The data collection itself will be carried out in a cross-sectional manner, where data and information will be taken once.

Data and Research Methods

The data and information that will be collected and analyzed in this research will come from several BA adoption projects carried out at a multinational Oil and Gas Company over the last 3 years, especially from PQR Working Area, Regional STU. Primary data will be obtained from direct sources, such as management, project leaders, project teams, customers, and Subject Matter Experts (SME). While secondary data will be obtained from project reports, company performance reports and other related information or data.

The unit of analysis that will be used in this research is the BA Adoption Project. The unit of analysis is the entity that frames what is being looked at in a study, or is the entity being studied. This means that all projects related to the application or implementation of the BA will be the focal point of the research.

In this context the researcher will divide the projects into 2 large groups, the first are 12 projects that have been identified from the start as material for a multi (comparative) case study, where data collection will be carried out using qualitative methods by conducting in-depth interviews with management, project leaders, project teams and SMEs. From these 12 projects, collected information can be further analyzed to confirm and finalize the model, construct, variable, and relationship. The expected information data is also in the form of best practices and lessons learned which will be used as the basis for analyzing the BA Adoption framework.

The second group of projects is more general in nature, there are 210 BA adoption projects identified. Those projects are expected as the feeder of data and information for the quantitative data collection process, namely surveys of all parties involved in these projects. For this second group, the scope and criteria made for the project to be researched are looser and broader, with the aim of getting the number of projects that can meet research and data analysis standards.
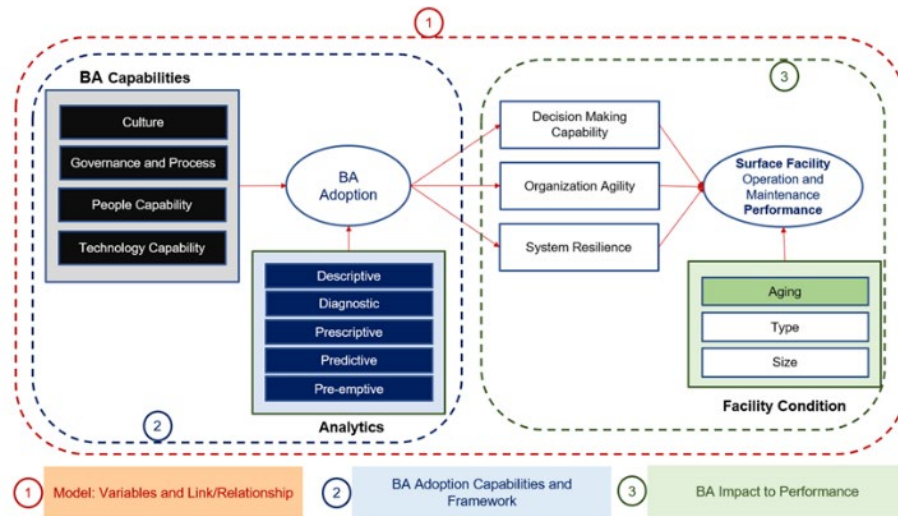
Figure 6. Research Question and Proposed Model

This study will use a deductive approach or method, where the basics of the theory have been obtained and several propositions and hypotheses have been prepared, when the literature review and preliminary observations from the field have been carried out. Models and hypotheses will be sharpened by analyzing the data and information obtained in the early stages of the study using a qualitative approach, namely interviews and FGDs.

The deductive approach develops the hypothesis or hypotheses upon a pre-existing theory and then formulates the research approach to test it (Silverman 1998). The deductive approach can be considered particularly suited to the positivist approach, which permits the formulation of hypotheses and the statistical testing of expected results to an accepted level of probability (*Snieder and Larner*, n.d.). It is characterized as the development from general to particular: the general theory and knowledge base is first established, and the specific knowledge gained from the research process is then tested against it (*Kothari* n.d.).

However, a deductive approach may also be used with qualitative research techniques, though in such cases the expectations formed by pre-existing research would be formulated differently than through hypothesis testing (Saunders & Lewis 2012). With a deductive approach, the research will be performed with a predetermined theoretical corridor and will test it with data and information that will be obtained, analyzed, and discussed during research operations.

A deductive approach will be used to further explore the existing hypotheses in relation to the research question, the first is about the BA Adoption model/framework and the relationship between variables, the second will explore further about BA Capabilities and the assessment, and the third will examine BA Adoption Impact on O&M performance at O&G, especially for surface facilities.
Figure 3.1 shows the three research questions that will be discussed in this study. The first is about the overall model of how BA Adoption, second is how BA capabilities are formed and developed and how they affect the readiness of a BA adoption, and third is how BA Impact has on the performance of the Upstream O&G Surface Facility

Research Models
The research is intended to fill the gaps from the previous study based on the SOTA analysis, describing the impact or critical influence of BA adoption on the O&G Industry to support the surface facility management program, especially to overcome the facility aging challenges. A literature review and a preliminary study, figure 3.4 shows the initial model for further assessment dan review during the research.
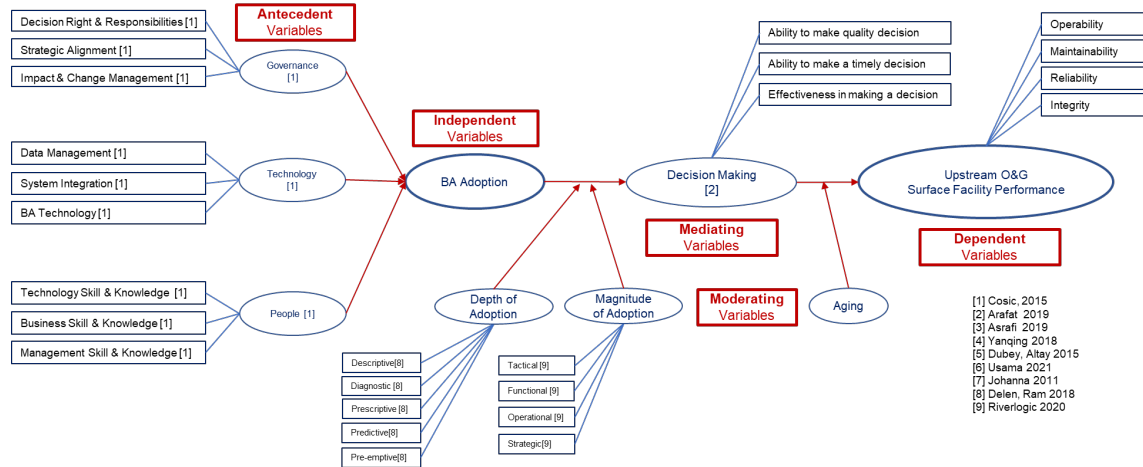
Figure 7. Proposed Variables, Parameters and Relationship

Antecedent Variables: Analytics BA Capabilities (Governance/Process, Culture, People, Technology.

At the same time, three BA capabilities will be explored further for deeper understanding and explanation, which are people, process, and technology. Those BA capabilities will be explored further by reviewing relevant literature review and gathering data and information for the available project/program BA adoption to identify the deeper element of capabilities.

1. Governance: A Mechanism for managing BA resources and the assignment of decision rights and accountabilities to align BA initiatives with organizational objectives (Weill & Ross, n.d.).
2. People: Individuals who use BA as part of their job function (Davenport et al., 2007).
3. Technology: Development and use hardware, software, and data within BA activities (Negash & Gray, 2008).

The complex mediating variables will be assessed and examined further based on case study information and data. The mediating variables Mediating variable consists of 3 components, namely: Decision-Making.

Decisions are integral to daily business practice. Sound and agile decision making is argued to be a core strategic capability. Knowledge helps avoid the consequences of ill-informed decisions. Facts and expertise provide content; know-how about the pitfalls and requirements of thinking through problems in different contexts contributes to sound process. This decision-making variable will be further explained by soliciting the information of the ability to make high quality and timely decision as well as how efficient the organization (or project) in making a decision.

Control or Moderating Variable: Facility Age (Aging)
Considering the characteristics of the facility depending on its aging, the proposed model considers the age of the facility (Facility Ageing) as control variable. Since the data analysis will leverage SEM, then there is actually no concept of control variables. However, the model should be structured in such a way that all relevant variables are contained. "Relevant variables" are those that create "non-causal" links between an independent variable and a dependent variable.

4. Data Collection
Research Strategies - Multiple (Comparative) Case Study
The strategy of this research is a case study. The case study strategy is focused on a one or more people or a single area. It can offer an insight into the specific nature of any example and can establish the importance of culture and context in differences between cases (Silverman 1998). In brief, case study research is the assessment of a single unit in order to establish its key features and draw generalizations(Bryman 2017).

The proposed research aims to fill the gap on the BA Capability and Impact for O&G Industry by explaining the mediating and moderating variables influence and contribution to the performance which characterize and relate to

the aging surface facility management program. The case study approach was chosen on the grounds since this strategy provides the best opportunity to obtain information and data as qualitative and quantitative as possible from existing or ongoing BA adoption projects and programs. Case Study will provide an opportunity for researcher to deeply analyze and investigate the activities of the parties involved and the SME.

Research Choices - Mixed (Qualitative and Quantitative)
Qualitative research is a form of research in which the researcher collects and interprets data, meaning the researcher is as important in the research process as the participants and the data they provide. According to (Clissett, 2008) qualitative research involves a variety of research methods that can be used to explore human experience, perceptions, motivations, and behaviors.

Like all scientific research, qualitative research aims at the systematic application of a predetermined set of procedures, to collect and analyze evidence, and present findings that resolve issues. Qualitative research however aims to gain an understanding only on the case studied rather than to generalize, or to use the data to support hypothesis.

To get the accurate data and information and represent conditions on the ground, this study will use a mixed method, a combination of qualitative and quantitative, where qualitative approaches are more prominent. Broadly speaking there are 3 groups of information and data that will be collected, analyzed, and discussed. The first is related to the construction model for BA Adoption, variables, and relationships between variables. Second, information and data related to adoption frameworks and capabilities, as well as their assessment. Third data and information about the impact and contribution of BA on surface facility management performance

Qualitative approaches will mainly be used in the early stages of research, where BA adoption construction and models are being built and BA capabilities are being identified, so that the overall model building, and variable harmony can be represented. This qualitative method with an interview and FGD approach will be carried out on 12 projects that have been identified from the start.

While quantitative method will be used in the middle or end of the research to retest construction and discussion results using surveys which limited to project teams, users, and SMEs. Quantitative will be carried out by survey and secondary data collection, on a much larger number of projects and meeting the criteria to meet research standards.
In addition to determining the method of retrieving and gathering information, the most important thing is to also determine and plan from the beginning is to identify the audiences or sources of information data that need to be engaged. Audience or subject research is determined based on strong criteria to ensure all the necessary data can be obtained accurately and on time. Table 1 shows the draft matrix methodology of data collection and information along with the candidate subjects that will play a role in this research.

Table 1. Research Data Acquisition Matrix

	1 Model: Variables and Link (Relationship)	2 BA Adoption Framework and Capabilities Assessment	3 BA Impact to Performance
Literature Review	Underlying Theory, Previous Studies	Previous Studies	
Interview	Top Management, Subject Matter Expert (SME), Project Manager	Top Management, Project Manager, Subject Matter Expert (SME)	Top Management, Project Manager, Customer Manager
Focus Group Discussion	Project Manager, Project Team, Subject Matter Expert (SME)	Project Team	Customer
Observation	Project Team and Operator Capabilities, Technology Capabilities		O&M Performance, DSC Performance
Survey	Project Teams	Project Teams	Project Teams, Customers
Secondary Data	Project Report, Lookback Report, O&M Report	Organization Structure, Opex/Capex Report, Infrastructure Configuration, Process/Guidance/Guidelines/Standard etc.	Lookback Report, Operation and Maintenance Report

There are 3 ways to get information or data from audiences, first do an in-depth review, for example for literature and secondary data. Second, by conducting an interview, which will be done to decision makers or experts. Third by conducting a survey, which will be done on working teams and users.

The literature review has been carried out at the SOTA preparation stage; however, it will continue to be carried out for research purposes and as a material for the triangulation process to ensure consistency, reliability and validity of the research. Literature review will also be carried out in order to enrich the data and information obtained during the interview process and secondary data collection.

The interview will be conducted with two approaches, both structured interviews, where questions have been prepared in writing, and all participants or respondents will receive the same questions with the same sequence. Semi-structured interviews will also be conducted, especially in the early stages of the research, where the focus of the interview is still on the stage of preparing and finalizing the model, construct and identifying variables and their correlations.
The survey will be conducted in the middle or final stages of the research. This method will be used to confirm and finalize the models and hypotheses that have been prepared previously from the literature review and interviews. The survey results will be further analyzed using the Structural Equation Modeling (SEM) approach.

A 'survey' is a research strategy in which experts on a particular subject are asked about their perception of relevant organizational aspects. A survey allows for a closer relationship between academia and the real world because it facilitates the testing of conceptual models based on real-world data, which makes this approach appropriate for the current research.

Deductive approach will be applied to analyses the interview result, it will require a structured or predetermined approach. In this case, the researcher will build categories in advance of the analysis. Then, it will map connections in the data to those specific categories.
Inductive approach also will be an option for analyzing the interview result. First, thematic content analysis begins with weeding out biases and establishing the overarching impressions of the data. This will identify common themes as the study search the materials organically.

The goal is to find common patterns across the data set. Second, a narrative analysis involves making sense of the interview respondents' individual stories. Use this type of qualitative data analysis to highlight important aspects of their stories that will best resonate and highlight critical points the study has found in other areas of the research.

5. Expected Results and Discussion

There needs to be a thorough evaluation or lookback to review whether efforts to implement BA as a solution to surface facility challenges, especially those related to aging facilities, have produced the promised solution, and can return the benefits of investment that has been allocated. Even though there are some adoptions of business analytics concept on in O&G Industry, some remaining questions and challenges remain there, such as:

- What is/are the key element of BA capabilities which has/have an impact and significant role? Furthermore, how big is the impact?

  It is necessary to further examine what capability characteristics upstream O&G needs before deciding to build a BA approach. And any capability that has a greater impact than others, on a BA Adoption success and how much of an impact it has.
- How to measure the BA capabilities readiness (maturity) in the O&G Industry? What is the minimum level of maturity of BA capabilities for the success of the program?

  It is necessary to determine how to assess existing capabilities in the organization and how ready for BA implementation as part of the Surface Facility Management solution.
- What is BA adoption impact on surface facilities reliability, operability, and maintainability Performance?

Further assessment and review are needed, how much impact BA adoption actually has on the performance of Upstream O&G, especially in the management of surface facilities. How much success rate a BA adoption to answer problems on the ground.

What is the framework in adopting/implementing the Business Analytics concept to face operation challenges?

6. Conclusion

In the last 5 years, different kinds of novel BA Adoption and Impact have been proposed and numerous studies have been conducted to investigate. This paper systematically summarized a Literature and state-of-the-art review on the underlying theory, model and variables, capabilities, analytics aspect, and design and analysis methods.

The research is important to better understand and explain how the BA (Descriptive, Prescriptive, Predictive Analytics) adoption will impact O&G Industry performance through facility integrated optimization, comprehensive maintenance, and reliable operation program, and assess the BA capabilities readiness to support the adoption. Having a better understanding of those two areas will benefit the development of a framework of BA Adoption.

In general, there are 5 important stages in this research. The first stage is literature review and preparation of the SOTA table, the second stage is compiling the research methodology, the third stage is data collection and collection, the fourth stage is in-depth analysis and data analysis, and the fifth stage is compiling conclusions and recommendations.

References

Amrouch, H., & Henkel, J., Reliability degradation in the scope of aging - From physical to system level. *Proceeding of 2015 10th International Design and Test Symposium, IDT 2015*, 9–12, 2016.

Bevilacqua, M., Bottani, E., Ciarapica, F. E., Costantino, F., Donato, L. Di, Ferraro, A., Mazzuto, G., Monteriù, A., Nardini, G., Ortenzi, M., Paroncini, M., Pirozzi, M., Prist, M., Quatrini, E., Tronci, M., & Vignali, G. (n.d.). *Digital Twin Reference Model Development to Prevent Operators' Risk in Process Plants*.

Bryman, A., Quantitative and qualitative research: further reflections on their integration. *Mixing Methods: Qualitative and Quantitative Research*, 57–78, 2017.

Carvalho, E., Tang, F., Allen, E., & Sharma, P., A case study of asset integrity and risk assessment for subsea facilities and equipment life extension. *Proceedings of the Annual Offshore Technology Conference*, *1*, 670–681, 2015.

Clissett, P., Evaluating qualitative research. *Journal of Orthopaedic Nursing*, *12*(2), 99–105,2008.

Corvaro, F., Giacchetta, G., Marchetti, B., & Recanati, M., Reliability, Availability, Maintainability (RAM) study, on reciprocating compressors API 618. *Petroleum*, *3*(2), 266–272, 2017.

R., Shanks, G., & Maynard, S., A business analytics capability framework. *Australasian Journal of Information Systems*, *19*, S5–S19,2015.

Delen, D., & Ram, S., Research challenges and opportunities in business analytics., 2–12,2018.

Delen, D., & Zolbanin, H. M., The analytics paradigm in business research. *Journal of Business Research*, *90*(April), 186–195, 2018.

Holsapple, C., Pakath, R., Sundaram, D., Lee-Post, A., & Pakath, R., *A unified foundation for business analytics Related papers How t he Use of Big Dat a Analyt ics Affect s Value Creat ion in Supply Chain Management Cont ext ual Adapt ive Knowledge Visualizat ion Environment s Aunified foundation for business analytics*, 2014.

Khan, R., B. Mad, A., Osman, K., & Asyraf Abd Aziz, M.,Maintenance Management of Aging Oil and Gas Facilities. *Maintenance Management*, 2020.

Krishnamoorthi, S., & Mathew, S. K., Business analytics and business value: A comparative case study. *Information and Management*, *55*(5), 643–666,2018.

Leidner, D. E., & Kayworth, T., Review: A review of culture in information systems research: Toward a theory of information technology culture conflict. *MIS Quarterly: Management Information Systems*, *30*(2), 357–399, 2006.

Majchrzak, A., Technology Affordances and Constraints. *Encyclopedia of Management Theory*, 833–834,2013.

Mohammadpoor, M., & Torabi, F., Big Data analytics in oil and gas industry: An emerging trend. *Petroleum*, *6*(4), 321–328,2020.

Negash, S., & Gray, P., Business Intelligence. *Handbook on Decision Support Systems 2*, 175–193, 2008.

Power, D. J., Heavin, C., Mcdermott, J., & Daly, & M., Defining business analytics: an empirical approach. *Journal of Business Analytics*, *1*(1), 40–53, 2018.

Research Methodology: Methods and Techniques - C. R. Kothari - Google Books. (n.d.). Retrieved February 25, 2022.

Saunders, M., & Lewis, P., Doing Research in Business & Management: An Essential Guide to Planning Your Project. In *Pearson Education Limited* (Vol. 66). Pearson, 2012.

Silverman, D.,Qualitative research: meanings or practices? *Information Systems Journal*, *8*(1), 3–20, 1998.

The Art of Being a Scientist: A Guide for Graduate Students and their Mentors - Roel Snieder, Ken Larner - Google Books. (n.d.). Retrieved February 25, 2022.

Thomas Davenport, J. H. (n.d.). *Competing on Analytics: Updated, with a New Introduction: The New Science of ... - Thomas Davenport, Jeanne Harris - Google Books*. Retrieved October 23, 2021.

Weill, P., & Ross, J. (n.d.). *A Matrixed Approach to Designing IT Governance*.

Biographies

Agung Prasetya is a Program Manager of Information Management, PT Pertamina Hulu Rokan of Pertamina. He is also candidate doctor for Doctor of Science in Management (DSM) at the School of Business and Management (SBM), Bandung Institute of Technology (ITB). He earned his Master degree in Magister of Information Technology from the Sepuluh November Institute of Technology, Surabaya, Indonesia. and his Bachelor of Engineering (S.T.) degree in Electrical Engineering from Bandung Institute of Technology. Previously, he worked for PT Chevron Pacific Indonesia of Chevron, has numerous assignments on Information Technology, Project Management, Operations, Facility Engineering, and Planning &Technology. He has presented in some international conference in Project Management and Information Technology area.

Yos Sunitiyoso is an associate professor in decision making at School of Business & Management, Institut Teknologi Bandung (SBM ITB), Indonesia. He received his PhD from the University of the West of England (UWE) Bristol, United Kingdom in 2007, after completing his Master of Engineering degree from the Nagaoka University of Technology, Japan in 2004. His degree is in industrial engineering from ITB, graduated in 2000. Yos joined SBM ITB in January 2010 after previously working for the University of Southampton, UK in 2008-2010. He led the SBM ITB Jakarta Campus as the Director in 2010-2020 to grow the MBA Program from less than 100 student-body to become over 800 student-body, contributing to around 21% of the business school revenue. Since 2020, he became the head of the Decision Making and Strategic Negotiation Group until now. He also serves as the Vice President of Research, Training and Development for Intelligent Transport Systems (ITS) Indonesia since 2021 until now.

Meditya Wasesa is an assistant professor at the School of Business and Management, Bandung Institute of Technology. He earned his Ph.D. in Management Information Systems from the Rotterdam School of Management, Erasmus University, the Netherlands. He earned his M.Sc. in Logistics Engineering with the highest distinction from Duisburg-Essen University, Germany, and his Bachelor of Engineering (S.T.) degree in Mechanical Engineering from Bandung Institute of Technology. Previously, he worked for General Motors Europe GmbH - Germany, Rotterdam School of Management, and Almende BV – the Netherlands. In Indonesia, he has handled several consultancy projects for a number of private, state-owned companies (BUMN), notable start-up unicorns, and ministries. He has gained notable exposure to different industries such as transportation and logistics, e-commerce, fast-moving consumer goods, renewable energy, construction industries, etc. His research focuses on the applications of advanced information systems to improve business decisions, especially business analytics. He has published in notable journals such as the Journal of Information Systems Engineering and Business Intelligence, The Asian Journal of Shipping and Logistics, Systems Research and Behavioral Science, Journal of Enterprise Information Management, Decision Support Systems, and so on.