Knowledge Management Maturity Assessment in Air Drilling Associates using G-KMMM

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Abstract—Since the early 1990s, companies in the oil & gas industry have realized that their business operations are knowledge-based, where company performance can be derived from faster identification, an assessment of an opportunity, and the speed of an exploitation. The oil & gas industry is one of the leading industries in the application and development of knowledge management; this is caused by changes in market and technology from 1990s to the beginning of the 21st century. Utilizing knowledge management is a must to be able to compete with other oil and gas industry companies. Currently, Air Drilling Associates (ADA) as one of the companies in oil & gas industry already has implemented knowledge management system, but its benefits are far from the expectation. In order to position their efforts and initialize knowledge management, companies need framework to use as a template. The objective of this paper is to measure the knowledge management maturity of Air Drilling Associates and other suggestion related to knowledge management for improvement.

Keywords—knowledge management, knowledge management maturity model, oil and gas industry

I. INTRODUCTION

Over the last few years, Knowledge Management (KM) has become one of the success factors of an organization. The main goal of the KM initiative in every organization is to improve the performance of the people involved with the organization [1]. The industrial world is expected to support and use KM to facilitate their resilience in an increasingly dynamic and competitive business environment. Similarly, the oil and gas industry has long utilized KM. According to Robert M. Grant [2], since 1990, the company's interest in KM has been increasing. This is due to technological trends and which reveal many opportunities to exploit existing knowledge in the organization.

Since the early 1990s, companies in the oil & gas industry have realized that their business operations are knowledge-based, where company performance can be derived from faster identification, an assessment of an opportunity, and the speed of an exploitation. In line with previous statements, Zaied, Hussein, and Hassan [3] reveal that the 21st century is an era of economic knowledge, where many organizations have a lot of knowledge that can be used to develop their performance.

The oil & gas industry is one of the leading industries in the application and development of knowledge management; this is caused by changes in market and technology from 1990s to the beginning of the 21st century. This change encouraged industry to further discuss locations, provide space for environmental responsibility, and develop technology tools in the fields of seismology, drilling, and offshore exploration and production (E&P). The development of information and communication technology (ICT) also enables companies to collect and analyze a huge number of information which enable communication and collaboration among employees in all over the world.

Around the year 2000 to 2010, the Society for Petroleum Engineers (SPE) estimates that there will be 231.000 years of cumulative experience and knowledge that will be lost over the next 10 years as many technical and petroleum engineers will retire [2]. From a different perspective, this urgency is supported by Muthuveloo, Shanmugam, and Teoh [4] who stated that customers will avoid to establish business relationships with company who has employee turnover problem, especially the one in key positions. This tendency is based on customer fears as to whether the organization still has the knowledge required for business continuity and performance, despite the decline of its employees. To address this, a knowledge management is required [5]. Knowledge itself can be a tool for supporting the company's adaptation and survival [6].

To position their efforts and initialize knowledge management, companies need some kind of framework to use as a template [5]. According to Zaied, Hussein, and Hassan [7], KM becomes very important as it can provide assistance to direct organizational and competitive performance. A maturity assessment model is required to measure KM performance. Assessment of KM maturity model will provide the level of maturity of a company so that we can determine the strategy needed to improve it [8].

Air Drilling Associates (ADA) as one of the companies in the oil & gas industry also suffer from the same issues as any other companies in the same industry. Currently ADA already have knowledge management system. The KMS named ADA Knowledge-based were developed to support KM practices in the ADA. Initially, ADA Knowledge Base were specifically expected to improve the operational efficiency of the drilling project at the site where the ADA is operating. Management expects the Project Supervisor of each project to record each End of Well Report into the ADA Knowledge Base as a lesson for the next project. However, the implementation is still considered not as expected. Knowledge transfer from employee-to-

company and among employees does not occur regularly, so there are many insights and opportunities lost in the process. Other than that, ADA must maintain their business continuity process and stay competitive among their competitors who also practice knowledge management. The objective of this study is to measure the KM maturity in ADA and analyze improvement related to KM.

II. CONCEPTUAL BACKGROUND

A. Knowledge Management and Knowledge Management System

KM may simply be defined as the management of the activities and the processes that enhance the utilization and the creation of knowledge within an organization, according to two strongly interlinked goals, and their underlying economic and strategic dimensions, organizational dimensions, socio-cultural dimensions, and technological dimensions: (i) a patrimony goal, and (ii) a sustainable innovation goal [5]. Mazzoni, Capriotti, Ferrazza, and Giudicati [7] said that KM covers the whole cycle of knowledge, from knowledge generation, capture, mapping, storage, sharing and capture. The collection of experiences and procedures, their cataloging and conservation is particularly crucial together with the development of new ideas, in a virtuous cycle enabled to valorize and power both single people and the company. Knowledge needs to be managed as it can reside in several different location, including people, artifacts, and organizational entities [9].

As quoted by Ovbagbedia [15], Alavi and Leidner (2001) describe the Knowledge Management System (KMS) as an information technology-based system applied to the development, expansion and support of organizational processes to provide, store, retrieve, alter and use knowledge [9][10]. KMS provides strategic potential for the organization and acts as a decisive source. It is essential to assist the management of key resources and intellectual capital of the organization in creating a competitive advantage [16].

B. Maturity Model

A development of entities can be simplified and described by using multiple levels of maturity. These levels are characterized based on certain requirements that an entity must achieve. The entity progresses from the bottom to the highest level without skipping a level [12]. In the context of KM, maturity is related to the organizational competency in managing knowledge as organizational intangible asset [11].

C. Knowledge Management Maturity Model

KM maturity model is the extent to which KM is explicitly defined, managed, controlled, and effected [12]. It describes the stages of growth of KM initiatives in an organization. KM assessment is needed to obtain a KM maturity model. It consists of comparing the tools regarding use cases, principles measured, outputs and contextual factors [13].

Pee and Kankanhalli [12] categorized KM maturity model into two groups, depending on whether or not they are developed based on the Capability Maturity Model (CMM). On their paper, they identified and compared four KMMMs based on CMM, i.e. Siemen's KMMM, Paulzen and Perc's Knowledge Process Quality Model, Infosys' KMMM, and Kulkarni and Freeze's Knowledge Management Capability Assessment Model (KMCA). They also identified and compared six KMMMs that are not based on CMM, i.e. KPMG Consulting's Knowledge Journey, TATA Consultancy Services' 5iKM3, Klimko's KMMM, WisdomSource's K3M, Gottschalk and Khandelwal's Stages of Growth for KM Technology, and VISION KMMM (V-KMMM).

III. RESEARCH DESIGN

To assess the overall level of Air Drilling Associates, we apply each of the General Knowledge Management Maturity Model elements to each division and unify the final result.

A. Case Background

Air Drilling Associates (ADA) was founded in 2003 by Chaman Malhotra and Don Wells, the former owners of Air Drilling Services (ADS). It quickly became a leader in SE Asia, Middle East Asia-Pacific region, and in North and South America. The air compression packages provided by ADA operate as stand-alone, self-sustaining operations that are stocked with abundant spare parts and redundancy in mind. ADA probably has the youngest equipment fleet in the industry, with most equipment after 2002. ADA is a world leader in applying air-, mist-, foam-, aerated fluid and other underbalanced techniques for petroleum and geothermal drilling projects.

ADA's vision is "to be the preferred and leading provider of equipment and services for wellbore pressure management while drilling and for commissioning and testing of pipeline and process systems".In order to achieve this, this company has mission of "dedicated to providing innovative drilling and production solutions to our customers in a safe and exceptional level of performance". There are two main departments in ADA; Operational and Finance. Each department is headed by a C-Level leader, Chief Finance Officer and Chief Executive Officer. Headed by a Chairman and Vice Chairman, a CEO oversees three operational directors, each responsible for operational activities in 3 regions; Asia-Pacific, Russia and Europe, Middle East; as well as a Sales Manager and Engineering Manager. A CFO heads a finance director who is responsible for the company's cash flow.

B. Methodology

General Knowledge Management Maturity Model (G-KMMM) proposed by Pee and Kankanhalli [12] is utilized to measure KM maturity

in ADA. This study performs modeling based on studies and comparisons of pre-existing knowledge management maturity model (KMMM), either based on Capability Maturity Model (CMM, i.e. Siemens KMMM, KPQM, Infosys' KMMM, and KMCA) or not (i.e. Knowledge journey, 5iKM3, K3M, and Stages of Growth for KM Technology). This model was chosen because it covers aspects of people, process, and technology which are important aspects in knowledge management. The model can be seen in Table 1. In this model, the key proccess areas (KPA) people covers aspects related to organizational culture, strategy, and policy; KPA process includes aspects related to KM activities

such as sharing, application, and knowledge creation; KPA technology covers aspects related to technology and KM infrastructure.

At the *initial* level, the organization only have low level of attention or not at all to manage knowledge formally because it is not considered important for the organization's success and goals. At the *aware* level, organizations have an awareness to manage knowledge formally because they already realize the importance of knowledge for the company, but it is possible that they don't know how to implement it. At the *defined* level, organizations

TABLE I.   G-KMMM MODEL [12]

Maturity Level	General Description	Key Process Areas		
		People	Process	Technology
Initial	Little or no intention to formally manage organizational knowledge	Organization and its people are not aware of the need to formally manage its knowledge resources	No formal processes to capture, share and reuse organizational knowledge	No specific KM technology or infrastructure in place
Aware	Organization is aware of and has the intention to manage its organizational knowledge, but it might not know how to do so	Management is aware of the need for formal KM	Knowledge indispensable for performing routine task is documented	Pilot KM projects are initiated (not necessarily by management)
Defined	Organization has put in place a basic infrastructure to support KM	- Management is aware of its role in encouraging KM - Basic training on KM are provided (e.g., awareness courses) - Basic KM strategy is put in place - Individual KM roles are defined - Incentive systems are in place	- Processes for content and information management is formalized - Metrics are used to measure the increase in productivity due to KM	- Basic KM Infrastructure in place (e.g., single point of access) - Some enterprise level KM projects are put in place
Managed	KM initiatives are well established in the organization	- Common strategy and standardized approaches towards KM - KM is incorporated into the overall organizational strategy - More advanced KM training - Organizational standards	Quantitative measurement of KM processes (i.e., use of metrics)	- Enterprise-wide KM systems are fully in place - Usage of KM system is at a reasonable level - Seamless integration of technology with content architecture
Optimizing	- KM is deeply integrated into the organization and is continually improved upon - It is an automatic component in any organizational processes	Culture of sharing is institutionalized	- KM processes are constantly reviewed and improved upon - Existing KM processes can be easily adapted to meet new business requirements - KM procedures are an integral part of the organization	Existing KM infrastructure is continually improved upon

TABLE II.   G-KMMM Assessment Instrument [12]

Level	Question	
KPA: People		
2	PEO2a	Is organizational knowledge recognized as essential for the long-term success of the organization?
	PEO2b	Is KM recognized as a key organizational competence?
	PEO2c	Employees are ready and willing to give advice or help on request from anyone else within the company
3	PEO3a	Is there any incentive system in place to encourage the knowledge sharing among employees?
	PEO3b	Are the incentive systems attractive enough to promote the use of KM in the organization?
	PEO3c	Are the KM projects coordinated by the management?
	PEO3d	Are there individual KM roles that are defined and given appropriate degree of authority?
	PEO3e	Is there a formal KM strategy in place?
	PEO3f	Is there a clear vision for KM?
	PEO3g	Are there any KM training programs or awareness campaigns?
4	PEO4a	Are there regular knowledge sharing sessions?
	PEO4b	Is KM incorporated into the overall organizational strategy?
	PEO4c	Is there a budget specially set aside for KM?
	PEO4d	Is there any form of benchmarking, measure, or assessment of the state of KM in the organization?
5	PEO5	Has the KM initiatives resulted in a knowledge sharing culture?
KPA: Process		
2	PRO2	Is the knowledge that is indispensable for performing routine task documented?
3	PRO3a	Does the KMS improve the quality and efficiency of work?
	PRO3b	Is the process for collecting and sharing information formalized?
4	PRO4a	Are the existing KM systems actively and effectively utilized?
	PRO4b	Are the knowledge processes measured quantitatively?
5	PRO5	Can the existing KM processes be easily adapted to meet new business requirements?
KPA: Technology		
2	TEC2a	Are there pilot projects that support KM?
	TEC2b	Is there any technology and infrastructure in place that supports KM?
3	TEC3	Does the system support the business unit?
4	TEC4a	Does the KMS support the entire organization?
	TEC4b	Is the KMS tightly integrated with the business processes?
5	TEC5	Are the existing systems continually improved upon (e.g. continual investments)?

already have a basic infrastructure that supports KM,

and there is management support that states the KM strategy along with training and incentives. At the *managed* level, KM has become part of the company's strategy along with the model, standard, and KM effectiveness assessment in the company. At the *optimizing* level, KM strongly supports the key business activities of the company along with a voluntary knowledge-sharing culture undertaken by members of the organization.

KM maturity assessment instruments developed by Pee and Kankanhalli [12] are shown in Table 2. These questions are divided for each KPA and the corresponding level. G-KMMM can provide a comprehensive and systematic assessment to be able to identify areas that need to be focused so that the company's performance can continue to increase continuously. Previous studies have also utilized this model to assess KM maturity on firm performance and knowledge creation process [11][14], and to see the effect of organizational culture on KMM [15].

As a comparison, we also assess two other oil & gas companies, namely Royal Dutch Shell and Schlumberger. We chose these two companies because they have succeeded in obtaining MAKE (Most Admired Knowledge Enterprise) awards, an award that seeks to recognize organizations which outperform their peers in creating shareholder's wealth by transforming tacit and explicit enterprise knowledge and intellectual capital into superior products/services/solutions. The data is collected from a review paper by Grant [2].

C. Data Collection

Data collection is done by interviewing key person from three main divisions in ADA: Sales (SA), Finance (FIN) and Operational (OPS). Due to the peculiarities of the business process and different culture, the results of KM maturity assessment of each division can be different. The results contribute to the general KM maturity assessment on ADA. The G-KMMM assessment instrument is used as interview guidelines.

IV. Result and Analysis

KM maturity of each division is assessed by evaluating whether a particular practice is performed or not. For every practice that is done then the answer is 'Y', otherwise it will be 'N'. In order to qualify for the level of maturity within the KPA, a division must implement all key practices at that level. For example, the division that practices item PEO2a to PEO4a but not the item PEO4b can be said that it has reached the level 3 of maturity in the People's KPA, as it has not yet implemented all practices that characterize level 4. Table 3 summarizes the maturity ratings of each division.

Based on our assessment using GKMMM with the data from Grant's paper [2], both Royal Dutch Shell and Schlumberger belongs to KM maturity level 5. It fulfils all level 5 assessment questions in all of the key process area, which is related to knowledge sharing culture, easy adoption of KM processes to meet new business requirements, and continuous improvement on existing systems. On the other hand, based on interviews, observations and document studies, KM maturity level of ADA is still at level 2. A clearly visible difference between KM practice in Royal-Dutch-Shell-and-Schlumberger and ADA is that both Schlumberger and Shell formed a steering committee with knowledge champion, as well as assign a Chief Knowledge Officer. While in the ADA, the practice of Knowledge Management is still managed by the Operations division whose main focus is to provide the best drilling services, thus KM management is just a side responsibility for the division.

A. People Area

All factors why the level of maturity of the people area is still at level 2 are related to the commitment and management support in encouraging KM culture and application in the company's work environment. Starting from the absence of formal KM strategy, lack of clear vision on KM implementation, lack of training or program to increase awareness to KM, no special personnel appointed who has the authority to handle KM, to the fact that there is no incentive system for employees who implements knowledge sharing.

Apart from the existence of the knowledge management system in the company, culture and management support becomes one of the main factors that can initiate and maintain the activities of sharing information between employees, whether one division or cross division.

B. Process Area

Assessment in the process area does not produce the same value for the three business units with sales and finance still at level 2, while operations are at level 3. This difference lies in the application of KMS that has improved the quality and efficiency of the work performed by the business unit of the operation, but the impact did not occur on sales and finance business unit. KM implementation becomes important for the operations unit because the team consists of many people and spread so that the KM will improve the work process of the team. This is not the problem in the sales and finance units as they have fewer number of personnel with placements located only in Indonesia, so KM implementation does not have a significant impact. In addition, the process of collecting and sharing information on sales and finance units is not formalized, only limited to non-formal activities. Therefore, the sales and finance

TABLE III. ASSESSMENT RESULT

Item	SA	FIN	OPS	Item	SA	FIN	OPS
People Maturity	2	2	2	*Process Maturity*	2	2	3
PEO2a	Y	Y	Y	PRO2	Y	Y	Y
PEO2b	Y	Y	Y	PRO3a	N	N	Y
PEO2c	Y	Y	Y	PRO3b	N	N	Y
PEO3a	N	N	N	PRO4a	N	N	N
PEO3b	N	N	N	PRO4b	N	N	N
PEO3c	Y	Y	Y	PRO5	N	N	N
PEO3d	N	N	N	*Technology Maturity*	3	3	3
PEO3e	N	N	N	TEC2a	Y	Y	Y
PEO3f	N	N	N	TEC2b	Y	Y	Y
PEO3g	N	N	N	TEC3	Y	Y	Y
PEO4a	N	N	Y	TEC4a	Y	Y	Y
PEO4b	N	N	N	TEC4b	N	N	N
PEO4c	N	N	N	TEC5	N	N	N
PEO4d	N	N	N	*Overall Maturity*	2	2	2
PEO5	Y	Y	Y	*Company Maturity*	2	2	2

units still cannot be categorized to be in level 3 in the process area.

C. Technology Area

Although some divisions can only reach level 2 in other areas, in the area of technology they all reach level 3. This is because the availability of tools that support the practice of KM, i.e. knowledge management system. This KMS is developed with management initiatives that recognize the importance of KM to facilitate corporate resilience in an increasingly dynamic and competitive business environment. The KMS developed is align with the company's commitment to ensure that employees have the right knowledge, skills, experience and behavior to meet business objectives and customer needs both in the short and long term.

Unfortunately, KMS implementation is done without assessing the readiness of the organization in adopting KM. Thus, KM strategy cannot be defined for designing roadmap of KM implementation and planning of KM mechanism, including preparing individual to accept and participate in KM practice.

V. Conclusion

Based on the results of the KMMM assessment, the Air Drilling Associates company is at the level 2 of KM maturity. This result is obtained from the assessment that has been done by considering aspects of people, process, and technology area. It implies that the company is at the aware level where they already realize the importance of knowledge for the company, but it is possible that they don't know yet how to gain the maximum advantage of KM usage.

Other oil and gas companies mentioned earlier has reach maturity level 5. Thus, to be able to compete among competitors, ADA must be able to increase the level of maturity KM to level 5.

The following are suggestions of improvement to achieve knowledge management maturity level 5:

1. Form a division to manage KM daily
2. Appoint a Chief Knowledge Officer
3. Mapping knowledge and establishing Community of Practice based on mapping results
4. Organize regular knowledge sharing sessions; this could be in the form of morning meeting for office and workshop base employee or daily transfer between morning and night shift and vice versa for project base employee
5. Incorporate KM into the overall organization strategy
6. Allocate a special budget for KM
7. Evaluate the KM practice periodically
8. Encourage active KMS utilization; Every contribution to the KMS should be counted and included in the annual performance assessment as one of the performance indicators and awarded with incentives.
9. Integrate KMS with business process; recording the End of Well Report (EoWR) into KMS can be one of the efforts. The company might be able to enforce this by not letting a supervisor to close a project before submitting the EoWR into ADA Knowledge Base.

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