Factors that Influence AI Investment Decisions in Oman’s Hydrocarbons Industry: A Review of the Theoretical Literature and Proposed Theoretical Model

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Abstract

Artificial Intelligence technologies have exceptional capabilities that enhance the production efficiency of oil and gas companies by saving time and energy in terms of the technologies used and the workers involved, provided that the technology used is cost-effective for the field of concern. AI gradually penetrates various stages of the oil and gas sectors, such as intelligent drilling, intelligent development, intelligent pipelines, and intelligent refineries. This paper presents a comprehensive model for studying the elements that drive AI investment decisions in Oman’s hydrocarbons industry. This study combined theories of the technology acceptance model (TAM), innovation diffusion theory (IDT), business environment factors, and risk management with AI investment decisions. This study aims to discover the key factors that influence AI investment decisions by studying numerous elements that impact AI investment decisions in the sector. These drivers include AI’s innovation attributes, the external and internal business environment, risk management, and the moderating of perceived usefulness and perceived ease of use. Gaining insight into these elements enables players in Oman’s hydrocarbons sector to make informed decisions about AI investment decisions. This, in turn, can lead to increased operational efficiency, cost savings, and better decision-making processes.

Keywords: Artificial Intelligence; Industrial Revolutions; Investment Decisions; Oman’s Hydrocarbons Industry

Introduction

The hydrocarbons industry in Oman is crucial to the country’s economy, contributing significantly to revenue and employment opportunities. In recent years, there has been an increasing interest in utilizing artificial intelligence (AI) technologies to improve operational efficiency, lower expenses, and improve decision-making processes. This paper aims to investigate the important characteristics that drive AI investment decisions in the hydrocarbons industry in Oman. Understanding these aspects allows industry stakeholders to make informed decisions about AI deployment and maximize the benefits of these technologies.

Artificial intelligence (AI) has become increasingly popular in recent years as more organizations use it to automate tasks. Artificial intelligence is one of the most trending and innovative technologies in different sectors. However, the manipulation of artificial intelligence has been heightened in the last 20 years. In numerous regions of the world today, AI is driving the fourth industrial revolution. The Sultanate of Oman is one of the GCC countries that has begun to embrace digital transformation to streamline procedures and increase efficiency. In the contemporary digital economy, Oman’s Vision 2040 is pushing innovation through fostering diverse economic growth and employment creation. According to BMI Research, the Sultanate of Oman’s IT industry is expected to rise by 8% to $379.22 million by 2021, and the market is ready for digital adoption in some key industries (Oman Observer, 2019). In addition, Oman established a $200 million investment fund in 2016 to help rising technology businesses in the Sultanate and across the region (Oman Observer, 2019).

AI has recently gained traction and consideration, which has led to increased importance and investment in this field by many firms (Lui et al., 2021). AI is increasingly being used in manufacturing, education, medical care, banking, logistics, and the hydrocarbons sector, transferring individuals’ lives more intelligent and entire humanity towards intelligence (Liu, et al., 2020).

Artificial Intelligence in the Hydrocarbons Industry

According to Hanga and Kovalchuk (2019), multiple research projects have investigated the use of AI in the oil and gas industry to enhance operational efficiency, manage supply chains, and overcome potential production and maintenance-related tasks. In addition, artificial intelligence can increase productivity and be useful in all petroleum industries, according to recent research and development (Solanki et al., 2022).
Moreover, in the oil and gas industry, the Internet of Things (IoT), machine learning, and AI have paved the way for considerable efficiency and productivity improvements (Kandziora, 2019). However, BP, Shell, Saudi Aramco, and Gazprom Neft are among the oil and gas companies investing heavily in their AI ambitions (Koroteev & Tekic, 2021). Furthermore, there is a growing interest in AI and related technologies, as well as increased investment in industries that are crucial to long-term sustainability (Galaz et al., 2021). Compared to other countries, Oman's hydrocarbon business has very little AI investment. The World Economic Forum (2020) reported that Oman's AI readiness rating is below the worldwide average, indicating a lack of infrastructure, expertise, and legal models for AI investment. In contrast, the United States, China, and Norway have substantial levels of investment in artificial intelligence, with several significant oil and gas firms and startups making similar investments.

The Gulf Cooperation Council (GCC) economies—Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE)—have launched many high-profile efforts in recent years to support the development of the artificial intelligence (AI) sector and market. The economic impact of AI on the GCC countries is anticipated to exceed US$277 billion by 2030 (Hanafi et al., 2021) as expressed in Figure 1.

![Figure 1: AI contribution to the economics of GCC countries by 2030 (Hanafi et al., 2021)](image)

Various operational procedures in the oil and gas industry create data on a constant basis. The oil and gas industry has become more concerned about the recording and proper exploitation of these data. Moreover, decision-making based on predictive and inferential data analytics allows for quick and precise decisions. Despite numerous obstacles, the oil and gas industry is increasingly turning to data analytics for decision-making. However, in the field of research mentioned above, a significant amount of progress has been made. Many complex problems can now be tackled with ease thanks to artificial intelligence (AI) and machine learning (ML) approaches. Thus, data from the past as well as data from the present can be combined to boost output (Choubey & Karmakar, 2021).

AI gradually penetrates various stages of the oil and gas sectors, such as intelligent drilling, intelligent development, intelligent pipelines, and intelligent refineries. AI technology can significantly reduce oil production costs, increase average oil field recovery, and improve business management performance, all while indirectly promoting economic and social growth (H. Li et al., 2020).

According to the U.S. Department of Energy, incorporating predictive maintenance results in a 30% reduction in maintenance costs, a 70% reduction in breakdowns, and a 40% reduction in downtime for oil and gas organizations. (Sullivan et al., 2010).

The oil and gas industry acquires large and complex datasets for exploration and field development purposes. However, these datasets are not being optimally used to extract useful information. With the recent advances in machine learning and computational power, advanced machine learning for AI methods can be used to not only extract useful information from these complex datasets but also reduce the manpower costs to process and make sense of them (Maniar et al., 2019).

Machine learning in the oil and gas industry is a powerful tool for making fast and accurate predictions. In a matter of hours, machine learning models can predict the outcome of tens of thousands of field creation designs in various geological and economic settings. When given clean and reliable data, these models can be more accurate than traditional models. Numerical reservoir simulators are accurate because they render predictions based on real data without simplifying assumptions (Tamimi et al., 2020).

AI has been used in a variety of oil and gas production activities, ranging from formation characterization and well production capability estimation to the formulation of drilling fluid characteristics and process optimizations (Ossai & Duru, 2020).

Artificial Intelligence technologies have exceptional capabilities that enhance the production efficiency of oil and gas companies by saving time and energy in terms of the technologies used and the workers involved, provided that the technology used is cost-effective for the field of concern.

According to H. Li et al. (2020), based on the research into the use of AI in hydrocarbon industry development, it is conceivable to conclude that the intelligent oil industry is on its way to mixing business applications, decision and deployment direction, real-time production management, meditation on inclusive research, and information supply distribution. The authors added that the oil fields deploying AI will eventually evolve into a smart ecosystem that contains exploration, expansion, assembly, processing, and control. In addition, based on the ecosystem, the relationship between all operation activities, areas, and sections may be comprehended to lengthen the life cycle of oilfields, improve decision-making efficiency and quality, reduce cost, raise economic value, and...
finally attain the movement from digital to AI oilfields. Finally, the ability to apply AI in the oil and gas industry hinges on the collection and processing of data.

Oman AI Strategy

Oman has been hard at work developing a comprehensive digital strategy for the country. Oman's government is devoted to transforming the country's IT services into a comprehensive smart country with the pillars of Oman Vision 2040. However, in 2019, Oman is ranked 80th in the Global Innovation Index and 63rd in the E-Government Development Index (Al Hilali & Shaker, 2021). Moreover, GCC countries, including Oman, are working to embrace the digital transformation process as part of the global drive to use the applications of the Fourth Industrial Revolution (Industry 4.0), which includes AI. The goal of digital transformation is to boost productivity and streamline procedures. Thus, in the digital economy, Oman Vision 2040 considers innovation to be a foundation for growth in the economy, diversification, and employment generation.

According to a research study by Al Harrasi et al. (2021), the Sultanate of Oman is working to adopt the digital transformation process as part of a global push to use the applications of the industry 4.0, which includes AI. The goal of digital transformation is to increase and improve the efficiency and effectiveness of work processes. However, in Oman Vision 2040, which started in 2020, innovation is seen as a foundation for economic growth, diversification, and job creation in the digital economy. The authors stated that the IT market in Oman is predicted to increase by 8% by 2021, indicating that the time is right for digital adoption across the board. The authors' highlighted Oman is working to demonstrate a variety of AI applications, including chatbots, traffic congestion and vehicle accident prediction, disease and hazard prediction, cyber-attack prevention, and big data analysis. Moreover, to increase the overall efficiency of government performance, Oman's Digital Strategy aims to incorporate best practices in e-Government and sophisticated technology, including AI-based solutions.

Oman's economy and society must rely on innovation and knowledge rather than non-renewable resources by investing in opportunities generated by regional and international dynamic forces. Figure 2 illustrates the main ten indicators of Oman's 2040 vision.

Nevertheless, knowledge, technology, and innovation are clearly significant elements in the Oman 2040 vision's strategic directions. Furthermore, there are seven components of Oman's readiness to transition to knowledge and innovation, as demonstrated in Figure 3. The availability of complementing organizational resources is referred to as the organization's readiness for AI deployment (Alsheiabni et al., 2018).

On his inauguration as Sultan of Oman, His Majesty Sultan Haitham bin Tariq pointed out in his speech on February 23, 2020, that "our government will follow up progress in various sectors, including small and medium enterprises and..."
entrepreneurship, particularly those based on innovation, artificial intelligence, and advanced technology. This is in addition to training and enabling youth to benefit from the opportunities made available in this vital sector, so that it could form a cornerstone in the national economy” (Oman News Agency, 2020).

The COMEX Artificial Intelligence (AI) International Conference is envisioned as Oman’s largest AI event, with the goal of realizing the country’s national vision of AI adoption in the public and private sectors, including the hydrocarbons sector. Figure 4 explains the key highlights indicated by the COMEX Artificial Intelligence (AI) International Conference 2021.

### Significance of the Study

Artificial intelligence (AI) has recently gained traction and attention, resulting in a surge in interest and investment in the field. On the other hand, the impacts of various determinants that affect AI investment decisions in the hydrocarbons industry in Oman are hardly discussed. The researchers stated three primary reasons why this study is significant as a basis for this research: theoretical significance, research significance, and practical significance.

#### Theoretical Significance

Based on the primary research on applicable literature reviews, it was found that limited studies have been directed on the topic of AI investment in the hydrocarbons industry in Oman. Moreover, this research will add significant insights to the current literature on AI investments and their influence on organizations’ operational efficiency. In addition, the identified literature gaps in Artificial intelligence investment decisions in the hydrocarbons industry will be determined.

However, the novelty of this research in terms of knowledge is the use of a combination of different factors to examine the impacts of the innovation attributes of AI (relative advantage, compatibility, and observability), external business environment factors (government factors, economic factors, and technological factors), internal business environment factors (management structure, physical facilities, and knowledge capability), and risk management towards AI investment decisions in the hydrocarbons industry in Oman. In addition, the combined IDT and TAM models had perceived usefulness and perceived ease of use as moderating variables. Likewise important, the researchers aimed to increase the level of understanding of the influence of the AI investment decision on organizations’ operational efficiency.

#### Research Significance

According to Miles (2017), there are three parts to research significance: continuation, extension, and novel investigation. This research is important because it is a novel investigation into the hydrocarbon industry in Oman. From the literature review, we found very limited research performed in this field. This research will provide insight on the importance of AI investment in the hydrocarbon industry to gradually replace current conventional methods and minimize the effect of oil prices fluctuating over the past few years.

#### Practical Significance

In terms of the practical contribution of this study, the proposed model for AI investment decisions can be applied by different companies as well as the public sector in the Sultanate of Oman to redesign their technology investment models with a view to enhancing operational efficiency in their organizations. Eventually, the research findings will accelerate the development of innovative methods of AI investment that could be further employed to enhance the private and public sectors.
operational efficiency. In terms of contributing to policymakers, the results of this research study will encourage the government to adopt investment policies in artificial intelligence for other sectors in line with Oman’s Vision 2040. In addition, to alert policymakers of the importance of rising AI knowledge for the new generation in Oman.

Literature Review

**Industrial Revolutions and Artificial Intelligence (AI)**

Modern technology has penetrated almost every corner of business and systems of modern life since the industry 4.0 era (Bag & Telukdarie, 2018). The strengthening of flexibility and increasing resource proficiency over digitization and the explosion of industrialization knowledge and associated technology have been focused on that revolution. The First Industrial Revolution occurred from the late 18th century up to the early nineteenth century (Agarwal & Agrawal, 2017), and it was associated with a mass transfer from manual labor and muscle force in the industry to steam engine energy in the 17th century (Pozdnyakova et al., 2019). After that, because of the invention of steam engines, the second revolution marked the beginning of mass production (Alaboul et al., 2020). The First Industrial Revolution occurred in the 18th and 19th centuries in Great Britain, and the second in the late 18th and early 19th centuries in the United States, with the 1870s seeing a literal explosion of rail transit (Beaudreau, 2018). Furthermore, the rise of Taylorism, or scientific labor organization, had a significant impact, and the Third Industrial Revolution ushered in a new era of scientific and technological growth in the 1970s and 1980s (Feshina et al., 2019). As noted by A. Nuvolari (2019), the Third Industrial Revolution was characterized by the widespread use of information.

Afterward, the Fourth Industrial Revolution appeared for the first time at the Hannover Fair in 2011 and the plan entails converting industrial production to full smart automation, which includes the use of self-automation, self-configuration, self-diagnosing, and problem-solving, knowledge, and intelligent decision-making as part of the goal (Karabegović, 2018). Besides, the Fourth Industrial Revolution is the continuous revolution of traditional manufacturing and industrial methods, which is being supported by new smart technology. Its emphases are on advanced devices for machine communication and Internet of Things (IoT) applications to provide greater automation, self-monitoring, and healthier networks, in addition to smart machines capable of assessing and identifying difficulties without the need for human interaction (Afolalu et al., 2021).

In industry 4.0, the direction of production and manufacturing processes has been computerized, and this has been made feasible by the creation of a more complicated IT infrastructure, which has resulted in network and framework modifications (Kumar et al., 2019). Furthermore, industry 4.0, which is the intelligence era, aims to employ information technology to accelerate industrial progress (Lu et al., 2019). Moreover, nearly one-third of businesses already rate their digitization as high, and this percentage is predicted to climb from 33% to 72% in the next five years (Stănciuciu, 2017). Although mechanical change made a difference in work efficiency and was later deciphered in organizations involved in financial development and job creation, new technology and automation have replaced labor in many businesses and occupations, thus uprooting some of the occupations that used to be performed by the human element (Kergroach, 2017).

According to Carl Benedikt Frey and Michael Osborne’s 2013 study, 47% of US employment and a higher percentage in China and India (77% and 69%, respectively) are at risk of being automated in the next two decades as AI spreads (Frey et al., 2016). On the contrary, Afolalu et al. (2021) showed that because of industry 4.0, job opportunities will increase by 6% during the next ten years, and the demand for skilled employees could grow by 10% for the same cycle. In addition, unskilled employees who perform simple assignments could lose their employment because of the trend towards automation, thereby increasing the demand for expertise in information technology and other qualified people. However, job profiles considered routine and repetitive activities requiring minimal digital skills may see the greatest reduction in employment, dropping from over 40% to around 30% in 2030 (Bughin et al., 2018). Along the same lines, according to the findings by M. Mutascu (2021), artificial intelligence has a nonlinear influence on unemployment, with increased use of AI reducing unemployment but only at small inflation levels. In fact, there is no “switch effect” in this situation between “displacement impact” and “replacement effect”. Aside from that, artificial intelligence has a negligible impact on unemployment. Moreover, increasing organization productivity by utilizing digitization and automation will create new jobs, change current jobs, and some jobs will disappear or be transferred to other areas (Szakáll et al., 2017).

According to a study by Koh et al. (2019), implementing industry 4.0 is not only about merging new technology with production processes but should include changes in all parts of management, not just at the internal level but also in relationships with all partners and, more broadly, actors in the ecosystems in which the organization operates. Likewise, industry 4.0 is still in its early stages, and while some technologies are being verified and authenticated and, there are still substantial improvements needed to be achieved on innovation and technology (Klingenberg & Junior, 2017). Nonetheless, linking many objects to the internet, the availability of sensors, the expansion of wireless communications, the development of robots and intelligent machines using artificial intelligence, and real-time data analysis all have the potential to change the way industrial work is done (Stănciuciu, 2017). Besides, to witness AI's genuine influence in the next generation of industrial systems, there is an urgent need for methodical AI development and deployment (Lee et al., 2018). Thus, the underlying idea of smart factories and industry 4.0 is the use of artificial intelligence (AI) to perform complicated jobs, diminish costs, and improve the quality of goods and services (Ribeiro et al., 2021). Similarly, according to the study by Afolalu et al. (2021), they supported the previous literature and summarized the past revolutions until the fourth revolution as follows: in the first industrial revolution, steam power was the energy for operating the manufacturing industry, which started in Britain in the early 1800s and then moved to mass production in the early 1900s, where factories were energized through electricity and hence replaced previous sources of energy; during the 1970s, information technology and automation were the driving forces for the new era of manufacturing. According to the same study, the world is currently living in the fourth industrial revolution, where digitization, the Internet, artificial intelligence, cyber-physical systems, and other modern technologies are driving the industrial and knowledge explosion and boosting productivity.

The origins of AI can arguably be traced back to the 1940s, notably 1942, when American Science Fiction writer Isaac Asimov released his short novel Runaround. The premise of Runaround revolves around a robot created by Gregory Powell and Mike Donavan. In 1956, Marvin Minsky and John McCarthy (a Stanford computer scientist) conducted the eight-week
According to Haenlein & Kaplan (2019), artificial intelligence (AI) is “a system’s ability to interpret external data correctly, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation”.

Likewise, Duan et al. (2019) illustrated in their study AI as the capability of a machine to learn from existing practice, fine-tune to new inputs, and then achieve human-like undertakings. Even though artificial intelligence has been a hot topic for decades, there is currently no broadly recognized definition in the literature (Mikalef & Gupta, 2021). According to Sohn and Kwon (2020), AI technologies such as natural language processing, speech recognition, and machine learning have exploded in popularity as computing capabilities and networks have improved, as shown in Figure 5.

Furthermore, AI is a collection of technologies rather than a single technology. Computer vision, natural language processing, robotic process automation, virtual assistants, and advanced machine learning are the famous five basic areas of AI technology, and according to research by McKinsey Global Institute, 70% of businesses will have implemented at least one form of AI technology by 2030; however, fewer than half will have fully engrossed all five types (Bughin et al., 2018).

Therefore, from a review of the previous literature, it becomes clear that the Third and Fourth Industrial Revolutions had a key role in using technology to raise production efficiency and achieve high profitability, and then the idea of applying the internet and automation, thus creating the first building block of the artificial intelligence concept, The Fourth Industrial Revolution can raise worldwide pay levels and improve personal satisfaction for populations throughout the globe due to the spreading of manufacturing and high productivity with lower operating expenses. Also, there is a strong association between using new technology and hiring qualified employees. People must acquire more skills in line with the requirements of the Fourth Industrial Revolution so that their income is not jeopardized.

Nahavandi (2019) highlighted that while industry 4.0 is still in its infancy, many industry pioneers and technology experts are looking forward to the Fifth Industrial Revolution: automated manufacturing with artificial cognition in and on the loop, with an estimated 3 billion additional internet users by 2025. The author stated that, whenever its three primary components intelligent equipment, intelligent systems, and predictive analytics merge with the physical environment in collaboration with human intelligence, the Fifth Industrial Revolution will appear.

**Figure 5: Industrial Revolutions and AI (CBI Insights, 2017)**

**Industry 5.0**

The spread of digitalization, aided by technologies such as the Internet of Things (IoT), cognitive computing, and the convergence of Big Data and Artificial Intelligence (AI), is a significant element of the Fourth Industrial Revolution, which was only coined in 2011. Furthermore, in recent years, industry 4.0 has become the industry standard for applications, as its technologies have been swiftly applied and have a favorable influence across all industries. However, these advancements have failed to produce the anticipated results and have prioritized robots above humans, ignoring the environment. As a result, the industry 5.0 revolution is a call to action for putting sustainability ideals into practice, integrating human values with technology, and accomplishing sustainable development goals (Sindhwani et al., 2022).

The first three revolutions were separated by a century. From the third to the fourth, it only took about 40 years. However, it is possible that it will take fewer than 40 years to get to the fifth one (Demir et al., 2019). In comparison to industry 4.0, industry 5.0 is seen as the next industrial evolution, with the goal of leveraging the creativity of human experts in combination with efficient, intelligent, and accurate machines to provide resource-efficient and user-preferred manufacturing solutions.
(Maddikunta et al., 2021). Nevertheless, while industry 4.0 is demarcated as the use of the Internet and evolving technologies to drive a new fundamental paradigm shift in industrial production, industry 5.0 complements it by putting research and innovation at the service of the transition to a more sustainable, human-centric, and robust industry (Gürdür et al., 2022).

Industry 5.0 is about the importance of the industry to accomplish societial goals beyond jobs and growth and to become a sturdy provider of success by ensuring that production respects the boundaries of our planet and places the well-being of industry workers at the center of the manufacturing process. Likewise, industry 5.0 is founded on the premise or assumption that industry 4.0 focuses less on the basic concepts of social fairness and sustainability and more on digitalization and AI-driven technologies for boosting production efficiency and flexibility. As a result, the notion of industry 5.0 offers a fresh perspective and emphasizes the necessity of research and innovation in ensuring the industry’s long-term contribution to humanity within ecological sustainability (Xu et al., 2021).

Industrial automation is being transformed into industry 5.0 compliance by using modern IP-enabled sensors, actuators, and controllers to achieve complete autonomy with minimal human interaction. (Thakur & Kumar, 2021). Moreover, industry 5.0 could bring humans and machines together and find new methods to collaborate to boost manufacturing performance and effectiveness (Eltar et al., 2021). Likewise, in industry 5.0, AI is designed to collaborate with humans rather than replace them and will combine humans and machines to boost innovation and efficiency (Durmaz & Kitapci, 2021).

Moreover, industry 5.0 will focus on human-robot relationships rather than digital transformation, and future manufacturing will result in the best possible partnership among machines and people (Shloma & Volotka, 2021). Furthermore, the main goal of industry 5.0 is to create an evolution of industry 4.0 that is both gradual and evolutionary. Collaborative robots, commonly referred to as cobots, are a concept introduced in industry 5.0. These collaborative robots are the instruments needed to meet the demands of today’s businesses that create individualized products for customers (Pathak et al., 2019). However, humans and robots worked separately and independently in industry 4.0. They shared the same working place, but there were clear distinctions between the robot’s and human’s tasks. This line is muddling with industry 5.0, and efforts are being made to enhance the human brain’s cognitive skills with robotic support (Bhandurje & Bhide, 2021).

According to Pathak et al. (2019), the following are some of the principles of industry 5.0:

- Mass Customization: providing a platform that allows customers to customize products or services while staying within a reasonable pricing range and comfort level.
- Cultural Collaboration: industry 5.0 dismantles national and regional boundaries. This provides the firm with the opportunity to expand their business globally. When cultures collaborate, better ideas emerge, resulting in better products.
- Customer-Centric: industry 5.0 is focused on the goals of customers and overcoming business constraints in the development of products and services, which may include reengineering business processes.
- Cyber-Physical Systems: constructing an intelligent system that assists in serving consumers by maximizing the benefits of both human and machine intelligence.
- Green computing: concentrate on renewable energy sources, which are required for environmentally friendly manufacturing processes.

Modelling Technology Acceptance

In today’s enterprise, technology and innovation are seen as necessary components for many organizations and businesses to achieve their objectives. As a result, various technological theories and models have been developed and implemented in a variety of disciplines to expand the use of technology. Several contending models of technology acceptance have been formed, each with its own set of acceptance factors. The most well-known models are Innovation Diffusion Theory (IDT), Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and Theory of Planned Behavior (TPB).

Innovation Diffusion Theory (IDT)

The Rogers model of innovation diffusion, initially developed in 1962, has long been cited in discussions of new product technology adoption. (Wells & Nieuwenhuis, 2018). Moreover, IDT research has been used in a variety of sectors, including marketing, science, sociology, agriculture, communication, health care, technology, the internet, etc. (Lou & Li, 2017). However, IDT was used by Scott and McGuire (2017) to promote universally designed college instruction. Moreover, diverse views of innovation can lead to different user adoption patterns (Choe & Noh, 2018).

Nonetheless, organizational growth and survival are thought to be dependent on innovation (Beausoleil, 2019). However, diffusion of innovations is the method by which new ideas are conveyed to the social system over time and is about the dissemination or adoption of new information or technology. As a result, when measuring social change, the change might be random, as in individual encounters, or it can be influenced by governmental constraints. (Raisanen & Oturakci, 2018). According to Oturakci and Yuregir (2018), an individual or other unit of adoption observes an idea, activity, or thing as novel. The rate of adoption refers to how quickly individuals in a social system adopt a new idea. On the other hand, IDT supports the prediction of an innovation’s likelihood and step of adoption (Lou & Li, 2017).

In fact, according to Kim & Chung (2017) the innovation method is divided into two phases: adoption and implementation. Adoption refers to the organization’s decision to use an invention or a technology, while implementation refers to staff members persistent usage of the innovation after it has been adopted. Moreover, according to the diffusion of innovation theory, potential users make decisions about whether to accept or reject new technology based on preconceived notions about that technology (Ullah et al., 2021). In addition, Individual perceptions, social relationships, manager qualities, demography, and trait-like inclination are all elements that influence how well a company implements innovation (Kim & Chung, 2017). Likewise, Beausoleil (2019), in his research, indicated that individuals, teams, and social systems are the ones who construct the innovation process. In addition, the author stressed the need to know the capabilities required to engage in and manage the innovation process effectively. However, according to Oturakci & Yuregir (2018), Lou & Li (2017), and Chiu et al. (2017), there are five main properties of inventions presented in the diffusion of innovation theory. The properties are Relative Advantage, Compatibility, Complexity,
Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is a measure of a person's willingness to accept specific information technology and information systems. (Davis, 1989). Davis developed the Technology Acceptance Model (TAM, Figure 6) (1985) that can help researchers better understand why individuals are resistant to using certain technologies, forecast how users will react to new systems or developments, and increase the acceptability of information technologies by modifying the way they are introduced (Räisänen & Tuovinen, 2020). Moreover, TAM's purpose is to forecast user acceptability and identify any design flaws before people correlate with the new technology, which is a commonly used theoretical framework for analyzing how people make decisions about adopting new technology (Koul & Eydgahi, 2017). According to Sohan and Kwon (2020), to better understand the user acceptability of information systems, the TAM was derived from the Theory of Reasoned Action (TRA).

According to TAM, perceived usefulness (PU) and perceived ease of use (PEOU) are two main drivers in understanding individual users' adoption intentions. While PU refers to how confident a person is that utilizing a certain system will improve his or her job performance, PEOU refers to how confident the person is that using the system will be painless (Lou & Li, 2017). Furthermore, Koul and Eydgahi (2017) in their research supported that and stated that Lane and Coleman (2012) applied TAM by looking at the PU and PEOU of social networking media, such as Facebook and MySpace, within a group of business students at a U.S. regional university. The results of that study found that higher PEOU led to higher PU, which ultimately led to higher use of social networking media.

On the other hand, Koul and Eydgahi (2017) demonstrated some limitations of using TAM in their research, including the fact that it is used to predict behavioral intention to accept technology without enough exposure to the technology before the assessment and that the original TAM model did not contain social impact, but the technology under study was of an individualistic landscape and self-determining of the usage of social means. In addition, TAM needs to be developed according to different types of technology or enhanced with external factors that affect PU and PEOU (Choe & Noh, 2018). However, Compatibility has a positive link with the rate of innovation adoption and has been found to have a substantial impact on PU (Choe & Noh, 2018).
Thus, from the previous review, the literature indicated the relationship between artificial intelligence technology and the industrial revolutions; hence, technology innovations started with the third industrial revolution and got further developed in the fourth industrial revolution until the appearance of the artificial intelligence era. Reviewing the theories relating to technology acceptance, both IDT and TAM theories will be examined in this research by developing a combined model of IDT and TAM.

**Relative Advantage**

Rogers (2003) defines relative advantage as the degree to which an innovation is perceived as being healthier than the idea that it succeeds. Furthermore, relative advantage is a hotly disputed topic because it affects how quickly users adopt new technology services and products (Mombeuil & Uhde, 2021). According to Pan et al. (2022), the term “relative advantage” refers to the amount of value that innovation can provide to an organization. Moreover, relative advantage refers to the degree to which an innovation is seen to be superior to its predecessors (Pandi et al., 2022). However, relative advantage is one of the most important features of innovation in predicting whether a technology breakthrough will be accepted and adopted (Hmoud & Várallyai, 2022). Moreover, the perceived relative advantage of an innovation is the degree to which it outperforms the idea it replaces; the larger the perceived relative advantage of an innovation, the faster it will be adopted (Tsai & Chen, 2022). Thus, relative advantage indicates that AI innovation is more advantageous in comparison with current technology.

**Compatibility**

Rogers (2003) defines compatibility as the degree to which an innovation is perceived as compatible with present values, historical experiences, and the needs of possible adopters. Furthermore, compatibility is the fit between the desired application and technology, and a better match between the technology and the task will lead to higher levels of acceptance.
and utilization (Enholm et al., 2021). However, the technical compatibility of existing systems with new AI technology is crucial and has a significant impact on AI investment decisions (Schaefer et al., 2021). Likewise, according to Tsai and Chen (2022), the degree to which an invention is regarded as being consistent with the existing values, prior experiences, and needs of potential adopters is known as compatibility. An innovation that is incompatible with the system's dominant values and norms will not be embraced as quickly as one that is compatible.

**Observability**

Observability is the degree to which an innovation produces tangible consequences that contribute to increased visibility (Hidayat et al., 2022). According to Tsai and Chen (2022), the degree to which the outcomes of innovation may be seen by others is referred to as observability, and individuals will adopt innovations more quickly if they can see the consequences of the invention easily.

**Perceived Usefulness**

Perceived usefulness is defined by Davis et al. (1989) as an individual's belief that employing new technology will increase or improve his or her performance. However, a high perceived usefulness (PU) can boost AI's perceived value, influencing its acceptance (Anton et al., 2021). Moreover, artificial intelligence's perceived usefulness and marketing innovation have a considerable positive association (Sadriwala & Sadriwala, 2022). Likewise, incorporating AI into an organization's operations will enhance efficiency while also assisting employees in making quick decisions (Chatterjee et al., 2021). According to Atwal and Bryson (2021), PU and perceived ease of use are two factors that influence the decision to invest in artificial intelligence. Thus, the employee's perceived usefulness determines the degree to which the employee believes that using AI technology in the hydrocarbons sector would enhance his or her job performance.

**Perceived Ease of Use**

Yuen et al. (2021) find in their research on autonomous vehicle adoption that relative advantage, compatibility, and observability were all factors that affected PU and PEOU. In addition, perceived usefulness and perceived ease of use were positively related to new technology use in the education sector (Eze et al., 2021). However, perceived ease of use describes the degree to which the employees in the hydrocarbons sector in Oman believe that using AI technology would be free from effort.

**Business Environment and AI Investment Decision**

The business environment includes all factors that affect the business, such as the organization's strengths, weaknesses, internal power relationships, and orientations; government policies and regulations; the economy's nature and economic conditions; sociocultural factors; demographic trends; natural factors; and global trends and cross-border developments (Cherunilam, 2016). However, according to Ajaz Khan et al. (2019), the business environment includes rules and standards, laws and supervisory frameworks, governance, and overall trade and investment policy, as well as launch rules and regulations for business operations that may have a positive or negative influence on the business, market, investment flow, cost of doing business, and productivity. Furthermore, AI investments' Business decisions are influenced by two factors: the internal environment and the external environment (Cherunilam, 2016), as illustrated in Figure 9.

![Figure 9: Business Decision (Cherunilam, 2016)](image)

Trisakhon et al. (2018), in their research study, highlighted the definitions of both external and internal environments. The term "external environment" refers to the elements that can have an impact on an organization and is mostly made up of uncontrollable forces. Moreover, the external environment is divided into four main categories: political, economic, social, cultural, and technological. On the other hand, the internal environment refers to elements within the organization, and most internal factors are more manageable than external factors because they are controlled by the organization's management. Figure 10 demonstrates the external and internal business environments.
External Business Environment

External Business environmental factors, such as government and legal, economic, demographic, socio-cultural, geo-physical, and other factors, are often seen as unmanageable by a corporation (Cherunilam, 2016). Moreover, the external environment refers to a specific condition of the business environment as well as a set of elements that influence circumstances and business options (Borodin et al., 2021).

Government Factors

Huang and Palvia (2001) find that the government can support new technology adoption and introduce regulations that can set or remove barriers to introducing new innovations. However, government policy plays an essential role in promoting innovation (Lemke, 2003). The adoption of innovative new technology would be facilitated by government promotion by providing supportive infrastructure and legal and regulatory frameworks (Li, 2008). Moreover, the government’s assistance creates a favorable atmosphere for AI and will raise its distribution and effects (Agrawal & Goldrarb, 2019). Nevertheless, government policies have a powerful impact on the overall financial performance of different sectors, and in the absence of suitable economic policies, it is challenging for businesses to make effective investment decisions (Al-Thaqeb & Algharabali, 2019). However, government policies can impact development positively or negatively in each country (Okere, 2017). In addition, it is the responsibility of the government to build a beneficial business environment that will encourage investments and organizations development.

Thus, countries strive to adopt AI technology for a range of reasons, including domestic security, improving public services, and growing their GDP. As a result, numerous governments have established national AI adoption strategies. However, the Ministry of Transport, Communications, and Information Technology in Oman has developed the National Program for AI and Advanced Technologies for 2020. That program targets managing the development and implementation of an integrated national action plan for AI and advanced technologies, which includes research, innovation, industrialization, investment, and support for the formation of new businesses, as well as policy and legislative framework. Moreover, government regulations and policies provide directives that figure out how AI is developed (Enholm et al., 2021).

Economic Factors

Positive economics is a critical consideration when deciding whether to invest in artificial intelligence (AI) solutions (Wolff et al., 2020). Interest rates, inflation, and unemployment are crucial economic factors that affect many organizations, and these factors have a significant impact on how businesses behave and make decisions (Kowo & Popoola, 2018).

Investment efficiency can be boosted through the successful provision of funds. Thus, the oil price plays a considerable role in allocating the required funds, especially for those countries that depend on the oil price as the main source of income for their total domestic production. This leads to the following hypothesis: Moreover, oil price fluctuations have a huge impact on the economies of oil exporting countries, particularly OPEC members (Trang et al., 2017). In this case, a reduction in the price of oil creates a slew of negative consequences, including inflation, slower economic development, and higher unemployment.

Technological Factors

There is enough proof in the literature to show that AI technology provides new prospects that can lead to significant changes in enterprises and the economy in general (Soni et al., 2020). However, the systematic application of scientific or other organized knowledge to practical problems is referred to as technology (Kowo & Popoola, 2018). They additionally posit that technology evolves at a rapid pace, it is difficult to stay up, and organizations should always be on the lookout for new technology to incorporate into their operations. The goal and objective of technological development are to formulate a method of influencing a resource, system, or object that is more cost-effective than what was before available (Sukharev, 2019).
**Internal Business Environment**

Internal Business Environmental factors, such as staff, physical facilities, management structure, knowledge capability, and functional means, such as the marketing mix, are often seen as controllable factors because the corporation has control over them (Cherunilam, 2016). In a similar vein, according to Vlados (2019), the internal business environment incorporates all tangible and intangible resources under its direct control. However, material assets of an organization, such as industrial units, buildings, and financial assets, are known as tangible resources. On the other hand, non-material assets such as information, the company’s reputation, developed knowledge, and the overall business culture are examples of intangible resources.

**Management Structure**

Support from senior management is crucial to building a supportive environment and allocating enough resources for organizational adoption of AI innovation. (Li, 2008). However, according to Cherunilam (2016), management structure is an important element shaping business decisions, and some management structures delay decision-making while others speed it up. Cherunilam added that the quality of the board of directors, as the highest decision-making body that defines the direction for the organization’s development and monitors its performance, is a significant aspect of the company’s growth and performance. Likewise, agility in operations management resulted in higher operational efficiency and customer satisfaction, both of which have a beneficial impact on cost factors (Piya et al., 2020).

In this regard, according to Vlados (2019), every organization must integrate strategic, technological, and managerial aspects to survive and develop, with the goal of innovation that will allow the organization to maintain profitability and efficiency. Figure 11 illustrates the integration of strategy, technology, and management to achieve profitability and operational efficiency.

Management structure plays a key role in developing other aspects of organization and innovations. According to Piya et al. (2020), top management commitment, strategic alignment, management expertise, and information technology integration were discovered to be the major drivers for providing an agile supply chain. Along with digitized process reach, customer agility, and innovative awareness, agility is a capability of organizational process adaptability and flexible and fast execution of operational changes (Kohli & Grover, 2008; Barenfanger & Otto, 2015). Thus, firms’ managers require to detect the significant success considerations that lead to effective AI adoption in businesses and if managers have deeper competence and better IT knowledge, they can employ more authority on firms’ adoption of AI (Sun et al., 2018).

![Figure 11: Integration of Strategy, Technology and Management (Vlados, C., 2019)](image)

**Physical Facilities**

Facilities Management (FM) is a multi-discipline profession that helps an organization achieve its strategic goals and entails a variety of non-core specialty services, such as management, development, and coordination, in addition to buildings and associated systems, plants, IT equipment, and furnishings (Safiee et al., 2020). Furthermore, according to Malik et al. (2020), there is a considerable positive association between organizational structure, physical facilities, and leadership practices and educational decision-making to improve performance. However, the hydrocarbon sector is a large global industry that supports a wide range of manufacturing and service industries. Due to its vast expansion and massive infrastructure investments, it holds a promising position in the global economy (Piya et al., 2020). Moreover, organizations must determine whether their assets, talents, and commitment are appropriate for the specific AI adoption goal (Jöhnk et al., 2021). Thus, locating a convenient working place is crucial for supporting business innovations and decision-making.

**Knowledge Capability**

Knowledge capability is the structured procedure of an organization’s learning, integrating, and using knowledge to gain long-term competitive advantage and high efficiency and has the potential for large cost savings, significant human performance enhancements, and increased competitiveness (Candra, 2014). Moreover, according to Olusoji and Rose (2020), knowledge capability refers to the characteristics that provided the individual with the opportunity to perform; it is concerned with the professional knowledge, skills, values, and ethics that are required to exhibit competence.

**AI Investment Decision**

The decision to invest in artificial intelligence (AI) can be profitable and potentially rewarding, but it also needs to be well thought out and analyzed. A detailed understanding of the
According to Umarova and Uaysovich (2022), the term “investment” can be interpreted in a variety of ways. These are various sorts of property (material) and intellectual (intangible) values, as well as rights to them, that are invested in objects of entrepreneurial and other activities to get advantages. In the strictest sense, these are an investor’s own, borrowed, or lured capital invested to generate profit (income) and material or spiritual rewards.

However, according to Harris et al. (2016), there are some psychological factors, socio-political factors, and structural factors that control investment decisions. Moreover, there are two investing paradigms: the first considers investment as a want, while the second considers investment as a necessity (Patma et al., 2021). Furthermore, investment plays a significant role in the economic development of organizations. Investment entails the use of financial funds and assets with the goal of generating regular income, capital growth, or even both. However, many aspects influence investment decision-making, such as perception, interest, attitudes, pattern, and awareness (Hemalatha, 2019).

Besides, AI could transform the economy drastically (Furman & Seamans, 2019). In addition, AI has the potential to revolutionize the economics, national security, and society of a country (Luong et al., 2021). Nevertheless, in comparison to the digital revolution, AI investment is still very much in the early phases and very limited (Taiwo & Koury, 2017).

Moreover, investment decision-making is a complicated and difficult task since the consequences of investment decisions are influenced by psychology, sociology, and cognitive theory (Atif Sattar et al., 2020). Thus, investment decision-making is the method of making decisions, gathering relevant information, and making well-versed options.

**Business Environment and Investment Decision**

The business environment refers to the totality of all external and internal elements that impact or affect a firm. However, with increasing ideas in business ethics, corporate social responsibility, corporate governance, and consumer citizenship, the business environment is a dynamic notion or reality. In addition, every company and manager should have a solid conceptual and policy framework in place to facilitate the production and application of business and environmental data in decision-making (Hans, 2018).

According to Taiwo (2019), investment decisions are important to the company’s future growth and survival, and they rely on accurate forecasting and sensible judgments made by the company’s executives. The author specified that one of the most critical business decisions a company must make to remain competitive and efficient while also ensuring its long-term viability is to make an investment decision.

Sun (2020) highlighted that the market scenario is growing increasingly complex as the global economy continues to develop, making enterprise investment decision-making more tough. The author added that to achieve the goal of enhancing investment decision-making efficiency and stabilizing investment returns, it is necessary to continuously absorb new information processing technologies and increase the scientific and ethical standards of decision-making. Likewise, firms are required to develop new winning tactics in the face of a rapidly evolving business environment to acquire a competitive advantage and create value for their stakeholders (Rychłowska, 2019).

**Risk Management and AI Investment Decision**

Artificial intelligence (AI) is increasingly being used in various industries to reduce risk and increase operational efficiency (Li et al., 2020). Moreover, many external and internal elements influence an organization’s efficiency, including the industry environment, competitors, and regulations, as well as technology, innovations, culture, business risk management, business strategy, and some other factors (Frederica et al., 2021). In addition, Data science has proven to be an effective
technique to automate risk detection by utilizing Big Data in the AI era (Frederick et al., 2019).

Frederica et al. (2021), in their study, aimed to investigate and assess the influence of artificial intelligence (AI) and operational risk management on banking performance using regulations as a moderating variable, particularly in the context of banking digitalization. The findings revealed that AI has little impact on banking performance. Operational risk assessment, on the other hand, has a beneficial impact on banking results. The impact of AI on banking performance has been proven to be strengthened by the introduction of regulations. According to the research, operational risk assessment has a positive impact on banking results. The impact of AI on banking performance has been demonstrated to be bolstered by the implementation of rules.

Zhou and Huang (2021) research study is intended to investigate how AI technology can be used to control risks in the sports community. The author specified that it is a vital aspect of risk management planning to launch the intelligent risk control project in its entirety and further consolidate risk management capability, which will provide the organization with limitless future possibilities. In this concern, the author added that managers and executors must re-examine the risk characteristics of the business environment, combine traditional and emerging measurement methods, adopt new technologies, and strengthen risk prevention mechanisms to meet the requirements of future risk management and take preventive measures. The authors specified six factors and used the Pareto analysis method to examine risk management in the research field: personal factor, site factor, equipment factor, community management personal factor, and finally, community management factor. The results highlighted that human and site factors account for about 20% of the risk factors, and social factors account for the least, accounting for 6.56%.

Okpala et al. (2020) directed a survey of the literature on safety technology uses in the construction industry, which included academic study articles and business reports. The authors highlighted Artificial Intelligence Planner (AIP) technology that enhances data analysis and decision support to improve production planning efficiency. However, researchers have established several AI machine-learning algorithms to act as leading indicators, which are examples of potential AI applications in construction safety management. Furthermore, Natural language processing (NLP) and other machine-learning algorithms were used to pinpoint trends that have an advantage over specific safety outcomes. The outcomes disclosed a high level of accuracy and skill for the identified safety outcomes.

However, as part of integrated intelligent technology, AI can support the resolution of engineering challenges, the determination of safety-linked decisions such as work-related safety risk tolerances, and the improvement of operational efficiency. This technology takes advantage of the growing trend of using big data and computer processing to execute tasks that would typically necessitate a great deal of individual intelligence and experience. According to the research, AI can be used to improve construction administration by streamlining data flow as well as construction safety.

According to a research study by Okpala et al. (2020), a smart camera system is a network of cameras and recording devices that allows visual data to be gathered. Data collection allows for the dynamic tracking of construction equipment, personnel, and materials on work sites. Moreover, many safety hazards and concerns could be mitigated, as could the possibility of visualizing the job site by tracking the human and nonhuman resources at a workplace. Thus, this camera surveillance system is aimed at improving safety planning and awareness, physical workplace environments, and location safety compliance management.

Kurian et al. (2020) presented in-depth information on how to use artificial intelligence (AI) to evaluate occurrences and reduce risk in oil sands operations. According to the authors of this study, accidents can be reported more precisely and studied to provide learning value to firms that keep databases, allowing them to better prevent and mitigate risks, reduce the cost of losses, and improve safety culture. The authors found that artificial intelligence technology and machine learning (AI/ML) show significant promise for improving process safety management by analyzing data and pattern recognition across large databases in real time, evaluating the most effective key indicators, particularly in relation to low-frequency, high-consequence incidents, and identifying safety operational efficiencies. The writers conducted their research and manually analyzed the results of 70,000 incident reports to create a customized library. These incidents were used to build a machine learning algorithm that can anticipate class labels for new event reports. The labels used in machine learning, keywords from the event database, and a set of statements needed to appropriately define incidents were all included. In this concern, it was feasible to create outputs for any report of the incident that had commonalities with other incidents in the incident database and use these class labels in connection with keyword analysis.

This research yielded a machine learning algorithm that could accurately categorize occurrences with a labeling accuracy of 75–90%, and the outputs were utilized to create risk matrices and assess incident trends. However, Machine learning was applied in the study to eliminate human bias, and this strategy allowed for uniform incident reporting. As a result of adopting AI for incident management, oil and gas businesses will be able to develop better risk management strategies, increasing operational efficiency.

Operating in the hydrocarbon industry is not only expensive but also extremely dangerous. Moreover, the growth of Big Data and analytics can assist oil and gas firms in automating high-cost, dangerous, or error-prone processes, which not only improves safety by reducing human life risks but also has the potential to increase profitability while enabling efficiency benefits (Hassani et al., 2017).

Z. Ye et al. (2020) conducted the study about using artificial intelligence to address environmental difficulties in pollution control. The authors underlined that a great number of studies have found that AI technology can help control pollution in the environment and mitigate risks. The authors in this study added that, due to its exceptional ability to capture the nonlinearity between dependent and independent variables based on statistics using an appropriate training method, AI technology is being widely used as solutions for prediction, identification, and optimization in a variety of fields.

The authors found that AI technologies have become increasingly popular in the field of environmental pollution control in recent decades, and they have been viewed as appealing and efficient alternatives to dealing with the complexities of unpredictable, interactive, and dynamic environmental challenges. However, AI is enhancing the productivity of organizations while minimizing their environmental impact (Lakshmi & Corbett, 2020). In addition, once an oil spill happens in a pipeline, it can have serious and long-term consequences for human health, the environment, and the world economy, and nearly 80% of pipeline incidents result in the release of chemical pollutants (Badida et al., 2019).
Proposed Model

There are various studies that emphasize the technology acceptance model (TAM), which plays a key role in decision-making and emphasizes two principles: perceived usefulness (PU) and perceived ease of use (PEOU) (M. Islam et al., 2013). However, three innovation attributes of the IDT model, including relative advantage, compatibility, and observability, are observed to influence innovation adoption (Tan et al., 2009; Li, 2008; M. Islam et al., 2013; A. Mehra et al., 2020).

Researchers have previously demonstrated that the structures concerned in TAM are deeply noticed as a subdivision in the IDT model as showcases of perceived innovation; they complement each other, and thus it is recommended that merging these two theories might present a greater model than using them individually for a better understanding and rationality of perceptions (A. Mehra et al., 2020).

Thus, this study proposes a model by combining the IDT framework with TAM theory to validate the factors of AI adoption. Innovation attributes such as AI, relative advantage, compatibility, and observability are embedded in the framework.

Conclusion

This study provides a proposed model for the factors influencing AI investment decisions in Oman's hydrocarbon industry. This model intends to provide a thorough knowledge of the elements impacting AI adoption in the industry. The study seeks to determine the important drivers influencing AI investment decisions. These drivers included AI's innovation attributes, the external and internal business environment, risk management, and moderating factors of perceived usefulness and perceived ease of use. Understanding these aspects enables industry stakeholders in Oman's hydrocarbon sector to make sound choices on AI adoption and investment, thereby enhancing operational efficiency, lowering costs, and improving decision-making processes.

Overall, the proposed model provides a thorough examination of the factors influencing AI investment decisions in Oman's hydrocarbon industry. The findings of this study can help industry stakeholders, policymakers, and organizations looking to use AI in the hydrocarbon industry make strategic decisions and optimize the benefits of AI adoption.

Figure 13: The proposed model aims to facilitate an AI-based investment decision.

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