Virtual Reality Applied to Product Development in the Oil and Gas Industry: A Brief Review

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The oil and gas industry has become more competitive and unpredictable, and technology is a route to thrive. Developing solutions for the oil and gas sector entails the incorporation of cutting-edge technology, such as virtual reality. This study examines the role and potential of virtual reality in the oil and gas industry's product and solution development. The method consisted of a systematic literature review of works published over the past decade and adhered to the PRISMA guidelines. We observed that the use of virtual reality technology presents opportunities for the oil and gas industry since it lowers the costs, mitigates risks, increases production and efficiency, and provides long-term economic viability.
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Introduction

Companies in this sector are more actively pursuing innovative applications that make them more efficient by streamlining production, lowering costs, and improving the safety of operations, among other things [1]. In addition, the oil and gas industry is becoming more competitive and unpredictable due to the impending scarcity of fossil fuels. Therefore, these companies senior management sees digitization as a way to protect themselves against market shocks while maintaining profitability at lower costs and creating a competitive advantage throughout the production recovery phase [1]. Using artificial intelligence (AI) and machine learning-based technologies, together with the deployment of technologies that are quickly evolving and being embraced across the value chain, is how some industry leaders [1] see the future unfolding. Although the numerous benefits cloud technology provides and its tools' usage, it has yet to fully permeate the oil and gas sector due to various limitations. The oil and gas business relies heavily on data capture, aggregation, and storage, and data security and compliance are essential concerns when contemplating using cloud computing and related capabilities [2]. One example is the enormous amount of seismic data that must be shared and the significant investment in information technology infrastructure that is already a legacy of the oil and gas exploration and production business. However, increased data collection and storage investment is required to adopt more sophisticated technology.

Along with the challenges of data collection and storage during the oil and gas exploration and production stages, there is also the need to maintain the development and transportation structures. It necessitates reliable, accurate, robust, and efficient control systems for detecting leaks, cracks, or gusts on the pipeline and piping systems widely used by this industry [3]. In this context, research is being conducted on the sorts of equipment that can fulfill the different working conditions and technical specifications in a sturdy and technologically sound manner.

There are existing technologies used for remote control of processes, such as remote monitoring and control of a pipeline system pressure is known as Supervisory Control and Data Acquisition (SCADA) [3] system to monitor the pressure, for example. In this environment, cutting-edge technologies like Virtual Reality (VR) have become vital for developing solutions for the oil

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and gas sector. The focus of this paper is the uses of VR in the context of product development for the oil and gas sector, which is addressed in a brief overview of the literature produced over the last ten years.

Materials and Methods

The research searched literature linked to the subject inside the Science Direct platform database, where 393 publications were located under the search string "VIRTUAL REALITY," "PRODUCT DEVELOPMENT," and "OIL AND GAS INDUSTRY." The search was then refined based on publishing review papers and research articles in the recent ten years (2012 to 2022) publicly accessible to the full text. This refinement resulted in 44 papers chosen based on a study of the titles and abstracts to find those with more substantial relevance and conformity to the subject. Following the debugging of the study using the Revtools [4] program to choose articles with adherence to the subject, 17 publications were chosen and formed part of the bibliographic apparatus of this research. We chose 12 articles from 17 as references for this work. The bibliographical survey entailed examining existing works and evaluating each one's contribution to the suggested subject using the PRISMA [5] guideline (Figure 1).

Table 1 shows the articles used from 2015 to 2022. Many articles were published in periodicals with a tenuous connection to the petroleum and gas industry.

Figure 1. Systematic review flow diagram, adapted from PRISMA 2020 [6].

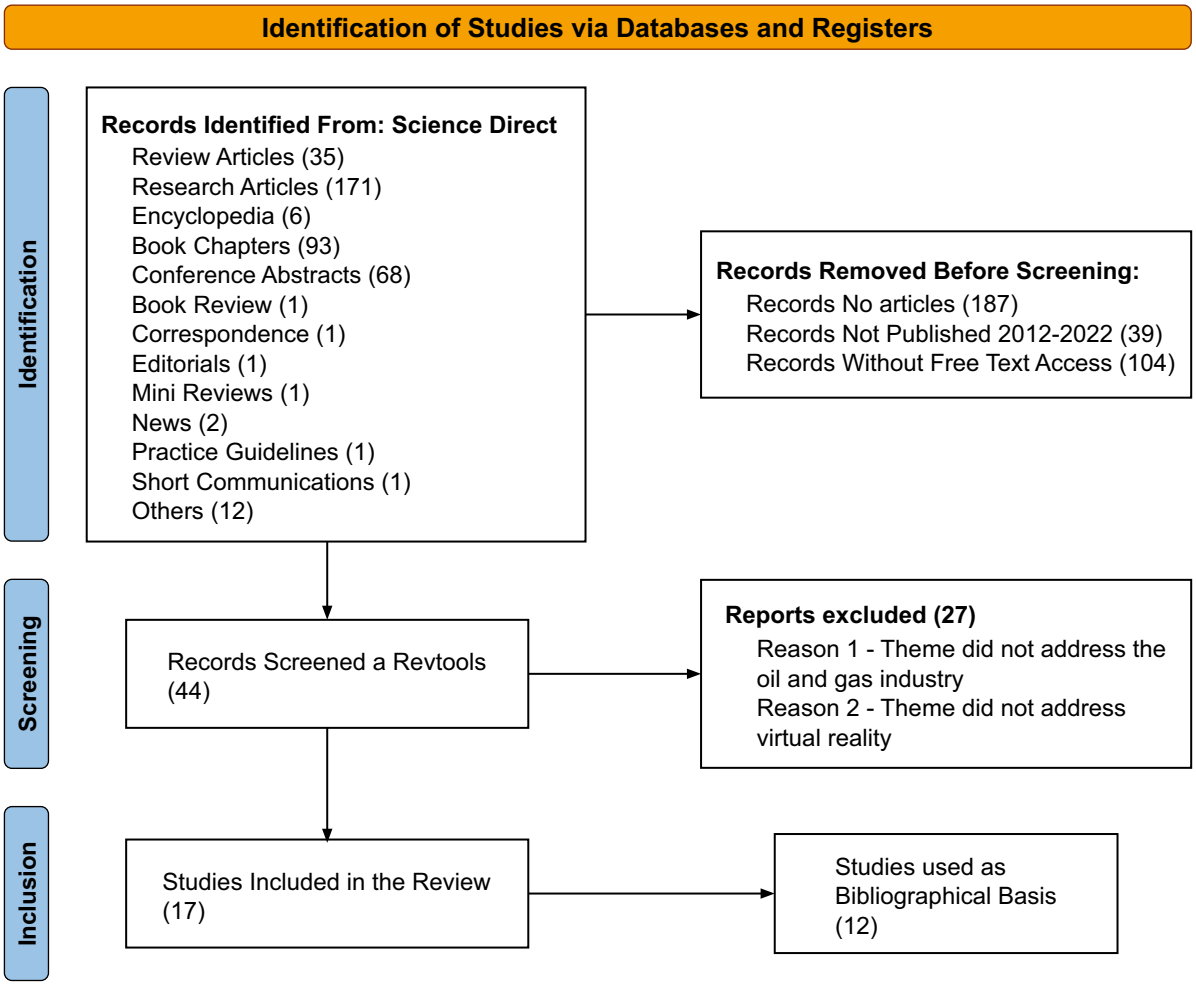

Table 1. Authors, publications, publication, and year.

Author	Publication	Periodical	Year
Bolodeoku PB and colleagues	Perceived usefulness of technology and multiple salient outcomes: the unlikely case of oil and gas workers.	Heliyon	2022
Sircar A and colleagues	Digital twin in hydrocarbon industry	Petroleum Research	2022
Sircar A and colleagues	Application of machine learning and artificial intelligence in oil and gas industry.	Petroleum Research	2021
Priyanka EB, Thangavel S, Gao X-Z	Review analysis on cloud computing based intelligent grid technology in the oil pipeline sensor network system	Petroleum Research	2021
Roberts R colleagues	Psychological factors influencing and technology adoption: A case study from the oil and gas industry.	Technovation	2021
Aramco	Digitalization technology development	Aramco.com	2021
Shahkarami A, Mohaghegh S	Applications of intelligent proxies for subsurface modeling.	Petroleum Exploration and Development	2020
Lawan MM, Oduoza CF, Buckley K	Proposing a conceptual model for cloud computing adoption in upstream oil & gas sector	Procedia Manufacturing	2020
Raboy K and colleagues	A proof-of-concept field experiment on cooperative lane change maneuvers using a prototype connected automated vehicle testing platform.	Journal of Intelligent Transportation Systems	2020
GEP	The increasing popularity of digital twins in oil and gas.	Oil and Gas Blogs	2020
Andoni M and colleagues	Applications of smart proxies for subsurface modeling.	Renewable and Sustainable Energy Reviews	2019
Medvedev D	A new reality: Russia and global challenges.	Russian Journal of Economics	2015

The short period, less than a decade, results from the rapid development of virtual reality devices starting in 2016. According to the literature, 2016 was a turning point in technological advancement with the public release of the first technologically advanced VR glasses[7]; in addition, 2016 had the most significant increase in global research into virtual reality [8]. Academics and professionals agree that the 2016 equipment launched was a "great advance" for virtual reality applications [9,10].

Results and Discussion

Research published this year in the scientific journal Heliyon [11] gave data illustrating the influence of the perceived utility of technology by workers of an oil and gas company in analyzing the implications of technology adoption in the oil and gas scenario. According to the study, the perceived utility of technology has a direct and considerable impact on employee performance. The findings indicate that employees are more likely to commit to their employment and the organization when they value the firm's technology. Furthermore, the higher the awareness of the value of the technology chosen by the business, the more happy workers will be with the organization's progress.

On the other hand, one of the hurdles to advancing and accepting cutting-edge technologies such as VR is the need for fundamental changes in industrial culture and removing barriers beyond financial investments. Barriers such as corporate culture are real hurdles that must be overcome for new technology to be introduced. It is made clear by research published in Technovation [12], which performed a case study in the Oil & Gas (O&G) business to evaluate the effect of psychological variables on technology adoption in the sector. According to the research, the fear of failure was one of the reasons for not implementing the technology.

The role of human capital engagement in adopting new technologies has proven to be a vital and preponderant aspect. It is no surprise that global economies have prioritized the human component as a foundation for significant transformation. Despite this, nations that have accomplished high levels of innovative development in recent decades have made significant investments in human capital [13].

With frontier technologies, particularly the usage of VR in the O&G business, as barrier issues connected to changes in human capital perception, such relevance becomes even more essential. New technology and breakthroughs fundamentally alter marketplaces and whole sectors [13]. It needs new market behaviors, such as new techniques for accomplishing massive, long-term projects involving significant crowd participation. There are several opportunities for implementing cutting-edge technology in the oil and gas business, notably using virtual reality (VR) to assess reservoir conditions. Reservoir simulation models may be implemented because of the cheap computational simulation cost associated with multiscale and multiphase reservoir-type simulation [14]. The success of models developed and validated in a virtual environment capable of reproducing results in fractions of time and with meager computational costs benefits other streams of reservoir management work operations such as sensitivity analysis, production optimization, and uncertainty assessment [14].

Another use of cutting-edge technology in the oil and gas business is the use of Artificial Neural Networks (ANN) [1], a collection of algorithms used in machine learning of data models and, in this case, are precursors to the use of VR and AR. Deep learning algorithms used in the oil and gas business help process large amounts of data, which is extremely necessary for VR adoption. Seismic pattern recognition, drilling diagnostics, improving gas well productivity, identifying sandstone lithofacies, predicting and optimizing performance, and providing pipeline condition prediction. The model can calculate the percentage of sand in the reservoir, bringing all this data together in Virtual Reality as a tool for field staff and creating design solutions [1]. One solution for the oil and gas industry to mitigate the uncertainties and risks of using technology in operations is to use more

technology. In this case, enabling technologies, such as Blockchains [15], can potentially be used for thoughtful device communication, transmission, or storage of data such as that required for VR use. In addition to providing secure data transfer, intelligent grids can further benefit from data standardization enabled by blockchain technology. This would enable the accuracy and validity of information to be used in proofs of concept in the case of virtual prototypes enabled by VR adoption in product development[15,16].

Another example of cutting-edge technology in the oil and gas industry is the use of Digital Twins (TD) in a variety of domains, such as numerical analysis to represent different scales and scenarios, data validation and maintenance in process industries such as refineries, as well as drilling and transportation [17]. Shale reservoirs, for example, are highly challenging to simulate because of the complexity of unconventional systems. However, modeling complicated scenarios, such as studies of gas absorption, flow, and transport of gas in shale reservoirs, understanding the features of adsorption and diffusion of this gas in water carriers, and other possibilities are achievable with the aid of digitalization [17]. In addition, developing products for the petroleum industry sector that go through the exploration, assessment, production, performance, and replacement stages must consider the underlying HSE (health, safety, and environment) dangers [13].

The industry is turning to Digital Twins technology to optimize its exploration processes to improve productivity by increasing efficiency, lowering HSE risks, lowering operating and capital costs, increasing revenues, and improving regulatory compliance [17].

Although the word DT is new to the drilling business, the oil sector has employed the concept for over two decades. DT in real-time drilling operations is increased further by installing diagnostic modules that automatically detect occurrences or issues in operations, allowing potential dangers to be avoided or handled as soon as feasible [17]. Using a DT in a drilling operation combines digital and physical data with predictive analytics and diagnostic signals, boosting the capability of drilling operations planning and decision-making accuracy [17].

In the oil and gas industry, for example, the DT is more than just a three-dimensional model (physical entity, virtual entity, and their connection). It mixes modern technology while considering various relationships and companies within a specific situation [17]. For decades, upstream professionals have worked tirelessly to acquire data from offshore sites to analyze and develop better-informed business plans. An internal audit of an industrial organization discovered that upstream staff spent approximately 80% of their time searching for and then changing data, mainly because the data was previously housed outside a platform [17]. Employees have always had to acquire massive volumes of data from many sources, such as database spreadsheets, data streams, and implicit knowledge. Currently, sensors attached to on-site or in-field equipment may send 1,000 data points per minute to engineers, conveying a massive quantity of data for them to review critically [17].

A practical example is that of the oil giant Saudi Aramco that are implementing certain new technologies such as Big Data Analytics, Industrial Internet of Things (IIoT), Robotics and Drones, Artificial Intelligence (AI), Cloud Computing, 3D Printing, Augmented Reality. /Virtual Reality (AR). /VR). Through advanced modeling and simulations, Aramco uses AR/VR technology to improve emergency preparedness, repair procedures, and facilities [17,18].

Another example is BP, which has created APEX [17,19], a very complex simulation and surveillance system that builds virtual models of all of the company's production systems. BP may design modifications and interventions in the digital twin before delivering them in the actual world using APEX. It identifies issues as a surveillance tool before they significantly impact output. The traditional simulation approach takes many hours and produces significant inaccuracies [17]. On the other hand, APEX may run the same simulation

in minutes and analyze the impact of potentially harmful activities in the safe virtual world setting with a smaller rate of errors [17,19].

Conclusion

This brief analysis concludes that using Virtual Reality and other cutting-edge technologies offers several application possibilities in the oil and gas business, despite the obstacles that overcome capital investments. The use of VR in product development for the oil industry has already demonstrated its potential for cost reduction, risk mitigation, increased productivity in efficiency, and long-term economic viability. The use of virtual reality (VR) in the petroleum industry is already a reality that will increase significantly in the coming decades, enabling new research as well as the generation of essential information for the issue.

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