DRIVING BUSINESS SUSTAINABILITY WITH PREDICTIVE TECHNOLOGY: A QUALITATIVE STUDY OF MALAYSIA'S OIL AND GAS SUPPORT SERVICES

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Abstract

This study focuses on the role of predictive technology in enhancing business sustainability within the oil and gas support service industry. The oil and gas industry is under increasing pressure to improve its environmental and social performance while maintaining profitability. Predictive technology, which involves the use of data analytics, artificial intelligence, and machine learning, has the potential to enhance business sustainability by improving operational efficiency, reducing costs, and minimizing environmental impacts. This study examines the imperatives of predictive technology adoption and implementation, as well as the challenges and opportunities associated with its use. A qualitative approach is used to investigate the use of predictive technology within a specific oil and gas support service company. Data were collected using semi-structured interviews and document analysis to meet the research objectives. Nine participants of this study were selected comprising managers and technical experts from the oil and gas support services industry in several cities within Malaysia. The findings of the study indicate that the industry players perceived predictive technology can significantly improve business sustainability by several ways namely increase operational efficiency, cost savings, better asset management, better service to the customer, enable well-informed decision and better risk management. This study proposes a framework of predictive technology implementation toward enhancing business sustainability from the oil and gas support services industry, which may assist industrialists in planning for effective technology adoption. The findings of this study limits generalizability to other business environment, which is common for qualitative research. While the study primarily focuses on an exploratory study of predictive technology's imperatives, further research could examine empirically to a larger sample, the factors found by this research.

Keywords: Predictive technology, Business sustainability, Oil and gas sector, Support service industry, Artificial intelligence.

1.0 INTRODUCTION

The importance of sustainability in the oil and gas industry cannot be overstated, as the sector faces mounting challenges from volatile commodity prices, complex operational risks, and increasing pressure for environmental responsibility. The industry is under increasing scrutiny from regulators, investors, and society as a whole to reduce its carbon footprint and mitigate environmental impact through Environmental, Social, and Governance (ESG) initiatives. Failure to address these sustainability concerns may result in significant reputational damage and financial consequences, driving companies to rethink their business strategies. In the oil and gas support services industry, it is believed that advancement in technology can help enhance business sustainability by improving operational efficiency, reducing costs, and minimizing environmental impacts.

Meanwhile, the Fourth Industrial Revolution has brought about significant technological advancements that have had a profound impact on industries worldwide, fundamentally transforming how businesses operate through the integration of digital technologies, automation, and data-driven decision-making (McKinsey, 2022). Artificial Intelligence and Internet-of-Things technologies have revolutionized business operations by providing enhanced understanding of customer needs, increased efficiency, and improved effectiveness in business processes. The rise of AI and IoT fundamentally transforming company operations. Predictive technology, a subset of AI, has been identified as a transformative technology that can create significant business value for companies across various sectors (Aljohani, 2023). It has gained considerable attention as a tool for enhancing business sustainability and improving decision-making processes.

The global market for AI applications in oil and gas value chains is projected to reach nearly USD 3 billion in 2024 and USD 5.2 billion in 2029, reflecting the sector's growing investment in these technologies (The Business Research Company, 2024). In the oil and gas industry, predictive technology has been identified as a valuable tool for enhancing sustainability through improved operational efficiency and reduced environmental impact. According to a Boston Consulting Group report, AI applications can reduce production and maintenance costs by up to 20% through predictive maintenance and optimized workflows (2024). Companies implementing IoT-driven predictive maintenance can reduce maintenance costs by up to 40% and decrease downtime by as much as 50%, significantly impacting operational efficiency and profitability. Therefore, there is growing interest among industry players to leverage predictive technology to enhance sustainability while maintaining operational excellence (Derrick, 2024).

In Malaysia, the oil and gas industry has played a pivotal role in the country's economic transformation since the discovery of significant offshore reserves in the 1970s. The industry contributes approximately 20% to Malaysia's annual GDP, with the oil and gas services and equipment sector expected to contribute between RM40-50 billion by 2030 (MIDA, 2025). Malaysia's national oil company, PETRONAS, has been at the forefront of digital transformation, implementing AI-infused predictive analytics solutions that have achieved significant cost savings and operational improvements. The sector has been instrumental in driving economic growth, facilitating technology transfer, and developing a highly skilled workforce while promoting local business growth in supply chain and support services (Research And Markets; 2021).

According to a report by the International Energy Agency (IEA), the oil and gas industry has been slow in adopting digital technologies, including predictive maintenance, due to its conservative culture and lack of expertise in the area (IEA, 2017). This is consistent with findings by a study conducted by McKinsey & Company, which found that only 20% of oil and gas companies have implemented predictive maintenance technologies into their operations (2019). This development underscores the industry's relatively slow pace in adopting these transformative technologies. It also emphasizes the substantial room for growth and optimization, as a vast majority of companies in the sector have yet to fully harness the potential benefits of predictive technology for enhancing operational efficiency, reducing costs, and ultimately bolstering business sustainability.

Similarly, a survey of Malaysian oil and gas companies by The National revealed that only 44% of respondents were using predictive maintenance technologies, while 32% were still relying on corrective maintenance (2020). This suggests that there is still a long way to go for the industry to fully embrace predictive technology and its potential benefits. One of the main challenges in adopting predictive technology is the high initial cost of implementation. A study by ResearchAndMarkets.com highlights that many companies in the oil and gas industry are facing financial pressures and are hesitant to invest in new technologies (ResearchAndMarkets.com, 2021). Additionally, there is a shortage of skilled professionals in the area, which further inhibits the adoption of predictive technology (The National, 2020).

Based on the issues and challenges discussed, this research aims to investigate the perceived imperatives of adopting predictive technology towards business sustainability among oil and gas support services industry in Malaysia. Overall, this research aims to provide insights into the perceived importance of predictive technology in enhancing the sustainability and competitiveness of the oil and gas support services industry in Malaysia.

2.0 LITERATURE REVIEW

2.1 Oil and Gas Industry in Malaysia

The oil and gas support services industry plays a crucial role in supporting the operations of the oil and gas (O&G) industry globally and in Malaysia. As an essential component of the broader O&G sector, support services encompass a range of activities that facilitate exploration, production, refining, transportation, and distribution of oil and gas resources (Schaefers, 2020; World Bank, 2021). According to the International Energy Agency (IEA), oil and gas will continue to be the primary sources of energy for the foreseeable future, despite the increasing focus on renewable energy alternatives (2021). This underscores the continued importance of the O&G industry and, by extension, the support services sector.

However, the O&G industry faces emerging issues in business sustainability that necessitate careful attention and proactive measures. One of the key challenges is the increasing emphasis on environmental sustainability and the need to transition towards a low-carbon economy (IEA, 2018).

2.2 Emerging Issues of Business Sustainability in Oil and Gas Industry

Globally, one of the primary emerging issues in the O&G industry is the increasing emphasis on environmental sustainability and the need to transition towards a low-carbon economy. The Environmental, Social and Governance (ESG) world-wide initiatives established by the United Nations has imposed requirements for industries to reduce greenhouse gas emissions and mitigate the environmental impact of its operations (IEA, 2017). This is driven by global climate change concerns and the recognition of the urgent need to limit global warming. The O&G industry is being called upon to embrace cleaner technologies, increase energy efficiency, and invest in renewable energy sources (IEA, 2021).

In Malaysia, the O&G industry also faces similar challenges in terms of environmental sustainability. The country has committed to reducing its greenhouse gas emissions intensity by 45% by the year 2030, as part of its commitment to the Paris Agreement (IEA, 2021). This poses a significant challenge for the industry, as it requires a transition towards cleaner energy sources and sustainable practices. The O&G industry in Malaysia needs to align with the country's sustainability goals and adopt measures to reduce its environmental footprint.

Another emerging issue in business sustainability for the O&G industry is the volatility of oil and gas prices (IEA, 2018). Fluctuating prices can have a significant impact on the profitability and viability of both upstream and downstream operations (IEA, 2020). Companies in the O&G industry need to navigate these market dynamics and develop strategies to optimize efficiency, reduce costs, and maintain profitability during periods of price volatility. Additionally, the O&G industry is facing increasing scrutiny from stakeholders regarding social and governance aspects. There is a growing demand for transparency, ethical practices, and responsible resource management. The industry needs to address issues related to community engagement, stakeholder consultation, human rights, and corporate governance to ensure sustainable and responsible operations.

To address these emerging sustainability issues, the O&G industry is gradually transitioning towards a more sustainable and diversified energy mix. Companies are investing in research and development of clean energy technologies, such as renewable energy, energy storage, and carbon capture and storage (IEA, 2021). Furthermore, there is a growing focus on improving energy efficiency, optimizing operational processes, and enhancing environmental management practices.

2.3 Business Sustainability

Business sustainability is a multidimensional concept that encompasses the integration of economic, environmental, and social considerations in organizational practices (Elkington, 1997; Arinze et al., 2024). In the context of the oil and gas support services industry, conceptualizing business sustainability involves understanding how organizations in this sector can achieve long-term viability, resilience, and responsible stewardship of resources. The concept of business sustainability in the oil and gas support services industry recognizes the interconnectedness of these dimensions and the need for organizations to balance economic, environmental, and social considerations (Polese et al., 2021). Economic

sustainability in the oil and gas support services industry entails the pursuit of profitability, growth, and financial performance. This includes optimizing operational efficiency, reducing costs, and maximizing returns on investments.

Additionally, environmental sustainability is a crucial aspect of business sustainability in the oil and gas support services industry. Given the industry's significant impact on the environment, organizations must proactively address environmental challenges and minimize their ecological footprint (Ioannou & Serafeim, 2022). This involves adopting sustainable practices, such as reducing greenhouse gas emissions, conserving energy, implementing waste management strategies, and promoting environmental stewardship (Karuppiah et al., 2021). On the other hand, social sustainability focuses on the industry's relationship with its stakeholders, including employees, local communities, and broader society. It encompasses fair and ethical labour practices, community engagement, social responsibility, and contributing positively to social development. Organizations in the oil and gas support services industry must prioritize the well-being and safety of their workforce, engage with local communities, and contribute to social initiatives (Petrov & Kozlov, 2025).

Achieving business sustainability requires a proactive and holistic approach that aligns organizational strategies, policies, and practices with the principles of sustainability (Karuppiah et al., 2021). By conceptualizing business sustainability in the oil and gas support services industry, this study aims to highlight the importance of integrating predictive technology as a means to enhance sustainability outcomes (Ioannou & Serafeim, 2022).

In the digital economy, businesses are increasingly expected to demonstrate their commitment to ESG principles. ESG considerations encompass environmental stewardship, social responsibility, and effective corporate governance (Polese et al., 2021). Businesses are under scrutiny to minimize their environmental impact, address social issues, and maintain strong governance practices. Technological advancements, market disruptions, and changing consumer behaviours create volatile business environments. Uncertainties such as economic downturns, trade tensions, and geopolitical shifts can pose challenges to business sustainability. Companies need to anticipate and adapt to economic uncertainties by implementing flexible strategies, diversifying revenue streams, and building resilience in their operations (Petrov & Kozlov, 2025).

The increasing integration of digital technologies into business processes and operations has significant implications for sustainability. On one hand, digitalization offers opportunities for increased efficiency, resource optimization, and reduced environmental impact (Anderson & Eriksson; 2023). For example, digital technologies enable remote monitoring, data analytics, and smart systems that can enhance energy management, waste reduction, and supply chain optimization. On the other hand, digitalization can lead to new sustainability challenges, such as energy consumption from data centers, electronic waste, and privacy concerns (Arinze et al., 2024). Businesses must navigate these challenges by adopting sustainable practices in their digital operations and addressing the potential environmental and social impacts of digital technologies.

2.4 Predictive Technology

Predictive technology refers to the use of advanced analytics, machine learning algorithms, and data-driven models to forecast future events, outcomes, and trends based on historical data patterns (Arinze et al., 2024; R Azmi et al., 2024). Based on the AI technology, predictive technology involves the use of data analytics and advanced algorithms to forecast future outcomes and make proactive decisions. By analyzing historical and real-time data, predictive models can identify patterns, trends, and correlations, enabling organizations to anticipate and respond to potential challenges and opportunities (World Economic Forum, 2023). The power of predictive technology lies in its ability to extract valuable insights from vast amounts of data, providing organizations with a competitive edge in a rapidly changing business landscape.

One of the key applications of predictive technology is predictive maintenance. By analyzing real-time data from sensors and equipment, AI algorithms can detect patterns and anomalies, enabling proactive maintenance and reducing the risk of equipment failure or downtime. Predictive maintenance helps improve operational efficiency, minimize costs, and extend the lifespan of assets (Deloitte, 2019). Organizations can strategically allocate resources for maintenance activities, maximizing the utilization of assets while minimizing the impact on production schedules.

2.5 Challenges and Opportunities of Predictive Technology Adoption

The adoption of predictive technology is influenced by a range of factors that can either facilitate or hinder its implementation. Technological readiness of organizations plays a significant role in the adoption of predictive technology. It includes factors such as the availability and quality of data, compatibility with existing systems, and technical infrastructure (Arinze et al., 2024). Organizations need to ensure that they have the necessary data collection mechanisms in place, robust IT infrastructure, and the ability to integrate predictive technology with existing systems to fully leverage its potential.

Next, organizational culture and change management practices are critical in determining the success of predictive technology adoption. A supportive culture that values innovation, data-driven decision-making, and continuous improvement fosters a conducive environment for the adoption of predictive technology (Chong et al., 2021). Effective change management strategies, including stakeholder engagement, communication, and training programs, are essential to address resistance to change and ensure a smooth transition to predictive technology.

Additionally, the commitment of organizational leadership and their strategic vision play a crucial role in driving the adoption of predictive technology. Strong leadership support provides the necessary resources, guidance, and alignment of organizational goals with the adoption of predictive technology (Anderson & Eriksson; 2023; R Azmi et al., 2024). Leaders need to articulate a clear vision for the adoption of predictive technology and communicate its benefits to gain buy-in from stakeholders at all levels.

Financial considerations, including the cost of implementing and maintaining predictive technology, influence adoption decisions. While predictive technology offers long-term benefits, organizations need to evaluate the return on

investment and weigh the costs against potential savings and improvements in operational efficiency (R Azmi et al., 2024). Financial planning, budget allocation, and risk assessment are essential to ensure the financial viability of predictive technology adoption.

On the other hand, the availability of technical expertise and workforce skills is critical for the successful adoption of predictive technology. Organizations need to assess their existing skill sets and identify any gaps that may hinder the effective utilization of predictive technology (Lee et al., 2019; Aljohani, 2023). Training programs, hiring strategies, and partnerships with educational institutions can help develop the necessary technical skills among employees to effectively operate and maintain predictive technology systems. Moreover, regulatory requirements and industry standards influence the adoption of predictive technology in the oil and gas industry. According to Chen et al. (2020) organizations need to ensure compliance with relevant regulations, data privacy, and security standards when implementing predictive technology.

2.6 Value Propositions of Predictive Technology Adoption among the Oil and Gas Support Services Industry

Several companies in the oil and gas support services industry have recognized the potential of predictive technology and have successfully implemented it in their operations. These case studies provide valuable insights into the benefits and challenges associated with the adoption of predictive technology.

Shell, a global energy company, has embraced predictive technology to enhance its asset management practices. By leveraging advanced analytics and machine learning algorithms, Shell has implemented predictive maintenance strategies to optimize equipment performance and reduce unplanned downtime (Shell, 2020). The adoption of predictive technology has resulted in improved asset reliability, reduced maintenance costs, and enhanced operational efficiency.

One of the world's largest oilfield services companies, Schlumberger, has utilized predictive technology to optimize drilling operations. Through the integration of real-time data acquisition, predictive analytics, and automation, Schlumberger has improved drilling efficiency and accuracy. The application of predictive technology has enabled proactive decision-making, reduced drilling risks, and enhanced overall operational performance (Schlumberger, 2021).

Another example of an oil and gas company adopting predictive technology is is Halliburton, a leading provider of products and services to the energy industry. It has embraced predictive technology to optimize well production and maintenance. By employing advanced data analytics and machine learning algorithms, Halliburton has implemented predictive maintenance strategies to predict equipment failures and schedule maintenance activities proactively (Halliburton, 2021). The adoption of predictive technology has resulted in reduced downtime, improved equipment reliability, and enhanced production efficiency.

Last but not least, Petronas, Malaysia's national oil and gas company, has been actively investing in predictive technology to improve its operations. Through the application of artificial intelligence and predictive analytics, Petronas has implemented real-time monitoring and predictive maintenance of assets, enabling proactive equipment management and optimization (Petronas, 2023). The adoption

of predictive technology has led to increased asset uptime, improved safety, and cost savings for Petronas.

3.0 RESEARCH METHODOLOGY

Exploratory research is the foundation of a good study, and it is normally flexible, unstructured and qualitative (Hair, 2019) Qualitative research designs are particularly suited for exploring complex phenomena, understanding subjective experiences, and generating in-depth insights (Creswell & Creswell, 2022). By employing qualitative methods, researcher aims to capture rich and contextualized data that can uncover nuances and provide a deeper understanding of the research topic. This study seeks to explore and gain better understanding of a new phenomenon among oil and gas support service industry on implementing predictive technology toward improving business sustainability. A case study approach is selected as it allows for a comprehensive analysis of real-world situations and enabling the examination of multiple issues pertaining to implementation of predictive technology and business sustainability within a specific organizational context (Creswell & Creswell, 2022), that is among oil and gas support services industry.

3.1 Case Study Method

A case study method is a valuable research approach utilized to investigate the impact of predictive technology on business sustainability in the oil and gas support services industry. It involves a detailed and holistic investigation of a particular case or multiple cases to gain a comprehensive understanding of the research topic (Yin, 2018). It offers an in-depth exploration of real-life situations, allows for a comprehensive analysis and provides contextualized understanding (Creswell & Creswell, 2022) of how predictive technology adoption may influence business sustainability. These organizations serve as representative samples to provide insights into the adoption of predictive technology and its impact on business sustainability. The case study approach is justified by its practical relevance to industry practitioners and decision-makers. By studying real-life cases within the oil and gas support services industry, the findings of the research can provide valuable insights and recommendations for organizations considering the adoption of predictive technology. The case study approach facilitates the identification of best practices, lessons learned, and potential strategies for enhancing business sustainability through predictive technology adoption (Eisenhardt & Graebner, 2007; Flyvbjerg, 2006).

3.2 Data Collection

The target participants for this research study includes professionals working in the oil and gas support services industry in Malaysia. These professionals hold positions such as General Managers, managers, department heads and technical experts of oil and gas support services in located in selected major cities in Malaysia – Klang Valley, Johor Baru (southern peninsula) and Alor Setar (northern peninsula). Their insights and perspectives are crucial in understanding the strategic considerations, challenges, and benefits (Hair, 2019) associated with the integration of predictive technology for business sustainability. This study utilizes purposive

sampling to select research participants who possess relevant knowledge and experience, and play key roles in decision-making processes and operational activities (Eisenhardt & Graebner, 2007) related to predictive technology adoption and its impact on business sustainability. Purposive sampling, also known as judgmental or selective sampling, involves intentionally selecting participants based on predetermined criteria to ensure they can provide valuable insights into the research topic (Patton, 2002; Oranga & Matere, 2023).

For the purpose of this research, interviews with key industry players, including senior managers, department heads, and technology experts of oil and gas support services companies, are chosen as a primary data collection method. Through semi-structured interviews detailed insights from the key players in the oil and gas support services industry were obtained. For example, in this study participants are asked to respond to questions like, “How do oil and gas support services industry players perceive the imperative of predictive technology in enhancing business sustainability? The use of open-ended questions in semi-structured interviews allows for in-depth discussions, providing rich qualitative data that captures the nuances of the research topic (Bryman, 2016). To complement data collected through interviews, document analysis was also performed. Relevant documents, such as company annual reports, company web sites, and publications, were reviewed to gather additional insights into the current state of predictive technology adoption in the oil and gas support services industry. The use of multiple data collection methods allowed for triangulation, ensuring the reliability and validity of the findings (Hair, 2019; UNEP, 2020).

3.3 Data Analysis

For this study, data are analyzed through thematic analysis to identify recurring themes and trends in interview transcripts, and extract meaningful insights for a robust examination of the impact of predictive technology on business sustainability. Thematic analysis involves identifying and organizing patterns or themes within the data. Researchers systematically analyze the data, categorize information, and extract key themes that emerge from the participants' responses (Braun & Clarke., 2006; Oranga & Matere; 2023). This approach allows for a comprehensive exploration of the data and provides insights into participants' perspectives and experiences (Creswell & Creswell, 2022).

4.0 RESULTS

4.1 Participant Profile

Based on document analyses obtained from participants’ companies published reports, this section provides an in-depth profile of the individual participants involved in the research. These key stakeholders represent various roles and expertise within the oil and gas industry, offering valuable insights into their respective companies, years of operation, and the products or services they offer. Table depicts the profile of participants oif this study.

Table 1: Participant Profile

Participants	Designation	Number of employees	Product/Services
P1	General Manager for Remote Operation	50,000	Upstream Operation
P2	Local Agent in Malaysia	50	AI Predictive Maintenance Technology
P3	Technical Principal	1900	Refinery O&G business
P4	Technical Principal	4,333	Fertilizer business
P5	Project Manager	200	Engineering consultant to Petronas
P6	Operation Maintenance Manager	2087	Operation & Maintenance for Upstream Business
P7	Head of Asset Delivery standard	50,000	International Business
P8	Operational Excellence	50,000	Operational Efficiency and Continuous Improvement
P9	General Manager for International Projects	2087	International Upstream Businesses

4.2 Industry Players Perception of Predictive Technology in Enhancing Business Sustainability

The investigation into industry players' perception revealed a widespread recognition of the significance of predictive technology in business sustainability as discussed below:

a) Improving operational efficiency

Participants expressed strong agreement on the transformative potential of predictive technology and its ability to revolutionize various aspects of their operations. For example, as stated by participants:

P1*:"Predictive technology plays a vital role in enhancing business sustainability for oil and gas support services industry players. Companies like Petronas and service providers have recognized the value of integrated operations, where predictive technology is a crucial component. It is not just about connecting people, but also about incorporating software solutions and workflow processes. By leveraging predictive technology, companies can analyze data from the past 20-30 years to predict outcomes and optimize operations."*

P2: *"Industry players recognize the significance of predictive technology in driving business sustainability. The continuous evolution of predictive technologies improves speed, accuracy, efficiency, and reliability"*

P4: *"For example, in our design process, we utilize tools like Clash Check in 3D modelling software to avoid clashes and ensure smooth fabrication and installation. This predictive technology enhances efficiency and reduces the need for rework, ultimately improving business sustainability."*

b) Cost savings through asset performance

Six participants emphasized the significant impact of optimizing asset performance through the adoption of predictive technology. The integration of predictive maintenance practices allows organizations to unlock the full potential

of their assets, leading to improved efficiency, cost savings and prolonged asset lifespans, as illustrated below:

P3**:***"Our company's strategy focuses on establishing a win-win scenario. By adopting predictive technology, we aim to extend maintenance intervals, resulting in cost savings and better asset management. Simultaneously, we believe that implementing predictive technology will enhance our industry's competency and knowledge base. This strategy involves engaging with service providers who can assist us in implementing and developing predictive maintenance solutions tailored to our specific needs."*

P5: *"However, for new facilities, integrating digital monitoring systems from the outset is more feasible. These challenges are also opportunities for industry players to collaborate on asset management, optimize costs, and develop more mature and affordable digital solutions."*

c) Better service to the customer

Predictive maintenance is perceived as a key enabler for delivering better service to customers as evident in the responses below:

P7: *"Certainly. Predictive analysis has transformed how we operate. In the case of my company, the adoption of predictive technology has been vital. Transitioning from traditional charts to smart transmitters and integrated DCS systems streamlined operations. These advancements empower us to predict field behaviour, thereby enhancing equipment lifespan and reducing operational downtime, hence providing a more reliable service to our customers. An interesting example is our approach to the Resab well, where we combined innovation and technological optimization to achieve platform size reduction while maintaining efficiency."*

P8: *"Indeed, this initiative reflects our adaptability to fluctuating oil prices. To enhance cash flow, we're simplifying our facilities. This involves optimizing the redundancy of equipment as production declines. By reducing operational maintenance and boosting efficiency, we align with sustainable practices. Embracing digital solutions, like the Protean platform, also reduces costs and enhances service effectiveness to our customers."*

d) Well-informed decision

Participants believe that predictive maintenance facilitates well-informed decision-making by providing timely and accurate insights into equipment health, thereby enabling more effective resource allocation and risk management, as indicated in their responses:

P1**:** *""Our company is focused on a progressive approach to adopting predictive technology. We have moved from corrective maintenance to preventive maintenance and now to predictive maintenance. Our goal is to eventually reach the stage of prescriptive maintenance, where the technology not only provides predictions but also diagnostic insights and recommendations for action*".

P6**:** *"The implementation of AI predictive maintenance in our company is slightly more advanced for rotating equipment compared to electrical equipment. We have a system called Protean that has been operational for over five years. It*

provides a quick check on the health of equipment and allows us to monitor historical data for analysis. This system has been proven to predict maintenance requirements for certain equipment, like compressors, based on parameters like vibration levels."

e) Better Risk Management

Managers in the oil and gas support services industry perceive predictive maintenance as a critical tool for enhancing risk management, as it enables the early identification and mitigation of potential equipment failures, thereby reducing operational hazards and supporting safer, more reliable operations. For example,

P8: *"Challenges stem from the significant investment and capital expenditure required to implement predictive technology. This includes adopting the latest hardware and data analytics tools. Moreover, risk management is vital. Predictive technology must prioritize safety, considering the hazardous nature of the industry."*

P9: *"Artificial intelligence significantly enhances business sustainability and operational efficiency. It improves reliability by predicting maintenance needs, which reduces operational expenses. We rely on time-based, condition- based, and risk-based strategies to maintain assets. A more reliable AI model can cut operating costs and prevent unscheduled shutdowns, contributing to business sustainability".*

Most participants acknowledged that predictive technology provides crucial insights for proactive decision-making, improving operational efficiency, and minimizing downtime. The majority agreed that predictive technology offers a competitive advantage, enabling them to meet client demands and adapt to dynamic market conditions effectively. Table 2 below summarises the findings for Industry Players' Perception on the Imperatives of Predictive Technology in Enhancing Business Sustainability.

Table 2: Summary of findings for industry players' perception on the imperatives of predictive technology in enhancing business sustainability

Company	Size category	Operational Efficiency	Cost Savings	Customer Service	Decision Making	Risk Management
P1	**Large (50,000+)**	√	√	√	√	-
P2	**Small (50)**	√	-	√	-	-
P3	**Mid-sized (1,900)**	√	√	√	-	√
P4	**Mid-sized (4,000)**	√	√	√	√	-
P5	**Small (200)**	√	√	-	-	√
P6	**Mid-sized (2,300)**	-	-	-	-	√
P7	**Large (50,000+)**	√	-	√	-	-
P8	**Large (50,000+)**	-	-	√	-	√
P9	**Mid-sized (2,000)**	√	√	-	√	-
Total Participants		**8**	**6**	**6**	**3**	**4**

Legend: *√ = Recognized benefit - = Not recognized*

5.0 DISCUSSION, CONCLUSION AND LIMITATIONS

The participants' responses reveal several interesting insights. Firstly, when it comes to improving operational efficiency, all participants (P1-P9) acknowledge the importance of predictive technology. They recognize that predictive technology can streamline processes, enhance productivity, and optimize resource utilization.

Large-scale operators with over 50,000 employees (P1, P7, P8) demonstrate remarkably consistent patterns in their predictive technology adoption perspectives. All three companies prioritize operational efficiency as their primary imperative, reflecting the scale-dependent benefits of predictive analytics in extensive operations where even marginal efficiency improvements can translate to substantial financial returns. The emphasis on operational efficiency aligns with research indicating that large oil and gas companies prioritize incremental improvements over radical transformation. Cost savings and asset management represent another priority among large operators, with P1 and P8 recognizing these benefits while P7 demonstrates less focus on this dimension. This pattern suggests that large companies with established asset bases view predictive technology primarily as a tool for optimizing existing investments rather than fundamentally transforming operations, which parallels to the findings by Buck et al (2023). Customer service enhancement shows limited recognition among large operators, with only P1 acknowledging this benefit, reflecting the business-to-business nature of large oil and gas operations where customer relationships are managed through long-term contracts.

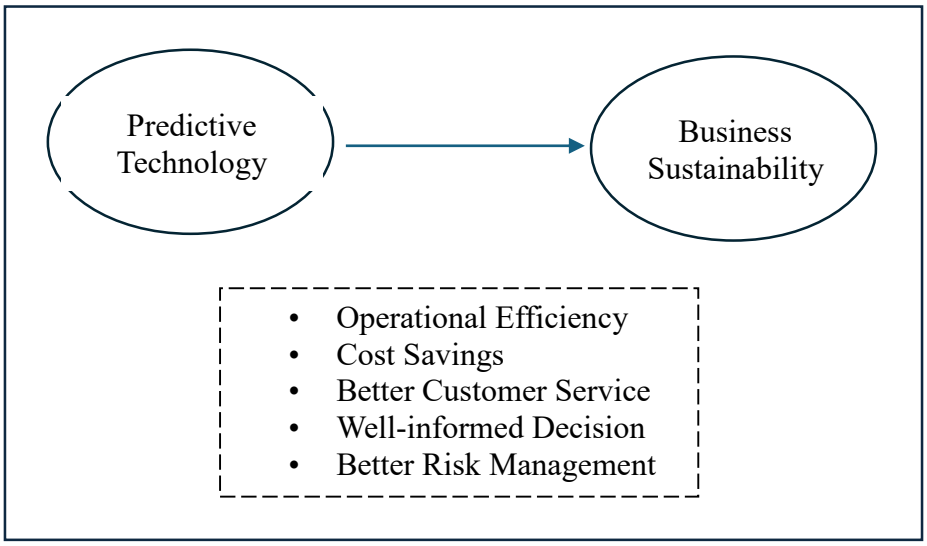
Mid-sized companies (P3, P4, P6, P9) exhibit the most diverse adoption patterns, reflecting the heterogeneous nature of this organizational segment. P3, the oil refining company with 1,900 employees, demonstrates comprehensive adoption across four dimensions, suggesting a focus on operational optimization rather than strategic intelligence1. Oil refining operations benefit significantly from predictive technology, as equipment failures can result in costly shutdowns and safety risks. P4, the fertilizer company with 4,000 employees, shows selective adoption focused on operational efficiency, cost management, customer service, and decision-making capabilities. This pattern reflects the emphasis on production optimization and market responsiveness. P6 demonstrates the most limited adoption pattern among mid-sized companies, focusing solely on risk management, suggesting either resource constraints or a specific risk-centric operational philosophy.

Small companies (P2, P5) present contrasting adoption patterns that challenge conventional assumptions about size-related technology adoption1. P2, with 50 employees, demonstrates selective adoption focused on operational efficiency and customer service, suggesting that small suppliers prioritize technologies that directly impact their core value proposition and customer relationships1. P5, with 200 employees, shows a more conservative approach focused on operational efficiency and cost management while recognizing risk management benefits.

The analysis reveals several critical patterns of how organizational size influences predictive technology adoption perceptions. Operational efficiency emerges as the most universally recognized benefit, acknowledged by eight of nine companies (89%) regardless of size, reflecting the fundamental value proposition of predictive analytics in optimizing oil and gas operations. Cost savings and asset management show a strong correlation with company size, with larger companies

more likely to recognize these benefits, suggesting that the financial impact of predictive technology becomes more apparent at scale. Customer service enhancement demonstrates an inverse relationship with company size, with smaller companies more likely to prioritize this benefit. This pattern reflects different market dynamics where smaller operators often compete on service quality and responsiveness rather than scale and cost advantages. Risk management capabilities demonstrate mixed adoption patterns across all size categories, suggesting that risk perception and management philosophies vary independently of organizational scale.

5.1 Proposed Framework



Based on the findings, this study proposes a framework predictive technologies imperatives in enhancing business sustainability in the O&G support service industry. It is evident that by implementing predictive technology, companies can improve operational efficiency, reducing costs, delivering better services to customers, making well-informed decisions and enhancing safety measures. Industry professionals should recognize the value of predictive technology as a strategic tool for cost effectiveness and resource efficiency planning, proactive decision-making and improving overall business performance

The proposed framework offers practical guidance for oil and gas support services companies considering the adoption of predictive technology. The insights gained from this research enable industry practitioners to make informed decisions regarding predictive technology implementation. By recognizing the potential benefits and enablers, decision-makers can develop data-driven strategies that optimize operational efficiency, resource allocation, and risk management. This emphasis contributes to responsible technology implementation, aligning with organizational values and promoting sustainable practices in the industry. Industry players to gain a competitive advantage by leveraging predictive technology to stay ahead of market trends and customer demands. Embracing data-driven decision-making can position companies as industry leaders in an ever-evolving market. Companies can allocate resources effectively, considering both short-term costs and long-term benefits, to ensure sustainable technology implementation.

The strategic implementation of predictive technology represents a fundamental shift toward sustainable business practices in the oil and gas support services industry. Research demonstrates that companies can achieve significant improvements in operational efficiency, cost reduction, and environmental performance through data-driven decision-making processes. Success requires careful attention to key enablers including leadership support, resource allocation, talent development, and organizational alignment. By embracing predictive technology as a strategic tool for sustainability, companies can position themselves for long-term success while contributing to responsible industry transformation and environmental stewardship.

The evidence presented strongly supports the strategic value of predictive technology as an essential tool for achieving business sustainability in oil and gas support services. Organizations should approach implementation with a comprehensive strategy that addresses technical, organizational, and financial considerations while maintaining focus on long-term sustainability objectives. Success requires balanced resource allocation that considers both immediate implementation costs and long-term benefits, ensuring sustainable technology adoption that aligns with organizational values and industry transformation goals.

The path forward demands commitment to continuous learning, strategic partnerships, and organizational change management. Companies that embrace this transformation while addressing implementation challenges through collaborative approaches, skilled talent development, and robust data management practices will be best positioned to achieve sustainable competitive advantages in the evolving global energy market.

5.2 Limitations of Study and Future Directions of Research

While this study on predictive technology imperatives in enhancing business sustainability in the oil and gas support services industry has provided valuable insights and contributions, it is important to acknowledge its limitations. Firstly, one of the limitations of this study is the sample size and scope. Due to time and resource constraints, the study focused on a specific region or a limited number of organizations within the oil and gas support services industry. This narrow scope may limit the generalizability of the findings to a broader context or different geographical regions. Future research could consider expanding the sample size and geographical coverage to provide a more comprehensive understanding of predictive technology adoption and its impact on business sustainability in the industry.

Secondly, the study primarily relied on qualitative research methods, such as interviews and thematic analysis. While qualitative methods are effective in capturing rich and in-depth insights, they may be subject to researcher bias and interpretation. The findings of this study are based on the perspectives and experiences of the participants, and other stakeholders' views may not have been fully explored. Combining qualitative methods with quantitative approaches, such as surveys or case studies, could provide a more holistic understanding of predictive technology adoption in the oil and gas support services industry.

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BUSINESS HIGHLIGHT: PROBLEMS AND SOLUTIONS

The study reveals that the oil and gas (O&G) support services industry faces a significant challenge in the uneven and inconsistent adoption of predictive technology, which is largely shaped by company size, resource availability, and strategic orientation. While operational efficiency is almost universally recognized as a benefit, the way predictive technology is leveraged varies: large firms tend to emphasize cost savings and asset management, mid-sized firms display fragmented adoption patterns, and small firms focus primarily on customer service and responsiveness. This variation highlights several business problems, including the lack of a unified strategic vision for predictive technology, resource constraints among smaller players, perceptions of high implementation risks and costs, and the danger of falling behind competitors who more fully embrace data-driven approaches.

The solution requires repositioning predictive technology as a long-term strategic asset rather than a limited operational tool. For large companies, predictive analytics should be scaled to maximize asset management, optimize resource allocation, and drive cost savings, capitalizing on their financial strength. Mid-sized firms, on the other hand, need a balanced approach that starts with operational optimization but gradually expands toward customer service and strategic decision-making to remain competitive. Smaller companies should prioritize targeted adoption in areas that directly enhance customer service and operational efficiency, enabling differentiation in a competitive market. Across all firm sizes, successful adoption depends on simplifying implementation processes, strengthening leadership commitment, investing in workforce capability, and building strategic partnerships. By embedding predictive technology within broader business and sustainability strategies, O&G support service companies can achieve long-term efficiency, enhance competitiveness, and contribute to responsible industry transformation.



