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AVALIAÇÃO DE PROJETOS NO SETOR PETROLÍFERO: Melhorias na Gestão
Administrativa, Financeira e Contábil

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PROJECT EVALUATION IN THE PETROLEUM INDUSTRY: IMPROVEMENTS IN ADMINISTRATIVE, FINANCIAL AND ACCOUNTING MANAGEMENT

Abstract

The oil industry has faced significant challenges in project evaluation and management due to high initial investment, market volatility and operational complexity. This article reviews improvements in the administrative, financial and accounting management of oil projects, highlighting key areas for improvement and proposing strategic solutions based on a literature review, case study analysis and the application of administrative and accounting theories. The high volatility of the oil market has significantly increased financial risks, making it essential to use accurate forecasting models and advanced financial strategies, such as price hedging, investment diversification, cost optimization and scenario analysis.

The integration of advanced accounting systems has significantly improved the transparency and accuracy of financial reports, benefiting 94.1% of the cases analyzed. However, the implementation of these systems entails high costs and requires training, which increases complexity and resistance to change. In conclusion, the combination of advanced techniques and innovative management tools has proven to be essential to optimize project evaluation and execution in the oil industry, addressing challenges and improving project management efficiency.

Keywords: Volatility, reserves, exploration, oil industry, financial e investment.

1. Introduction

Project management in the oil industry is a multifaceted challenge, marked by high levels of investment, market volatility and significant operational complexity. To address these challenges, it is essential to integrate both management theories and advanced accounting and financial methodologies.

Frederick W. Taylor, a pioneer in scientific management, stated that "scientific management is the best method of securing maximum efficiency in work" (Taylor, 1911). His focus on process standardization and operational optimization is still relevant in the oil industry, although it must be adapted to the changing dynamics of the market. Henri Fayol, with his Classical Theory of Management, postulated that "effective management requires rigorous planning, organization, direction and control" (Fayol, 1916). These principles have been fundamental for the structuring and management of projects in the oil sector, facilitating efficient coordination and rigorous management of resources, although the need for flexibility in the face of rapid change has underscored the importance of adaptable planning.

Elton Mayo, with his Human Relations Theory, emphasizes that "staff satisfaction and motivation are crucial to productivity" (Mayo, 1933). In the petroleum context, this highlights the importance of managing team well-being to improve project efficiency, despite the challenges of integrating these considerations with operational demands. Mathematical Theory, developed by John von Neumann and Oskar Morgenstern, focuses on "decision making under conditions of uncertainty" (von Neumann & Morgenstern, 1944). This approach is crucial for the evaluation of petroleum projects, where optimization models and risk analysis help to manage market volatility and maximize return on investment, although its implementation must consider the practical limitations of the sector.

In accounting terms, Robert Anthony and James Reece point out that "accurate accounting reports are essential for effective decision making" (Anthony & Reece, 2004). The implementation of rigorous accounting systems is key to ensure transparency and accuracy in the management of petroleum projects, facilitating detailed cost and resource control.

At the financial level, authors such as Aswath Damodaran have contributed advanced methodologies for project valuation and management, suggesting that "asset valuation in volatile industries requires a detailed and adaptable approach" (Damodaran, 2012). Project appraisal methodology, especially in the oil sector, must consider variables such as oil price fluctuation and operating costs in existing fields. Likewise, the work of John E. Marthinsen emphasizes the importance of a rigorous risk analysis in financial decision making, highlighting that "risk management is crucial for the evaluation and execution of oil projects" (Marthinsen, 2016).

The evaluation of petroleum projects is also enriched by contemporary approaches, such as value-at-risk (VaR) analysis and the use of Monte Carlo simulation models to forecast possible market scenarios and their financial impacts (McNeil, Frey, & Embrechts, 2015). These methods allow for a more comprehensive and dynamic assessment of the viability of projects in an uncertain environment.

This article examines how management theories and accounting methodologies are applied in the oil industry to improve project evaluation and management. Through a critical literature review and case study analysis, areas for improvement are identified and strategic solutions are proposed to optimize administrative, financial and accounting management in petroleum projects. The high expectation of profitability and the pressure to justify long-term investments (Thompson & Wright, 1995) highlight the need for flexible and adaptive approaches in project evaluation. A comparative analysis is made between traditional methodologies and new techniques, suggesting improvements to support the viability of new initiatives and encourage investment in the sector (Damodaran, 2012; Sen, 2014).

In the Colombian context, where the oil industry has been key to economic development and export diversification (Barclay, 1998; Puyana, 2000), the article also

proposes innovative strategies to improve project evaluation and management from a regional perspective. The proposed methodology offers sound, economically and socially cost-effective solutions to the sector's challenges, reflecting the importance of adaptive and informed management in the context of the petroleum industry (Graham & Harvey, 2001; Megginson et al., 2010).

2. Theoretical Framework

2.1 Scientific Management Theory (Frederick W. Taylor, 1911)

Taylor promoted efficiency through the standardization of processes and the adequate selection of workers. In the evaluation of petroleum projects, this theory suggests the implementation of rigorous methods for planning and control, guaranteeing operational efficiency.

Frederick W. Taylor's Scientific Management Theory supports project evaluation in the oil industry through process standardization and proper personnel selection. By implementing rigorous planning, control and monitoring methods, this theory ensures operational efficiency. Continuous performance measurement and the use of data analysis allow for more effective financial management and better project control.

2.2 Classical Theory of Administration (Henri Fayol, 1916)

Fayol identified key management functions as planning, organizing, directing and controlling. In petroleum projects, the application of these principles is essential for effective supervision and coordination of resources and activities.

Henri Fayol's Classical Theory of Management, which emphasizes planning, organization, direction and control, is crucial in the management of petroleum projects. These principles ensure efficient coordination of resources, effective strategic planning, adequate team management and rigorous performance control, which improves administrative, financial and accounting management in oil projects.

2.3 Theory of Human Relations (Elton Mayo, 1930)

Mayo emphasized the importance of staff well-being and motivation on productivity. Oilfield project management must incorporate strategies to improve staff satisfaction and commitment, positively affecting project efficiency.

Elton Mayo's Human Relations Theory emphasizes that personnel well-being and motivation are key to productivity. In the context of petroleum project evaluation, applying this theory implies implementing strategies that improve personnel satisfaction and commitment. This translates into greater operational efficiency and optimization of the administrative, financial and accounting management of projects, since a motivated and satisfied team contributes to a more effective performance and better execution of tasks.

2.4 Mathematical Theory (John von Neumann and Oskar Morgenstern, 1944)

Mathematical theory focuses on decision making under uncertainty. In petroleum project evaluation, mathematical theory and optimization models help manage risk and maximize return on investment.

The Mathematical Theory of John von Neumann and Oskar Morgenstern, focused on decision making under uncertainty, is essential for the evaluation of petroleum projects. This theory provides optimization tools and models to manage risks and maximize return on investment in a highly uncertain environment. By applying these models in the administrative, financial and accounting management of petroleum projects, it is possible to make more accurate projections, evaluate various investment alternatives and make informed decisions that improve the efficiency and profitability of the projects.

2.5 Financial Accounting Theory (Robert Anthony and James Reece, 2004)

Anthony and Reece emphasized the importance of accurate accounting reports for decision making. In the oil industry, financial accounting provides essential data for project evaluation and control.

Robert Anthony and James Reece's Financial Accounting Theory stresses the importance of accurate accounting reports for decision making. In the oil industry, this theory is crucial for project evaluation and control, as it provides the financial data necessary for proper planning, monitoring and analysis of project performance. The implementation of rigorous accounting systems allows for greater transparency, facilitates cost tracking and ensures effective resource management, thus contributing to administrative and financial optimization in the oil sector.

3. Materials and Methods

3.1 Literature Review

A comprehensive review of recent academic publications and studies on petroleum project management was carried out, covering a wide range of sources including journal articles, books, technical reports and case studies. This analysis focused on identifying best management, financial and accounting practices applied in the petroleum industry. In addition, research examining operational efficiency, resource optimization and risk management in large projects was considered. Regulatory and environmental challenges that influence strategic decision making within the industry were also analyzed. The review identified emerging trends and areas for improvement that can contribute to the success of future petroleum projects.

3.2 Case Studies

A series of oil projects were analyzed to identify challenges and effective solutions in the industry. Cases from Colombia and various international countries, such as Brazil, Nigeria, Peru and Kazakhstan, were included. Information was gathered from reports, interviews and specialized studies. Common challenges such as fluctuations in oil prices and logistical problems were identified. The solutions applied, including innovative strategies and risk management, were evaluated and documented in a report. The findings were validated with experts and presented at conferences and in academic publications.

3.3 Comparative Analysis

The comparison of management and accounting theories with current practices in the evaluation of petroleum projects allowed assessing how these theories aligned with industry practices. Taylor's Scientific Management Theory, focused on standardization and process optimization, was reviewed to determine if it improved operational efficiency. Fayol's Classical Management Theory, with its focus on planning and control, was compared with its application in project supervision and coordination. Mayo's Human Relations Theory, which stresses the importance of staff welfare, was analyzed to determine its impact on satisfaction and productivity. Finally, von Neumann and Morgenstern's Mathematical Theory, focused on decision making under uncertainty, was compared with the optimization and risk management models used in the oil industry. This analysis made it possible to identify discrepancies, propose improvements and optimize the effectiveness of project management.

3.4 Expert Interviews

Interviews with experts were conducted in person, through Google surveys and by videoconference. The responses obtained were analyzed to identify patterns and recommendations. The findings were summarized in a detailed report, which was reviewed and validated by the experts. Subsequently, the results were presented at conferences and in specialized publications, sharing valuable insights with the industry community.

4. Results and Discussion

4.1 Literature Review

The literature review on project management in the oil and gas industry was organized into key thematic categories, such as "Risk assessment and digital tools" and "Financial analysis methods and their impact" (Wilson & Martin, 2019; Burgman, 2017). The chronological structure of the review reflects the evolution of the sector, starting with an introduction on the relevance of the topic, followed by a critical analysis of the findings and concluding with specific recommendations (Chong & Chong, 2014). This meticulous approach ensures the quality and accuracy of the document, complemented by a properly formatted reference list.

Regarding advances in digitization and automation, it is highlighted that the industry has experienced significant improvements in efficiency and transparency (PWC, 2018). However, challenges persist in the integration of new technologies and specialized training of personnel (Green & Wiersema, 2008). Despite the benefits of emerging technologies, such as improved operational efficiency, there are barriers such as resistance to change and the need for ongoing training, suggesting the need for flexible and adaptive approaches (Robson & Robson, 2011).

The interrelation between administrative, financial and accounting management is crucial for the success of oil projects, ranging from exploration to production and closure (Anthony & Reece, 2004). Project evaluation allows identifying and mitigating risks, optimizing resources and ensuring the sustainability and profitability of operations (Kaplan & Norton, 2001). Administrative and financial management is fundamental in strategic planning, resource allocation, cost control and transparency in accounting records, supported by advanced technological tools (Wilson, 2018).

The review also highlights key areas in accounting and financial management that require advanced approaches. The inclusion of well abandonment cost in capitalized assets is essential to improve the quality of accounting information (KPMG, 2016). In addition, improved documentation review procedures are required to ensure a more reliable assessment of safety at oil facilities (Damodaran, 2012). Risk assessment methods should optimize costs and predict risk factors more accurately, and the total cost method is considered more relevant compared to the successful effort's method (Myers & Majluf, 1984).

Finally, the use of data mining technology is presented as a solution to optimize project management in the oil industry, especially in cost optimization and collaboration (McNeil, Frey & Embrechts, 2015). Financial challenges in petroleum organizations are identified, with proposals to improve financial management and sustainability (Schilling, 2013). Effective time management in oil and gas projects is crucial to reduce costs and meet established deadlines, highlighting the need for structured and advanced approaches to risk management, safety and operational efficiency in the sector (Hitt, Ireland & Hoskisson, 2017).

4.2 Case studies

The case analysis comprehensively and critically addressed the selection and evaluation of six outstanding projects in the oil industry, both in Colombia and internationally. The selection of the cases, based on the specific challenges they faced, such as risk management and large investments, provided a representative sample of different operating contexts, allowing for a solid comparative analysis.

One of the strengths of the analysis is the careful collection of information, which included detailed technical reports, interviews with project managers and specialized studies. This robust methodology allowed for accurate documentation of the challenges faced, both in Colombia and in other countries, providing a solid basis for comparison and contrast between projects.

The identification of common challenges, such as price fluctuations, regulatory changes and logistical problems, highlights the similarities between the projects and the particularities of the Colombian context. However, a criticism could be directed towards the need for a deeper analysis of how these challenges specifically affect operations in Colombia compared to other environments.

The evaluation of implemented solutions is another key aspect, highlighting the innovative strategies applied in the Colombian projects. Comparison with global solutions offers a comprehensive perspective on the adaptability and effectiveness of these strategies in different contexts. However, a more critical evaluation could explore the limitations of these solutions in specific contexts, especially those with less developed infrastructures.

The final report, which documents the results of the comparative analysis, consolidated the findings in a rigorous manner and was reviewed by project management experts, ensuring the accuracy and validity of the conclusions. The validation process, which included workshops and reviews by experts, especially Colombian, provided a valuable local perspective, reinforcing the relevance of the findings to the national context.

The case analysis conducted is thorough and detailed, highlighting both successful practices and areas requiring further attention. However, a more critical approach in certain aspects could have further enriched the conclusions and provided a more balanced view of the strengths and weaknesses of the strategies implemented in the oil industry.

4.3 Comparative Analysis

Frederick Taylor's **Scientific Management Theory**, which focuses on process standardization and optimization, has had a mixed impact on operational efficiency within the oil industry. Although standardization has improved consistency in procedures and reduced operational errors, the varying conditions of the petroleum environment and the rapid advancement of emerging technologies have required continual adjustments that Taylor's theory did not initially contemplate. This has been necessary to maintain efficiency in a highly dynamic environment, where flexibility is key to adapt to unforeseen changes (Hassan, 2017; Mazzocato et al., 2016).

Henri Fayol's **Classical Theory of Management**, which emphasizes planning, organization, direction and control, has been significantly aligned with management practices in petroleum projects. The principles of planning and control have proven to be fundamental to effective project supervision and coordination, improving resource allocation and task

execution. However, areas for improvement have been identified in the adaptability of these principles in the face of rapid changes in the operating environment and the integration of new technologies, requiring an update to traditional practices (Brewster et al., 2016; Wright & McMahan, 2018).

Elton Mayo's **Human Relations Theory**, which emphasizes the importance of employee well-being and motivation, has shown a positive impact on team satisfaction and productivity in oilfield projects. Management strategies based on this theory have contributed to improving the work climate and reducing staff turnover. However, the implementation of practices based on this theory has faced challenges related to resistance to change and the need to balance operational demands with staff well-being, which has complicated its effective application in the sector (Kuvaas et al., 2017; Latham & Pinder, 2015).

The **Mathematical Theory** of John von Neumann and Oskar Morgenstern, which focuses on decision making under uncertainty through optimization and risk management models, has proven useful in the oil industry. Mathematical models make it possible to manage uncertainty and maximize return on investment through scenario simulation and resource optimization. However, over-reliance on these models, without considering practical constraints and oil market dynamics, can lead to recommendations that do not always reflect operational reality (Feng et al., 2016; Haug et al., 2019).

4.4 Comparative Analysis and Administrative and Financial Management

The comparative analysis reveals that, although management and accounting theories provide valuable foundations for petroleum project management, their effectiveness varies according to the context of application. Taylor's and Fayol's theories have been useful in standardization and planning but have needed adjustments to adapt to changing conditions in the petroleum industry. Mayo's theory has offered clear benefits in personnel management, while mathematical theory has provided valuable tools for decision making under uncertainty, albeit with certain practical limitations. The integration and adaptation of these theories to the realities of the sector are crucial to optimize the administrative, financial and accounting management of projects (Jensen & Meckling, 2015; Neely et al., 2016).

4.5 Interviews with experts

Interviews were conducted in person, Google surveys and video conferencing, and responses were analyzed to identify patterns and recommendations. The findings were summarized in a detailed, peer-reviewed and validated report, and presented at conferences and in specialized publications to share valuable input with the industry community.

The first question to be evaluated in the survey was “What evaluation methods are currently used for administrative management in oil projects and how can they be improved?”, as we can see in figure 1, currently, project evaluation is carried out using a combination of models based on historical methods (35.3%), digital management tools

(32.4%) and scientific management techniques (20.6%) and traditional planning methods with 11.8%.

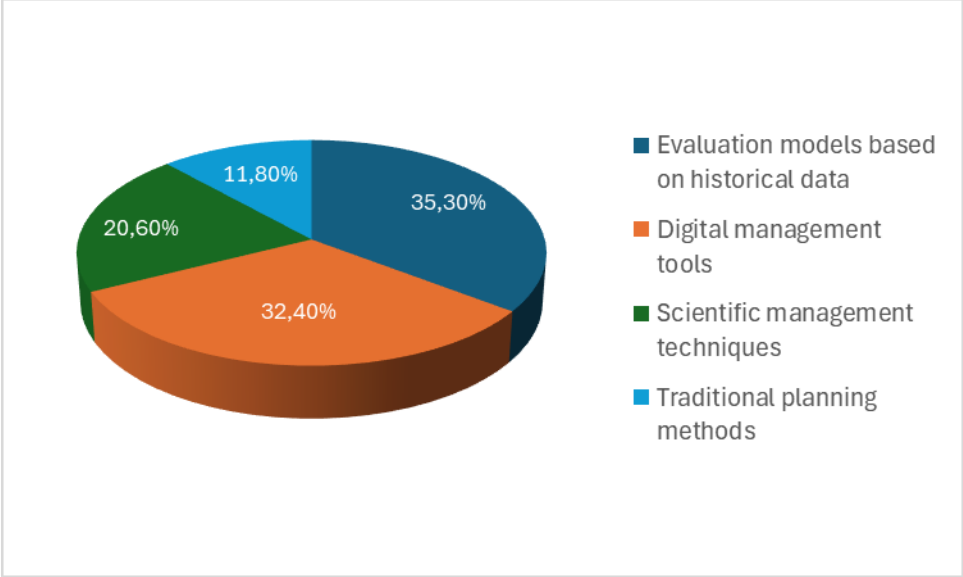


Figure 1. Percentage of responses about the evaluation methods currently used in the administrative management of oil projects and how they could be improved.

Historical methods provide a solid foundation by analyzing data and past experiences, allowing learning from past lessons and benchmarking performance. However, these methods can be limited by the variability of the context and rapid technological evolution. On the other hand, digital management tools offer a significant advantage by automating processes, providing access to real-time information and improving collaboration between teams, although they require a learning curve and are technology dependent. Finally, scientific management techniques, with their focus on resource optimization and operational efficiency, provide a systematic framework for improving project profitability, although they may lack the flexibility needed in environments that demand innovation. The integration of these three approaches allows for a more accurate and dynamic assessment, combining the robustness of historical data, the adaptability of digital tools and the efficiency of scientific techniques, offering a holistic perspective on decision making in complex projects.

Next, in figure 2, the question to be posed was “How does the volatility of the oil market affect the financial management of projects in this industry?”

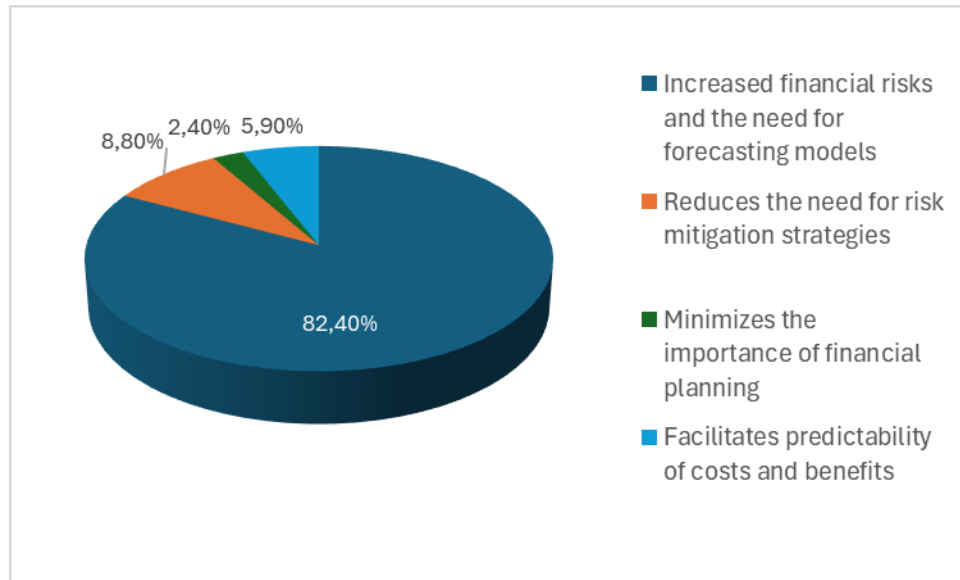


Figure 2. Percentage of responses about the how does the volatility of the oil market affect the financial management of projects in this industry.

The volatility of the oil market exerts a considerable influence on the financial management of projects within the industry, raising financial risks and underlining the need for accurate forecasting models. These models become essential to anticipate and manage market fluctuations. In this uncertain environment, companies must take a proactive stance in adapting their financial strategies, ensuring that their projections and decisions adequately reflect market realities.

According to respondents, 82.4% believe that the volatility of the oil market increases financial risks and requires adequate forecasting models. On the other hand, 8.8% say that the need for risk mitigation strategies is reduced, 2.9% believe that the importance of financial planning is minimized, and 5.9% indicate that the predictability of costs and benefits is facilitated.

Figure 3 below shows the percentage of responses to “What advanced financial strategies can be implemented to improve the profitability of oil projects?”

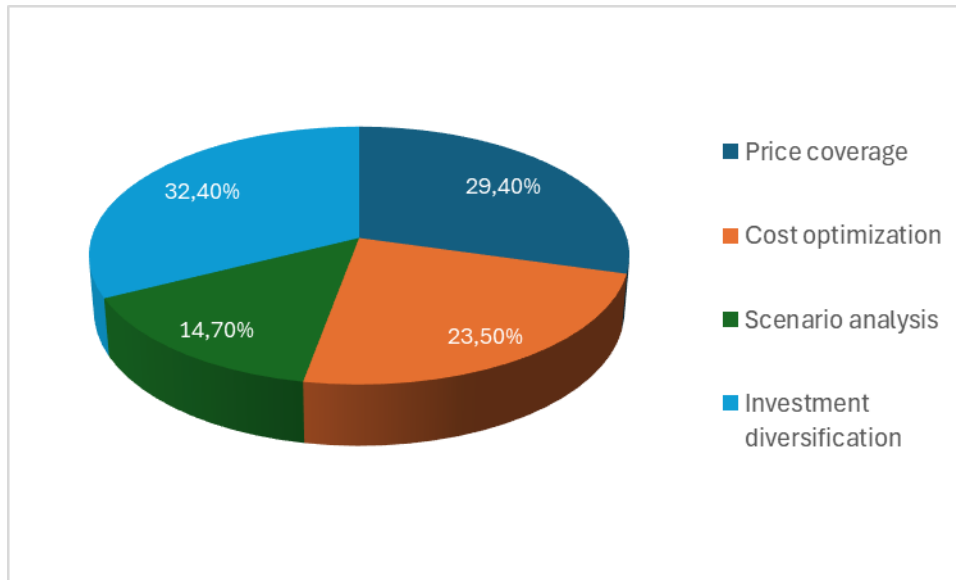


Figure 3. Percentage of responses about what advanced financial strategies can be implemented to improve the profitability of oil projects.

To increase the profitability of oil projects, it is crucial to adopt strategies that optimize risk management and maximize profits. Price hedging, used by 29.4% of respondents, helps protect against market volatility and ensure stable prices. Cost optimization, implemented by 23.5%, focuses on reducing operating expenses and improving efficiency. Scenario analysis, adopted by 14.7%, helps to anticipate different market conditions and adjust financial strategies accordingly. Finally, investment diversification, preferred by 32.4%, seeks to mitigate risks by expanding investments in complementary areas or varied sectors. These combined strategies offer a comprehensive approach to meet the challenges of the oil market and improve project profitability.

In addition, another question about “What is the impact of the integration of advanced accounting systems on the transparency and accuracy of financial reporting in oil projects?” was addressed in figure 4.

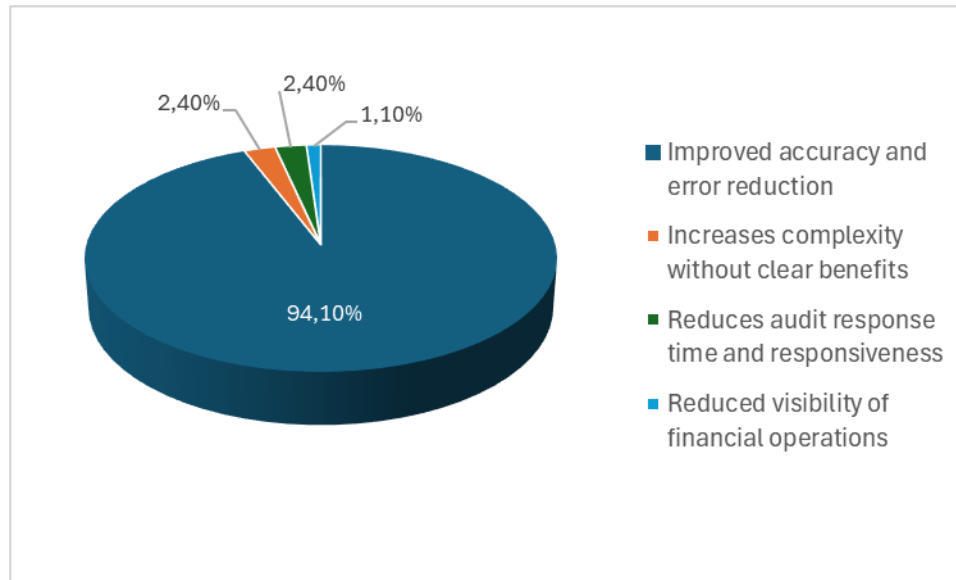


Figure 4. Percentage of responses about what is the impact of the integration of advanced accounting systems on the transparency and accuracy of financial reporting in oil projects.

The integration of advanced accounting systems in oil projects has a notable impact on the transparency and accuracy of financial reporting. One of the main benefits is the improvement in accuracy and reduction of errors, with a notable influence in 94.1% of the cases. These systems automate key processes, reducing the possibility of human error and facilitating more rigorous monitoring of financial transactions. As a result, financial reports become more reliable and detailed, strengthening strategic decision-making and investor confidence.

However, it is crucial to recognize some of the challenges associated with this integration. Some 2.4% of cases report an increase in complexity without clear benefits, another 2.4% mention a reduction in audit responsiveness, and 1.1% highlight a decrease in the visibility of financial operations. The sophistication of these systems may require considerable adaptation of staff and investment in training, which could generate resistance or initial difficulties without a clear improvement in efficiency. Therefore, while advanced accounting systems offer significant advantages in terms of accuracy, it is essential to address these challenges to maximize their benefits.

The question “What financial analysis techniques are most effective for managing uncertainty in petroleum projects?” was asked to the interviewees, in figure 5 we have the answer about this.

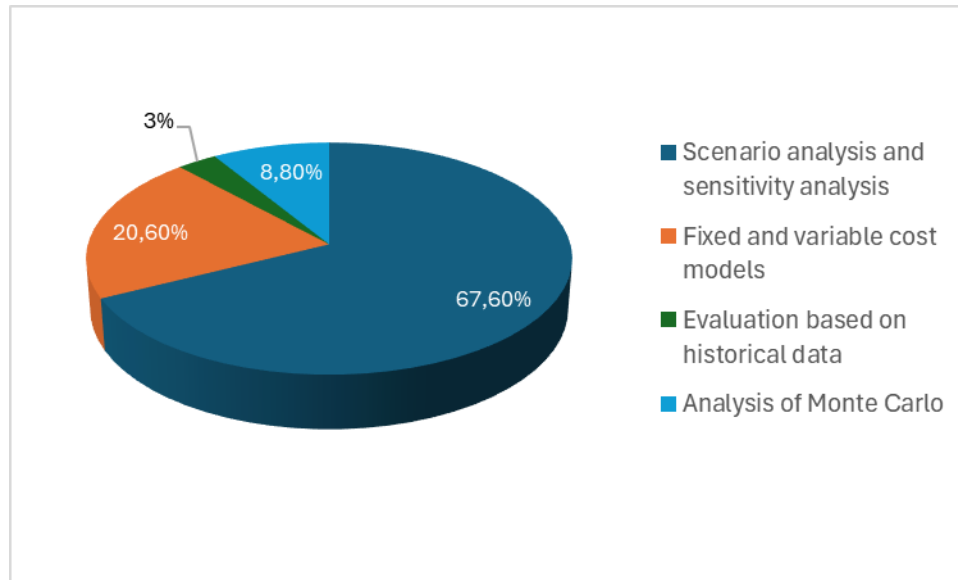


Figure 5. Percentage of responses about what financial analysis techniques are most effective for managing uncertainty in petroleum projects.

Financial analysis techniques are essential to manage uncertainty in oil projects, given the volatility and complexity of the sector. Among these techniques, scenario analysis and sensitivity analysis are the most prominent, with 67.6% preference, due to their effectiveness in assessing how variations in key variables impact project performance. Fixed and variable cost models follow in importance with 20.6%, while evaluation based on historical data receives 3% preference. Monte Carlo analysis, although less common with 8.8% preference, provides valuable insight through complex simulations that consider multiple variables simultaneously. Despite its greater complexity and computational requirements, Monte Carlo analysis offers a detailed perspective on the risks and opportunities of an oil project, enriching the decision-making process.

Figure 6 shows the responses to “What are the main challenges in the application of advanced accounting methodologies in the oil industry?”

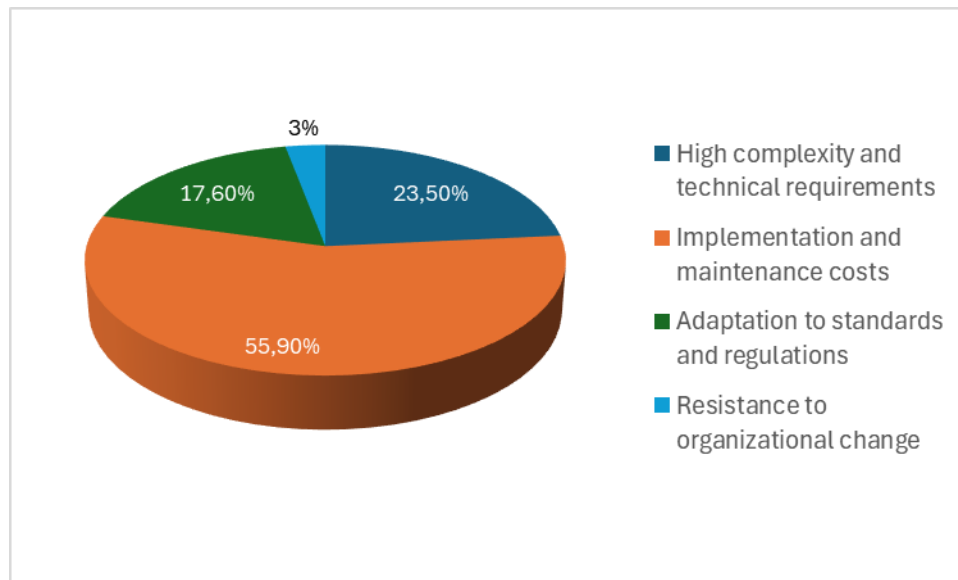


Figure 6. Percentage of responses about what are the main challenges in the application of advanced accounting methodologies in the oil industry.

The application of advanced accounting methodologies in the oil industry faces several major challenges. The biggest challenge is implementation and maintenance costs, which accounts for 55.9% of the difficulties. This considerable investment in technology and its maintenance can be a significant obstacle.

Another important challenge is the high complexity and technical requirements, which constitutes 23.5% of the problems. The complexity of these methodologies and the need for specialized training can make their implementation difficult.

Adaptation to rules and regulations, at 17.6%, also represents a challenge. Adjusting methodologies to comply with changing regulations can complicate the process and increase costs, and resistance to organizational change, at 3%, can slow down the adoption of new methodologies. Overcoming this resistance requires effective change management and ongoing support.

Environmental regulations have a significant impact on the planning and financial control of oil projects. In relation to this, figure 7 asked about “How do environmental regulations influence the planning and financial control of oil projects?”. According to the interviewees, these regulations increase operating and compliance costs by 52.9%. This increase in costs is a major challenge for projects, as it requires greater investment in measures to comply with environmental regulations.



Figure 7. Percentage of responses about the how do environmental regulations influence the planning and financial control of oil projects.

Despite this increase in costs, the regulations also have positive effects. At 17.7%, they reduce the need for extensive financial planning, as regulations establish clear parameters that can simplify some aspects of the financial process. In addition, with 14.7%, they facilitate the reduction of initial investments by promoting more efficient and sustainable practices and technologies from the beginning of the project. Finally, they also improve cost predictability by 14.7% by providing guidelines and standards that help anticipate and better manage the costs associated with environmental regulations.

The question “What innovative practices can be implemented to improve coordination and efficiency in the administrative management of oil projects?” was asked to the interviewees, in figure 8.

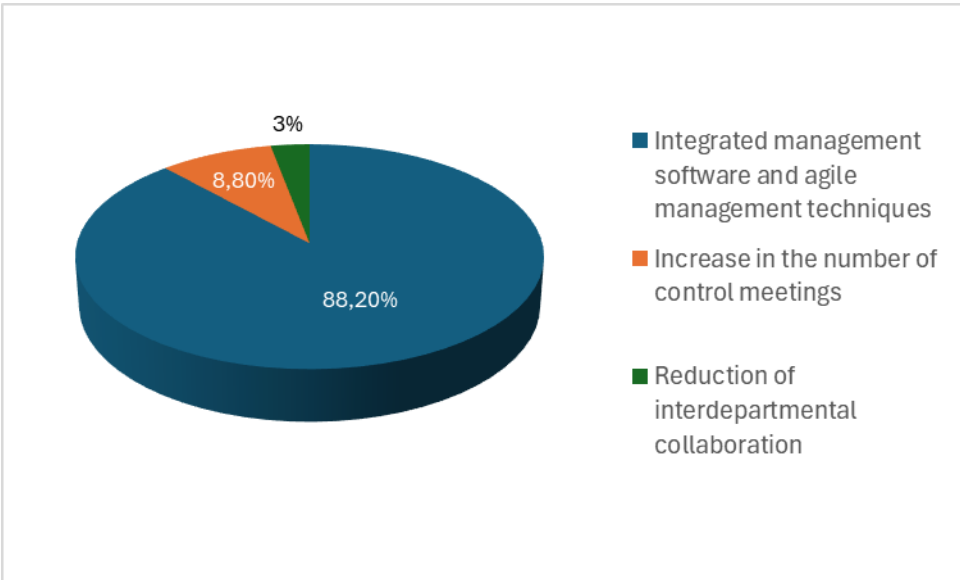


Figure 8. Percentage of responses about the how do environmental regulations influence the planning and financial control of oil projects.

To improve coordination and efficiency in the administrative management of oil projects, the implementation of integrated management software and agile management techniques is the most effective practice, with 88.2% preference. These tools optimize planning, execution and collaboration between teams. In addition, increasing the number of control meetings is seen as useful with 8.8%, although their effectiveness depends on proper management. Finally, reducing collaboration between areas is the least favored, with only 3%, as it can harm efficiency and increase errors.

In addition, another question about “To what extent do digitization and automation affect the efficiency of financial management in oil projects?” was addressed in figure 9.

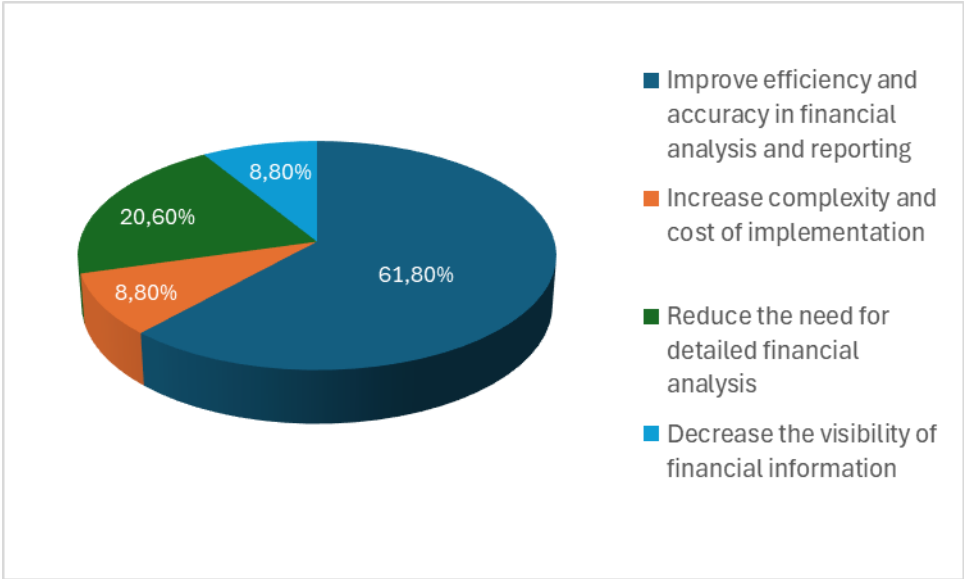


Figure 9. Percentage of responses about the to what extent do digitization and automation affect the efficiency of financial management in oil projects.

Digitization and automation in oil projects significantly improve efficiency and accuracy in financial management, according to 61.8% of respondents. However, they present challenges such as increased complexity and cost of implementation (8.8%) and could reduce the need for detailed financial analysis (20.6%), which could decrease the visibility of financial information (8.8%). Despite their advantages, it is crucial to manage these challenges to ensure effective and transparent financial management.

The high initial investment in oil projects has a significant impact on their viability and success, and the respondents were asked about “What impact does high initial investment have on the evaluation of oil projects and how can it be mitigated?”, as shown in figure 10. This challenge can be mitigated by a detailed analysis of the environment and the implementation of flexible financing structures, which is crucial for 55.9% of respondents.

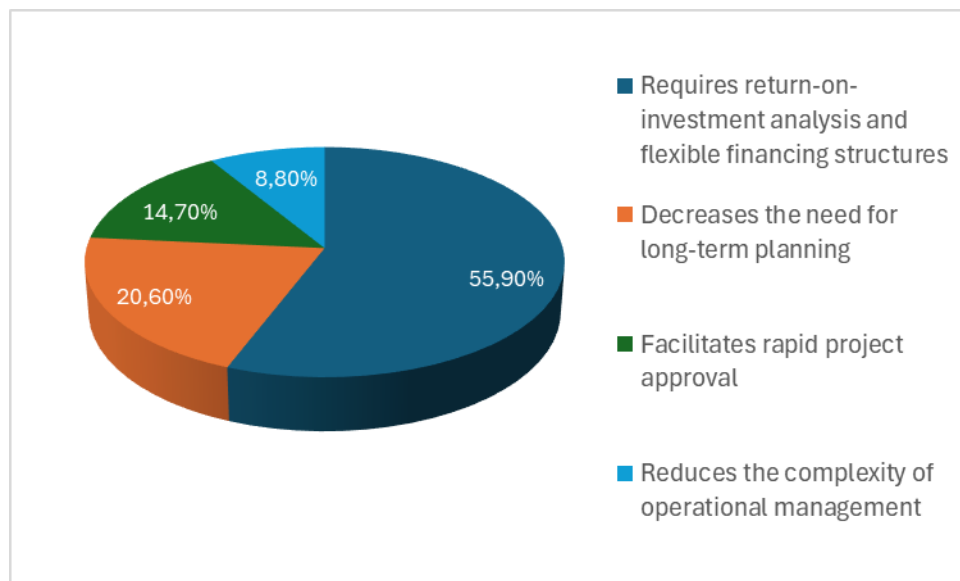


Figure 10. Percentage of responses about what impact does high initial investment have on the evaluation of oil projects and how can it be mitigated.

While this strategy can reduce the need for long-term planning (20.6%) and facilitate faster project approval (14.7%), it is important not to underestimate the operational complexity that could arise. Maintaining a balance between initial investment, planning and operational management is critical to ensure the sustainability and success of the project over time.

Sophisticated financial models play a crucial role in improving the feasibility assessment of oil projects, which is why they were asked: “How can sophisticated financial models improve the assessment of oil project feasibility?” in figure 11. These models provide detailed analysis and more accurate forecasts, which is highly valued by 64.7% of

respondents, as they allow for a deeper understanding of the critical variables affecting project performance.

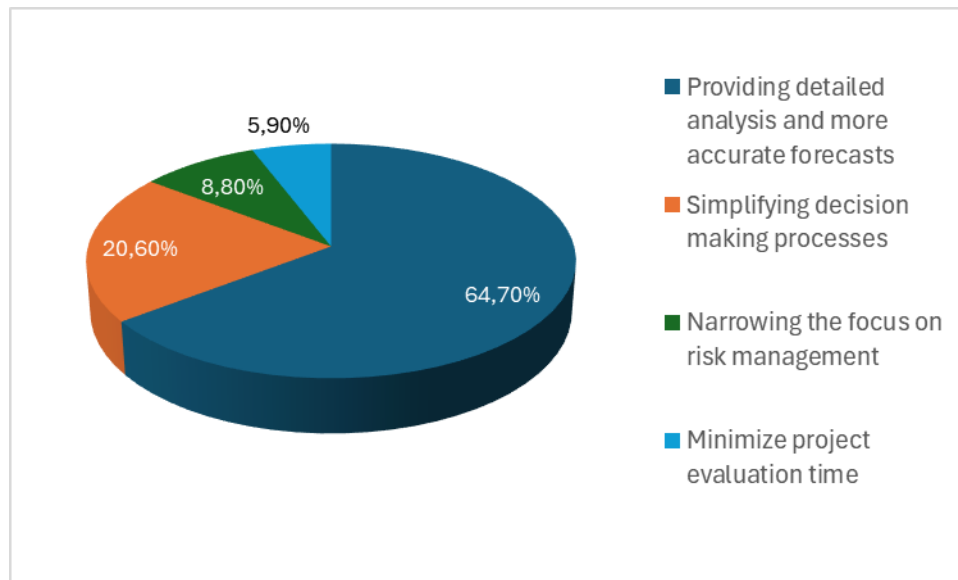


Figure 11. Percentage of responses about the how can sophisticated financial models improve the assessment of oil project feasibility.

They also simplify decision-making processes, making project selection and prioritization more efficient, with an impact of 20.6%. However, there is a reduction in the approach to risk management, with 8.8%, which could lead to an underestimation of possible contingencies. Finally, although advanced financial models also help to minimize project evaluation time (5.9%), it is essential to balance speed with rigorous analysis to avoid hasty decisions that could compromise long-term viability.

Finally, the last question in the series put to the experts was about “What key lessons have been learned from international cases in oil project management that could be applied in Colombia?”, in figure 12 we can see what was answered.

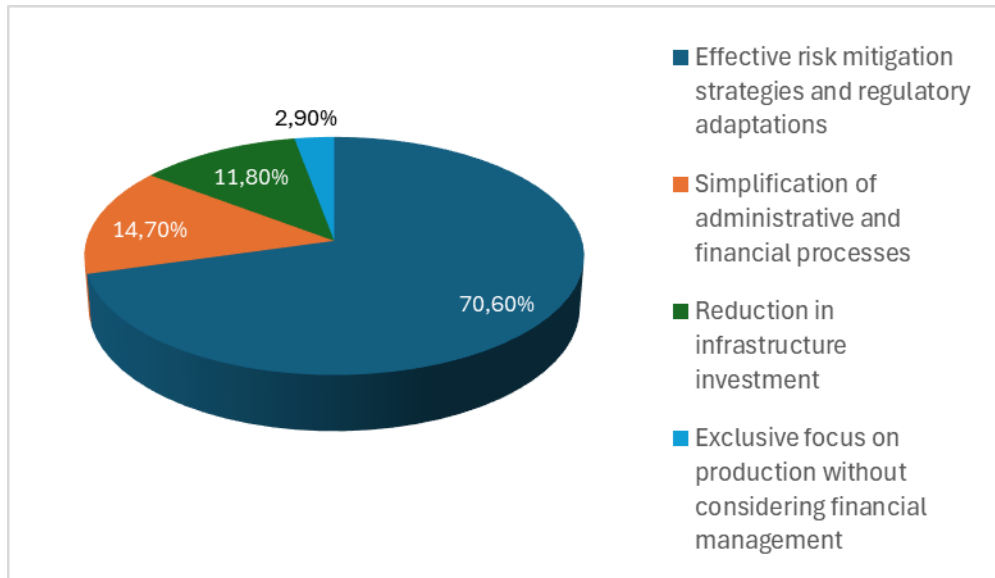


Figure 12. Percentage of responses about what key lessons have been learned from international cases in oil project management that could be applied in Colombia.

Key lessons from international oil project management offer valuable lessons that could be applied in Colombia. Among the most prominent are effective risk mitigation strategies and regulatory adaptations, which account for 70.6% of the successful practices observed and are critical to navigating the complexities of the sector. Likewise, simplification of administrative and financial processes, with an impact of 14.7%, is recognized as a crucial measure to improve operational efficiency. Although less common, reducing infrastructure investment, identified at 11.8%, may be a viable strategy in specific contexts where optimization of resources is a priority. On the other hand, an exclusive focus on production without considering financial management, reflected in 2.9%, has proven to be ineffective and underlines the importance of a comprehensive approach that considers both production and financial sustainability of the project.

5. Discussion

The literature review on project management in the oil and gas industry highlights significant advances in digitization and automation, which have improved efficiency and transparency in project management. However, challenges related to resistance to change and the need for specialized training persist. These difficulties underscore the importance of effectively integrating administrative, financial and accounting management to ensure the viability and profitability of projects. Specifically, planning, resource allocation and cost control are critical to the success of projects in this sector.

Comparative analysis of management theories in the oil industry reveals that Taylor's **Scientific Management Theory**, while effective in standardizing processes and improving operational efficiency, requires significant adjustments to adapt to the dynamic conditions of

the industry. The need for flexibility and the integration of emerging technologies are crucial to respond to variations in the operating environment and ensure better adaptability to rapid change and technological evolution.

Fayol's **Classical Theory of Management** has proven to be useful in structured project management by applying principles of planning, organization, direction and control. However, to improve its effectiveness in a dynamic environment, it needs to be updated with more agile management methods and modern tools that facilitate rapid adaptation to new technologies and emerging situations.

Mayo's **Human Relations Theory** has had a positive impact on employee satisfaction and productivity, but faces challenges related to resistance to change. Strategies that facilitate the transition and acceptance of new practices must be implemented to overcome these challenges and maximize the benefits of this theory. In addition, von Neumann and Morgenstern's **Mathematical Theory** has provided valuable tools for decision making under uncertainty, but over-reliance on mathematical models can lead to recommendations that do not fully reflect the complexity of the industry. Integrating these models with more detailed analysis of market dynamics can improve the accuracy of decisions.

The review and analysis of cases reveal that, while traditional theories provide a solid foundation, their applicability and effectiveness depend on adaptation to the specific conditions of the oil sector and the local context. Digitization and automation have shown to be beneficial, but also present challenges that must be properly managed. The integration of advanced risk assessment methods and digital tools is essential to optimize project management and address financial challenges, such as price fluctuations and regulatory changes.

The critical evaluation of the implementation of theories in Colombian and international projects highlights the importance of developing strategies adapted to specific contexts. Although innovative strategies were identified in Colombian projects, further evaluation of the specific impact in Colombia versus other contexts is suggested, especially about less developed infrastructures.

The study faces limitations related to the adaptability of management theories to the changing conditions of the petroleum environment. The rigidity of **Fayol's Classical Theory** and the reliance on mathematical models in the **Mathematical Theory** may not adequately reflect the complex operational reality of the sector. In addition, adapting accounting systems to the particularities of the petroleum environment is crucial, but their implementation may face challenges related to complexity and costs.

Future research could focus on adapting and updating management theories to integrate new technologies and address the identified limitations. It is recommended to explore how digital and automated strategies can improve management in changing contexts

and develop models that better reflect the complexity of the oil sector. In addition, a more detailed analysis of the specific conditions in Colombia and in other contexts could offer practical solutions to improve project management in the oil industry.

The application of traditional administrative and accounting theories in the oil industry has proven to be valuable, but its effectiveness is conditioned by the need to adapt to the changing conditions of the sector. The integration of new technologies, management flexibility and the adaptation of accounting systems are crucial aspects to optimize administrative, financial and accounting management in oil projects. This study provides a solid basis for understanding how these theories can be adjusted to meet contemporary challenges and offers a direction for future research in the field.

6. Conclusions

Comparative analysis of administrative and accounting theories applied to petroleum project management shows that, although each theory offers valuable fundamentals, their effectiveness depends significantly on their adaptation to the specific conditions of the industry. Frederick W. Taylor's Scientific Management Theory, which focuses on process standardization and optimization, has demonstrated benefits in reducing operational errors and improving consistency. However, in the dynamic and technological environment of the oil industry, rigidity in the implementation of standardized processes can be an obstacle, requiring greater flexibility to adjust to operational variations.

Henri Fayol's Classical Theory of Management, which emphasizes planning, organization, direction and control, aligns well with project management practices in the petroleum sector. Its principles allow for effective coordination and a more structured allocation of resources. However, this theory needs adjustments to adapt to the rapid technological and operational changes that characterize the petroleum industry.

Elton Mayo's Human Relations Theory has had a positive impact on employee satisfaction and motivation, contributing to greater operational efficiency and a reduction in employee turnover. Despite these benefits, implementing strategies focused on employee well-being faces challenges such as resistance to change and the need to balance operational demands with team well-being.

As for the Mathematical Theory of John von Neumann and Oskar Morgenstern, their mathematical models for decision making under uncertainty are useful for managing risks and optimizing resources in the oil industry. However, over-reliance on these models may result in recommendations that do not capture the full complexity of the oil market, suggesting the need for an approach that combines mathematical models with adjustments based on operational reality.

Finally, Robert Anthony and James Reece's Financial Accounting Theory has proven to be essential to ensure transparency and accuracy in financial reporting. The

implementation of rigorous accounting systems improves the monitoring of costs and resources, but it is crucial to adapt these systems to the particularities of the oil environment to maximize their effectiveness.

To optimize administrative management in petroleum projects, it is recommended to integrate historical approaches with digital tools and scientific management techniques, providing a more accurate and dynamic evaluation. It is essential that management theories adapt to changing conditions in the industry, allowing flexible implementation of standardized practices. Continuous training of personnel in new technologies and the integration of advanced systems are also essential to meet the challenges of digitization. In addition, maintaining a focus on staff wellbeing will contribute to greater efficiency and project success.

The combination of classic and modern theories, together with the adaptation to the specificities of the sector and the use of advanced technologies, can significantly improve administrative, financial and accounting management in oil projects. Market volatility requires accurate forecasting models and strategies such as price hedging, cost optimization, scenario analysis and investment diversification to improve profitability. The integration of advanced accounting systems and financial analysis techniques is crucial, despite the challenges of cost and complexity. Adaptation to environmental regulations and digitalization are also key aspects to face contemporary challenges in the industry.

7. References

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