

-RESEARCH ARTICLE-

INVESTIGATING THE IMPACT OF DYNAMIC CAPABILITY AND KNOWLEDGE MANAGEMENT ON GREEN INNOVATION IN THE UPSTREAM OIL AND GAS SECTOR

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—Abstract—

Upstream sector refers to both exploration and production stages in oil and gas industry. The sector remains unconnected with the end-user consumer and oil and gas supply chain. Despite its over-dependence on knowledge management and dynamic

Citation (APA): Munawar, A., Prabowo, I. H., Abdinagoro, S. B., Alamsjah, F. (2024). Investigating the Impact of Dynamic Capability and Knowledge Management on Green Innovation in the Upstream Oil and Gas Sector. *International Journal of eBusiness and eGovernment Studies*, 16(4), 83-103. doi:10.34109/ijebeg.202416405

capabilities of oil and gas companies, it faces the biggest challenge of controlling hydrocarbon production the pressure to adopt eco-friendly, sustainable green innovation techniques. This study explores the nexus between knowledge management and dynamic capabilities in enhancing green innovation within the oil and gas industry. The data was collected randomly from 105 participants working in the upstream oil and gas sector in Indonesia. It utilized Partial Least Squares Structural Equation Modeling to examine such factors and mediating devices that facilitate the adoption of green innovation. The study pursues the premise that knowledge management can directly influence green product and process innovation, with dynamic capabilities playing a mediating role. The results reveal that knowledge management alone does not have a substantial effect on green innovation but the presence of dynamic capability is required to play a moderating role. This study offers a unique and valuable insight into the concept of green innovation in the oil and gas sector. It suggests that the difficulty of implementing sustainable practices is affected by the interplay between knowledge management and dynamic capacities.

Keywords: Green innovation, upstream oil and gas, knowledge management, dynamic capability, sustainability, PLS-SEM.

INTRODUCTION

In the current era, oil and gas industries are encountering difficulties regarding discharging their social responsibility. The reason is that oil extraction often takes place in areas that are home to indigenous communities and sensitive ecosystems, leading to conflicts and displacement. These conflicts and hostilities can be easily resolved if industries agree for a transition in energy regulations, and respond to changing market needs by shifting from hydrocarbons to green energy (Beck et al., 2020). Industries should strive to reduce greenhouse gas emissions and shift towards cleaner energy options by adopting new approaches. Recently, there has been a global trend towards developing a more resilient and eco-friendly energy sector (Pickl, 2019). Efforts are being taken to identify hazards caused by the oil and gas Industry's operations, and what measures should be adopted to stop emission of greenhouse gases and prevent the environment. (Kumar et al., 2016) argue that industries must take the responsibility to adopt sustainable practices. Such resources should be generated that would pave the way to adoption of renewable energy and technology and reduce the impact of gas emissions on the environment.

However, the decision to transition towards a low-carbon economy is not an easy task. The companies will need to adapt their business models in such a manner that they continue to maintain their position and also remain competitive (Ramos & Veiga, 2011). Among several initiatives are included allocation of funds for sustainable energy sources, broadening their investment portfolios, and diminishing their environmental

impact by decreasing carbon emissions. Oil and gas corporations need to embrace sustainable practices that would include using carbon capture and storage technologies, and actively engaging in ecological preservation and rehabilitation programs (Cruz & Krausmann, 2013). They should also plan this transition by investing significantly in new and sustainable energy initiatives, such as solar, wind, geothermal, and hydrogen biofuels. In this manner, these companies can make significant contributions to the preservation of energy and the reduction of emissions (Li et al., 2022). The proactive approach taken by the sector would not merely be a reaction to necessity but a vital step towards guaranteeing its sustainable growth and development while also conforming to worldwide trends in low-carbon and renewable energy (Phan, 2022).

Significant progress has already been made; however, further endeavors are necessary to guarantee the long-term viability of the oil and gas industry and its activities. It is crucial to acknowledge that this progress is not uniformly spread since international oil and gas businesses are advancing faster than national oil and gas corporations, particularly in underdeveloped nations where the shift towards clean energy is typically slower. The probable cause of this issue is the discrepancies in the execution of knowledge management and variances in these companies' capabilities. There is no dearth of studies that have examined the influence of external factors, such as regulatory incentives and market pressures, on companies adopting sustainable practices. However, limited research has explored the internal organizational elements that drive the implementation of sustainability initiatives, particularly in industries like oil and gas, where firms must navigate the inherent tension between hydrocarbon production and carbon footprint reduction. This study seeks to address this research gap by investigating the internal mechanisms that facilitate green innovation, specifically identifying mediating variables that accelerate corporate adoption of sustainable practices. By doing so, this research aims to provide deeper insights into the internal drivers of green innovation, offering a more comprehensive understanding of how organizations can enhance their sustainability performance.

THEORETICAL FRAMEWORK

There is a prevailing notion for companies to cultivate novel methods to gain competitive advantages and confront present-day challenges. Several theories in strategic management lead to understand how organizations can uphold and enhance their competitive edge. The first theory is the dynamic capabilities theory, which is very pertinent in elucidating the construction of competitive advantage amidst swift transformations. The dynamic capability framework is extremely applicable to the Oil and Gas industry (Shuen et al., 2014) and contributes to rapidly evolve business landscape in establishing new competitive advantages. The second theory is the Resource-Based View (RBV) which suggests that knowledge management systems impact firm performance. The resource-based view underscores the importance of firms

continuously enhancing the value and uniqueness of their knowledge stocks at the individual level, such as human capital, to prevent knowledge decay and maintain competitiveness. This emphasizes the importance of knowledge management capabilities in facilitating innovation and business model evolution. Additionally, the application of intangible resources and digitized assets can accelerate the seizing and transformation of businesses, particularly in the context of digital transformation (Andrade et al., 2022).

This study employs both these theories to investigate the impact of dynamic capability and knowledge management on green innovation in the upstream oil and gas sector. Both the Dynamic Capabilities Perspective and the Resource-Based View (RBV) highlight the importance of resource selection and emphasizing its ongoing development and renewal. While one theory refers to capabilities and the abilities of a company, the other theory shows how to efficiently use and integrate resources in order to streamline organizational processes and achieve its objectives. The dynamic capability perspective builds upon and enriches the resource-based view (RBV), emphasizing the importance of a firm's ability to identify opportunities, allocate resources, and exploit them effectively. This viewpoint is crucial for strategic innovation, as it emphasizes the need for dynamic skills in utilizing resources for exceptional performance (Wang et al., 2022). Firms can improve their innovation capabilities and overall performance by utilizing strategic resources such as shared leadership and a market-oriented culture (Singh & Tantray, 2022).

Hence, this study investigated the influence of a company's resource stock and integrative skills on promoting innovation, utilizing concepts from both the Resource-Based View (RBV) and Dynamic Skills Perspective. Specifically, this study examined the influence of knowledge management on dynamic capabilities and green innovation. The study introduces dynamic capacities as a new intermediary factor in the relationship between information management and green innovation, which has so far been underexplored. Using data from Indonesia's upstream oil and gas sectors, an attempt was made to fill the research gap on dynamic capacities in knowledge management and green innovation.

LITERATURE REVIEW

Green Innovation

Green innovation, also known as eco-innovation, is built upon concepts like sustainable innovation, environmental innovation, and green product innovation. Each of these concepts has some specific and precise context, as far as the lexicon is concerned. Studies have emphasized, however, that there is no unified definition of green innovation, as this term typically involves all types of innovations used for resource conservation and environmental protection (Pan et al., 2022; Ullah et al., 2021). As

urbanization and globalization progresses, positive effects of green innovation on firms need to be well-documented (Liu et al., 2023), as it is important to put on record whether national high-tech zones significantly promote green innovation in businesses, enhancing their competitive advantage (Huang & Chen, 2022). Furthermore, green innovation also correlates with improved performance, hinting at companies' capabilities to practice corporate sustainability (Frempong et al., 2021).

By incorporating green innovation into business strategies, companies have gained strategic advantages and improved performance. For example, implementation of green organizational identity has been linked to enhanced green innovation performance (Chang & Chen, 2013). Moreover, implementing green information sharing, stakeholder pressure, and absorptive capacity has been demonstrated to favorably influence the outcomes of green innovation within firms (Song et al., 2020). Green intellectual capital, dynamic capabilities, and motivation to attain firm performance have been proposed as strategic assets for promoting green innovation results (Abrudan et al., 2022).

Knowledge Management

Knowledge management is defined as a strategic technique to enhance an organization's capacity to create knowledge and facilitate its implementation through decision-making. Knowledge management often includes activities like generating, acquiring, assessing, retaining, and distributing an organization's knowledge (Gao & Bernard, 2018). It encompasses the process of gathering and amassing knowledge within a company, distributing and utilizing this knowledge in organizational operations, exchanging best practices, safeguarding intellectual property rights, and incentivizing personnel to preserve valuable knowledge (Vu, 2019). It also involves enhancing an organization's capacity to efficiently generate, acquire, assess, retain, and distribute knowledge to accomplish its goals (Gao & Bernard, 2018). Knowledge management thus not only preserves knowledge, but also implements strategies and processes that help organizations to identify, organize and distribute an organization's intellectual resources in order to improve its performance and competitive advantage (Al Sehrawy & Amoudi, 2020).

Studies show a direct link between knowledge management and business performance (Mills & Smith, 2011). It is tied to the innovative behavior of knowledge workers, essential for organizational growth (Song et al., 2023). Effective knowledge management strategies boost innovation performance (Shujahat et al., 2018). Knowledge management yields diverse outcomes. In knowledge-intensive firms, it increases productivity (Kianto et al., 2019). By managing knowledge effectively, organizations can improve performance and innovation through techniques that facilitate knowledge acquisition, development, storage, sharing, and utilization (Shujahat et al., 2020). Additionally, it aids decision-making, fosters learning

ecosystems, and encourages information exchange within businesses (Vázquez Ingelmo et al., 2020).

Dynamic Capabilities

Dynamic capabilities are essential in strategic management, referring to an organization's ability to adapt to changing environments by effectively reorganizing resources and remain competitive. This involves combining and reorganizing internal and external skills, as well as identifying and leveraging opportunities. This capability of allocating resources, acquiring knowledge, and fostering long-term competitive advantages is dynamic (Huo et al., 2022). However, in order to identify opportunities, acquire resources, and reconfigure existing ones require developing dynamic capabilities through a proficient use of foresight tools. (Wang & Ahmed, 2007) describe these processes as acquiring, rearranging, and relinquishing resources to respond to market changes, and emphasizing strategic and organizational routines. While companies extend and reconfigure their operational capabilities to meet turbulent conditions (Pavlou & El Sawy, 2011), their dynamic skills are influenced by internal and external factors, including management attitudes. Dynamic capabilities do not ensure automatic performance improvements (Ambrosini & Bowman, 2009), they involve acquiring knowledge and continuously adjusting resources for competitive advantage (Su et al., 2014). However, dynamic skills can potentially predict organizational success across every vertical of the organization, particularly in project management where they influence the organizational performance at both program and portfolio levels, until the execution impacting overall performance (Hermano et al., 2022).

Knowledge management and green innovation

There is no dearth of research examining the correlation between knowledge management and green innovation. In a recent study, (Bhattarai, 2023) studied the impact of green knowledge management on green innovation in cement industries. The study found a culture of green innovation fostering a culture promoting environmentally friendly innovation inside cement organizations to improve sustainability initiatives. In a similar study, (Wang et al., 2022) reiterated the adoption of this green entrepreneurial attitude into green innovation, highlighting the mediating influence of the knowledge-creation process in this association.

However, knowledge does not always significantly influence innovation. For instance, (Singh & Tantray, 2022) found that knowledge management did not significantly impact organizational innovation. This suggests that individual skills and expertise may not always translate into favorable conditions for generating innovation. (Asgarian, 2012) emphasized that there was no direct correlation between knowledge acquisition and administrative innovation, thereby emphasizing the complex connection between knowledge management and innovation.

In addition, (Mathew et al., 2011) observed that factors such as leadership, networking, reward and recognition, structure, and technology did not significantly impact promoting innovativeness. This suggests a lack of connection between knowledge management efforts and their ability to foster innovation. These findings collectively suggest that while knowledge management is often seen as a facilitator of innovation, this relationship may not hold in some instances. Individual capabilities, organizational complexities, and contextual nuances can influence how knowledge management practices translate into tangible innovation outcomes.

Hypotheses development

This study offers a fresh viewpoint on the factors that lead to green innovation by emphasizing the importance of knowledge-creation processes within businesses. Moreover, it examined the influence of external knowledge sources on promoting environmentally friendly innovation and its subsequent effect on the performance of companies. This study also emphasizes the significance of utilizing external knowledge to propel green innovation projects (Agyabeng-Mensah et al., 2022). In order to understand the intricacies of these relationships in specific organizational contexts, and to determine the effectiveness of knowledge management in driving innovation, the following hypotheses were framed:

H1: *Knowledge management (KM) has a significant and positive impact on green process innovation (GI-PROCESS)*

H2: *Knowledge management (KM) has a significant and positive impact on green product innovation (GI-PRODUCT)*

Knowledge management and dynamic capabilities

There exists a link between knowledge management and dynamic capabilities, which helps in identifying knowledge management capability. (Li et al., 2020) found that dynamic skills mediate the connection between knowledge management practices and organizational success. (Lu & Liang, 2017) showed that knowledge management positively influences innovation, with dynamic capacities as mediators. (Mills & Smith, 2011) noted that knowledge management enhances innovation and organizational effectiveness. Considering the above discussion, following hypothesis is proposed:

H3: *Knowledge management (KM) has a significant and positive impact on dynamic capabilities (DC)*

The role of dynamic capabilities

Research shows that dynamic capabilities predict innovation (Al Wali et al., 2022). When paired with open innovation, they drive breakthrough innovation (Cheng & Chen, 2013). Dynamic capabilities enable executives to manage innovation processes

efficiently (Kearney et al., 2018). Their importance in fostering innovation spans sectors. In automotive, they enhance competitive advantage and innovation, affecting firm performance (Rotjanakorn et al., 2020). In green innovation, dynamic capabilities, like green dynamic capability, enhance innovation adoption (Yu et al., 2022). They positively influence a company's green innovation performance (Singh et al., 2019).

Dynamic capacities mediate the link between ambidextrous knowledge sharing and innovation performance (Han, 2019). Improving these capacities enhances information absorption, sharing, and innovation speed (Liu et al., 2023). Dimensions of IT-enabled dynamic capabilities significantly affect organizations' creative capabilities and overall performance (Ilmudeen et al., 2021). Considering the above discussion, we propose the following hypotheses:

H4: *Dynamic capabilities (DC) have a significant and positive impact on green process innovation (GI-PROCESS)*

H4a: *Dynamic Capabilities (DC) mediates the relationship between Knowledge Management (KM) and green process innovation (GI-PROCESS)*

H5: *Dynamic capabilities (DC) have a significant and positive impact on green product innovation (GI-PRODUCT)*

H5a: *Dynamic Capabilities (DC) mediates the relationship between Knowledge Management (KM) and green product innovation (GI-PRODUCT)*

Figure 1 presents the research model which guided the framing of the hypotheses and defining the relationships between the variables.

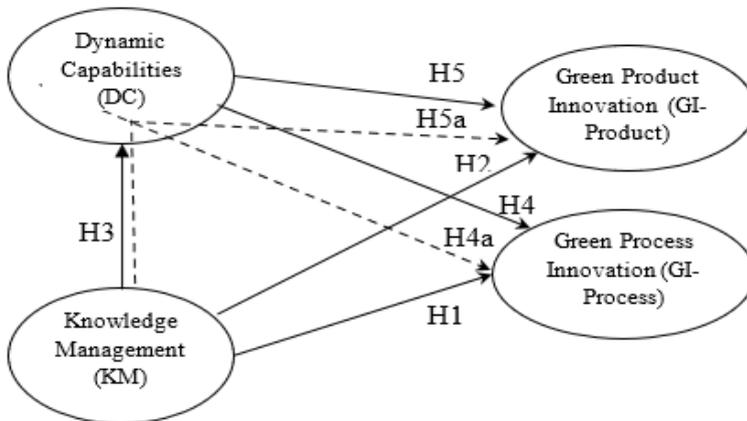


Figure 1: Research Model

RESEARCH METHOD

The target population of this study comprised upstream oil and gas sectors, specifically oil field operator companies and oil field services companies operating in Indonesia. These organizations have acquired certifications for environmental management

systems such as ISO 14001 series, EMAS, ISO 50001, or other similar systems. We sought the participation of high-ranking individuals, such as the CEO, vice president, managing director, senior managers, and managers, by officially requesting their involvement in the survey using a five-point Likert scale. This study utilized a simple random sample technique to gather data from upstream oil and gas companies via electronic communication between July 2023 and September 2023. Targeted individuals were sent reminders to encourage their involvement and enhance the response rate. Of the 224 survey questionnaires, 105 usable replies were obtained, resulting in a response rate of 46.9% from these respondents. Among the respondents, 40.9% occupied the top leadership level and were responsible for formulating organizational policies. Most of the participants' companies had been actively conducting business for over twenty years. Additionally, a significant proportion of these companies, precisely 61 percent, were classified as exploration and production companies (EP), while the rest were classified as oil and gas services companies (Services). Detailed findings of the company's profile are shown in Table 1, while respondent demographic information is shown in Table 2.

Table 1: Companies Information

Company Profile		(n = 105)	
Attributes	Distribution	Frequency	Percentage
Core Business	EP	64	61.0
	Services	41	39.0
Age	< 5 Years	14	13.3
	5-10 Years	14	13.3
	11-20 Years	11	10.5
	< 20 Years	66	62.9
Ownership	State-Owned	60	57.1
	Private	43	40.9
	Public	2	1.9
Employee Number	<10 person	3	2.8
	10-49 person	8	7.6
	50-249 person	9	8.6
	250-999 person	28	26.7
	>999 person	57	54.3

Table 2: Respondents' information

Respondent Profile		(n = 105)	
Attributes	Distribution	Frequency	Percentage
Leadership Level	Middle	62	59.1
	Top	43	40.9
Education	Bachelor degree	44	41.9
	Master's degree	58	55.2
	Doctoral degree	3	2.9
Gender	Male	100	95.2
	Female	5	4.8

The survey for this study was partitioned into three parts. Nine elements of knowledge management (KM) were placed in the initial section. Six items of the absorptive and transformative dynamic capacities (DC) characteristics were positioned in the second part. The remaining portion of the poll pertained to the quantification of green process innovation (GI-PROCESS), which encompassed five specific items, assessed aspects of the recycling process: energy efficiency, material efficiency, management system, and green supply chain. Green product innovation (GI-PRODUCT) was assessed using three elements that judged progress in emission reduction and energy transition. These measurements were derived from (Chen et al., 2006). A five-point Likert scale was used to evaluate the survey items with 05 indicating strongly agree and 01 indicating strongly disagree. A pilot was conducted with a sample of 30 respondents to verify the accuracy and dependability of the items, which were accepted with slight modifications (Hinkin, 1998).

The PLS-SEM approach was used to examine the connections between KM, DC, GI-PROCESS, and GI-PRODUCT, which was recognized as suitable for exploratory research (Hair et al., 2022). The PLS-SEM is a vital tool to use a robust alternative methodology based on Ordinary Least Squares (OLS) regression characteristics. Its ability to handle complex models with latent constructs and analyze predictive models with small datasets provides a significant advantage. Furthermore, PLS-SEM effectively estimates intricate cause-effect relationships involving latent variables, making it widely applicable across various disciplines.

RESEARCH FINDINGS

Right at the outset, the dependability and accuracy of the measurement model were measured (Hair et al., 2022), through reliability and validity assessments. The reliability of all items was checked using Composite Reliability (CR) and Cronbach Alpha (CA), followed by calculating the standardized factor loading values for all items to establish convergent validity. The values surpassed the recommended threshold of 0.70, demonstrating satisfactory convergent validity. Additionally, the Average Variance Extracted (AVE) values for all variables exceeded the required threshold of 0.50, providing further evidence of the convergent validity of the measurement model. Table 3 displays the comprehensive outcomes for GI-Product, GI-Process, DC, and KM.

Table 3: Reliability and validity of the constructs

Latent Constructs	Cronbach's Alpha (CA)	Composite reliability (rho_a)	Composite reliability (rho_c)	AVE
DC	0.910	0.911	0.931	0.691
GI-Process	0.807	0.811	0.867	0.566
GI-Product	0.836	0.850	0.900	0.749
KM	0.879	0.900	0.903	0.514

Table 4 presents the result of common method bias, represented by VIF, indicating values below the threshold of 3.3, suggesting no significant correlation among study variables and implying that common method bias is not a concern.

Table 4: Construct evaluation and inner VIF

Latent Constructs	Loading Factors	t-value	p-value	VIF
Knowledge management (KM)				
KM -> DC	0.823	27.174	0.000	1.000
KM -> GI-Process	0.221	1.711	0.087	3.096
KM -> GI-Product	0.007	0.055	0.956	3.096
Dynamic capabilities (DC)				
DC -> GI-Process	0.521	4.140	0.000	3.096
DC -> GI-Product	0.569	4.216	0.000	3.096

The discriminant validity (DV) was assessed using the Fornell-Larcker technique and the Heterotrait-Monotrait ratio (HTMT) (Hair et al., 2022). The Fornell-Larcker method revealed that the square root of the average variance extracted (AVE) exceeded the correlations in both directions. Conversely, the HTMT method found all values below the recommended threshold of 0.85. Thus, the study shows no issues with discriminant validity. Results are presented in Tables 5 and 6.

Table 5: Fornell-locker criterion for discriminant validity

	1	2	3	4
1 DC	0.831			
2 GI-Process	0.703	0.752		
3 GI-Product	0.575	0.602	0.866	
4 KM	0.823	0.650	0.476	0.717

Table 6: HTMT ratio for discriminant validity

	1	2	3	4
1 DC				
2 GI-Process	0.818			
3 GI-Product	0.640	0.729		
4 KM	0.892	0.745	0.530	

In the structural model to validate the relationships between dependent and independent variables, the verification process involved evaluating three key metrics: R², which measured the model's explanatory power; Q², which assessed its predictive accuracy; and the path coefficient values of the research model (Hair et al., 2022). The R² values of 0.25, 0.50, and 0.75 indicated weak, moderate, and high levels of predictive accuracy respectively. The coefficient of determination (R²) for DC was 0.677, showing a moderate level of correlation. The GI-Process showed R² value of 0.510, indicating a

moderate level of correlation. Lastly, the GI-Product had R^2 value of 0.331, suggesting an adequate level of correlation. The model's predictive accuracy was evaluated using the Stone-Geisser (Q^2) metric, which is considered a more reliable measure than R^2 (Sarstedt et al., 2020). This was achieved using blindfolding techniques. Q^2 values of 0.02, 0.15, and 0.35 signify weak, moderate, and substantial levels of predictive accuracy, respectively. The Q^2 value for DC was 0.660, indicating strong performance. The GI-Process recorded a Q^2 value of 0.394, representing a good result, while the GI-Product had a Q^2 value of 0.197, reflecting a moderate outcome. The results indicate that the endogenous factors possess a high level of predictive validity, as all values were above zero (Hair et al., 2022). Table 7 presents all these findings.

Table 7: Explanatory and predictive power

Latent Constructs	R-square	Q-square
DC	0.677	0.660
GI-Process	0.510	0.394
GI-Product	0.331	0.197

The importance of the hypotheses was assessed using a bootstrapping technique with 5000 sub-samples. A t-value exceeding 1.96 and a p-value below 0.05 were benchmarks for the β -value. The results indicated a strong correlation between DC and GI-Process, shown by a β -value of 0.521 and a t-value of 4.140, confirming the hypothesis (H4). Additionally, a strong correlation was seen between DC and GI-Product, with a β -value of 0.569 and a t-value of 4.216, supporting hypothesis (H5). A strong correlation between KM and DC was also evident, with a β -value of 0.823 and a t-value of 27.174, supporting hypothesis (H3). However, the correlation between KM and GI-Process was positive but not statistically significant, with a β -value of 0.221 and a t-value of 1.711, leading to the rejection of hypothesis (H1). Similarly, the positive correlation between KM and GI-Product was not statistically significant, with a β -value of 0.007 and a t-value of 0.055, resulting in rejecting the hypothesis (H2).

Table 8: Result of hypothesis testing

	Hypothesized path	b value	t-value	p-value	Decision
Direct Effect					
H4	DC -> GI-Process	0.521	4.140	0.000	Accepted
H5	DC -> GI-Product	0.569	4.216	0.000	Accepted
H3	KM -> DC	0.823	27.174	0.000	Accepted
H1	KM -> GI-Process	0.221	1.711	0.087	Rejected
H2	KM -> GI-Product	0.007	0.055	0.956	Rejected
Mediation Analysis (Total & Indirect effects)					
H4a	KM -> GI-Process	0.429	4.028	0.000	Accepted (Full Mediation)
	KM -> DC -> GI-Process	0.429	4.028	0.000	
H5a	KM -> GI-Product	0.468	4.038	0.000	Accepted (Full Mediation)
	KM -> DC -> GI-Product	0.468	4.038	0.000	

The mediating role was studied using a two-step approach (Nitzl et al., 2016). First, the direct impact of exogenous variables on the endogenous variable was assessed. Next, the direct effects among exogenous variables were examined, expected to be significant without the mediator. This study analyzes two mediating effects: KM and GI-Process mediated by DC and KM and GI-Product mediated by DC. Results showed significant indirect effects of KM with β -value = 0.429 for GI-Process and β -value = 0.468 for GI-Product. Analyzing the combined direct and indirect effects ($a*b*c'$), the researchers concluded full mediation for Hypotheses H4a and H5a. Table 8 presents all the details of hypotheses testing.

DISCUSSION

This study employs dynamic capability theory to construct a conceptual framework that examines the connections between GI-Product, GI-Process, DC, and KM in the upstream oil and gas sector. This area has received limited academic attention in the past. Data was gathered from high-ranking and intermediate-level executives in Indonesia to test the hypotheses.

Right at the outset, this study contradicts the idea that KM has no substantial influence on GI-Process ($\beta = 0.221$) and GI-Product ($\beta = 0.007$), hence rejecting the hypotheses (H1) and (H2). This contradicts the conclusions of prior research conducted by (Shahzad et al., 2020), and (Wang et al., 2022), all of whom had discovered a favorable correlation between knowledge management and green product creation. The correlation between knowledge management and innovation varies between industries and organizational contexts, as evidenced by studies undertaken by (Obeidat et al., 2016). Furthermore, this research reinforces the relationship between Knowledge Management (KM) and Decision-Making Capability (DC), with a coefficient (β) of 0.823, providing strong empirical support for the hypothesis (H3). Consistent with prior studies by (Najmi et al., 2018), these results further confirm a positive correlation between knowledge management and dynamic capabilities. The findings indicate that DC benefits the GI-Process ($\beta = 0.521$), thus supporting the hypothesis (H4). This finding aligns with prior research (Zhu & Wang, 2023), which similarly discovered a good correlation between dynamic skills and green process innovation across different industries. Finally, the study findings provide additional evidence that DC benefits GI-Product ($\beta = 0.569$), supporting the hypothesis (H5). The findings of (Qiu et al., 2019) support this observation, as they also identified a positive correlation between dynamic capabilities and green product innovation.

The concept of knowledge management has also gained significant attention in the business world as it is believed to be a critical factor in enhancing organizational performance and competitiveness. Effective knowledge management can significantly enhance the performance of an organization, but it is crucial that it is aligned with the

core business objectives to ensure maximum impact. This is especially significant in industries like the oil and gas sector, where the primary focus is on hydrocarbon production. In this context, it is crucial that the knowledge management strategies and initiatives are tailored to suit the specific needs and goals of the core business. This means that the knowledge management content must be relevant and applicable to the production of hydrocarbons rather than focusing on other areas that may not align with the core business objectives. As a result, while knowledge management may lead to improvements in hydrocarbon-related innovation, it may not necessarily facilitate green innovation in the oil and gas sector.

This study demonstrates that the influence of knowledge management on green innovation in Indonesia's upstream oil and gas sector is restricted. This discovery aligns with (Ode & Ayavoo, 2020), which similarly concluded that the mere dissemination of knowledge is insufficient to directly and significantly stimulate creativity in underdeveloped nations. However, the impact of knowledge on innovation is only apparent in an indirect manner, as it is mainly observed through its utilization in the management process. In a similar vein, (Zhang et al., 2022) argue that sharing knowledge does not directly influence the discovery and commercialization of innovation. However, the influence of spreading knowledge on innovation relies on intellectual capital, encompassing human, structural, and relational capital.

The study also demonstrates that knowledge management may not significantly influence green innovation since it is more focused on supporting the core hydrocarbon-producing business, contrary to the goal of reducing carbon footprint. The findings align with (Obeidat et al., 2016) observations that the relationship between knowledge management and innovation is inconsistent across different industries and organizational contexts. (Porter, 1990) also emphasized the influence of location on companies' capabilities, thereby affecting their competitive advantage. Last, but not the least, this research confirms the validity of a knowledge-practice framework rooted in dynamic capability theory. The proposed model highlights the significance of dynamic capability in facilitating knowledge management and driving green innovation, particularly in developing nations like Indonesia. The findings align with (Shuen et al., 2014) predictions that dynamic capability is crucial in the oil and gas industry.

It is important to note that the oil and gas sector is facing increasing pressure to adopt sustainable and environmentally friendly practices. However, implementing green innovation requires more than just knowledge management. It requires a holistic approach involving a combination of technology, processes, and culture. Therefore, it can be argued that for companies in the oil and gas sector to develop green innovation, they need to go beyond knowledge management and consider other aspects crucial for driving sustainable practices.

CONCLUSION

This study thus sheds light on the role of knowledge management in the oil and gas sector, which faces a significant challenge in developing green innovation. The oil and gas sector prioritizes knowledge management strategies that align with the core business objective of hydrocarbon production. While knowledge management can certainly lead to advancements in hydrocarbon-related innovation, it may not necessarily promote environmentally sustainable practices. This study attempted to examine how organizations operating in oil and gas sector can adopt a holistic approach to foster environmental sustainability. Through several novel outcomes, this study offers insights into the relationship between knowledge management and the green innovation process, with dynamic capability mediating. The findings demonstrate that although there is no direct link between knowledge management and the green innovation process, dynamic capability plays a crucial part in shaping the process through full mediation. This emphasizes the significance of dynamic capability in supporting the green innovation process, which has important implications for organizations striving to improve their environmental sustainability efforts.

Based on the Indonesian upstream oil and gas industry, this study framed hypotheses to test the extent to which knowledge management can directly influence green innovation, and whether dynamic capabilities can significantly mediate the effect of knowledge management. The findings highlight that knowledge management alone is inadequate to achieve substantial green innovation without dynamic capabilities. Therefore, companies in the industry must actively develop and nurture their dynamic capabilities to apply knowledge effectively toward sustainable innovation. The research emphasizes a broader implication for the industry: embracing knowledge management strategies and cultivating dynamic capabilities to translate knowledge into environmentally friendly practices and products. This study provides a framework for understanding how these essential concepts interact and pave the way for greener innovations necessary for the long-term sustainability of the oil and gas industry. This finding emphasizes the importance of implementing dynamic capability within the upstream oil and gas sector to achieve greener outcomes.

The study also entails that the rising dominance of clean energy, upstream oil and gas companies must prioritize implementing eco-friendly innovations to remain competitive and resilient in fluctuating commodity prices and growing demand for green energy (Beck et al., 2021). Integrating clean energy into primary operations can transform upstream oil and gas companies into integrated energy providers rather than solely relying on hydrocarbon energy production. Finally, governments should recognize the importance of conserving natural and energy resources in the current era of energy crises and resource scarcity. Offering tax exemptions and incentives, such as tax breaks for using renewable energy sources, implementing energy-efficient practices,

and reducing waste, can encourage individuals and businesses to reduce their use of these resources. In addition, professionals should also recognize the potential advantages of adopting sustainable practices. Organizations can become more resilient and adaptable by increasing efficiency and being better equipped to handle unexpected changes. This can lead to long-term success and sustainability.

The study identifies potential areas for further investigation in the future. Due to limited resources and time, a cross-sectional approach was utilized in this study, but a longitudinal approach would yield more comprehensive results and a more decisive conclusion. The scope of this research was limited to the upstream oil and gas sector in Indonesia, but future studies could expand to other regions for a more accurate outcome. Comparing the results of this study with those of other countries could also provide valuable insights. Additionally, it must be acknowledged that various cultural, social, ethical, environmental, and political factors may influence the results in different contexts. Therefore, it is recommended that this model be tested in other business sectors to enhance its generalizability.

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