International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 4, Issue 10, 2025
DOI: https://doi.org/10.38124/ijsrmt.v4i10.891

Designing and Applying Integrated Supply Chain–Contracting Frameworks for Reducing Non-Productive Time in Offshore Drilling Projects

Dr. Goodluck Agbor Mfonnom

Publishing Date: 2025/10/29

Abstract

The nature of offshore drilling projects is marked by the high complexity of operations and high financial risks, and Non-Productive Time (NPT) becomes a significant issue that compromises efficiency, safety, and cost-effectiveness. Current methods of mitigating NPT have primarily focused on technical solutions, such as automating drilling, predictive maintenance, and enhanced planning. Although useful, such strategies fail to provide a picture of the systemic role of fragmented supply chains and inappropriate contracting practices in increasing downtime. This conceptual review fills this gap by creating an integrated supply chain-contracting framework that helps reduce NPT in offshore drilling projects. This paper begins with an explanation of key concepts, including NPT, integrated supply chain management, and contracting structures, and discusses the concept of integration between these aspects. It employs various theoretical viewpoints, including Transaction Cost Economics, Resource-Based View, Systems Theory, and lean/agile supply chain principles, to support its argument for the necessity of integration. The review of the current literature reveals ongoing supply chain issues, existing methods of supply chain management, and shortcomings in current contracting models, which lack an overall framework that can interconnect governance with operations. In reply, the suggested framework implements collaboration, information sharing, digitalisation, performance-based contracting, and fair distribution of risks within a dynamic framework that minimizes downtime. The research also makes a theoretical contribution by filling gaps in supply chain and contracting scholarship, and provides practical value by offering a set of guidelines for operators, contractors, and suppliers to follow in a structured manner. Although conceptual, the framework provides a basis for future empirical validation through case studies, simulations, or field applications, and has implications for policy, practice, and sustainable operational excellence.

Keywords: *Offshore Drilling, Non-Productive Time (NPT), Integrated Supply Chain Management, Contracting Models, Performance-based Contracts, Digitalisation.*

I. INTRODUCTION

Offshore drilling has always been one of the major pillars of the world energy provision, but it is also marked by the great risk of operations, technical sophistication, and high levels of capital intensity (International Energy Agency [IEA], 2023). It is in this context that the Non-Productive Time (NPT) has become a very significant issue. NPT, which can be characterized as drilling-related downtimes or delays with no increment to value creation, is usually caused by machine breakdowns, logistics bottlenecks, incorrect alignment between contracts, or ineffective coordination between supply networks (Shafiee et al., 2021). Such inefficiencies increase the cost of operation in addition to worsening the project schedules and competitiveness in an industry that is already stretched by fluctuating oil prices and sustainability requirements (Briggs and Davidson, 2022). A combined solution involving supply chain management and contracting systems is also becoming widely viewed as a key to solving this problem (Garcia et al., 2023). The orthodox contracting frameworks in offshore projects tend to be in silos, and the contractors, suppliers, and operators seek individualistic interests instead of overall efficiency (Kaiser & Liu, 2021). Such disintegration encourages incoherent decision-making, conflicting incentives and redundancy of processes, which all contribute to the worsening of NPT (Bai et al., 2022). In comparison, the combination of supply chain and contracting systems enables a greater level of collaboration, real-time information exchange, risk distribution, and incentives based on the results (Garcia et al., 2023; Kaiser and Liu, 2021). This integration can lead to resiliency, agility and value value creation over the long-term drilling projects.

The key issue though is that there is no clear conceptual framework regarding how supply chain-contracting integration can be designed and implemented in a systematic manner to reduce NPT in offshore drilling. Although there has been a literature review of isolated research on contracting strategies or supply chain optimization, not many studies have sought to combine these views to create a comprehensive, holistic strategy. This gap of thought restricts intellectual knowledge as well as practice. The purpose of this conceptual review is therefore to critically analyse interrelationship between supply chain management and contracting in offshore drilling, to note the inadequacies of existing solutions and suggest an integrated system that can reduce NPT. The limits of the review are confined to conceptual and theoretical understanding as opposed to empirical validation and hence forms the basis of the future field research or pilot implementations. It is important as it provides an organized approach that might be used to lead industry players towards efficiency, cost-saving, and operational excellence sustainability.

➢ *Conceptual Clarifications*

The Non-Productive Time (NPT) is defined as time intervals when the drilling operations are interrupted, delayed, or rendered ineffective, and they do not make any progress of the well (Shafiee et al., 2021). It is normally attributed to technical breakdown, machinery unavailability, material shortages, logistical imbalances or even contractual conflict (Kaiser and Liu, 2021). NPT is a major cause of a financial loss in offshore projects where the cost of rig operations may run into hundreds of thousands of dollars per day (Briggs and Davidson, 2022). In addition to the immediate expenses, a long time off schedule affects the project schedules, makes the projects less safe, and makes the investors lose confidence (Garcia et al., 2023). Hence minimizing NPT is now a strategic choice of operators drilling in an effort to achieve both efficiency and competitiveness. The term Integrated Supply Chain Management (ISCM) in oil and gas refers to an integrated management with processes, flows, and actors, along the upstream value chain, encompassing procurement and logistics, operations and maintenance (Golan et al., 2020). ISCM allows collaboration, sharing of data and problem-solving, unlike fragmented supply chains where the departments or firms work in segregation (Garcia et al., 2023). Integration is especially important in the offshore drilling because of the complex interdependency of suppliers, service contractors and operators (Kaiser & Liu, 2021). Understanding and synchronising schedules, as well as gaining visibility through digital platforms, ISCM helps to eliminate redundancies and make sure that vital resources were available at the appropriate moment and in the appropriate state (Golan et al., 2020). This integration is directly valuable in reduction of NPT through reduction of supply chain related disruption (Shafiee et al., 2021).

Contracting structures stipulate the legal, financial, and operational agreement of the project owners, drilling contractors and service providers (Cruz & Kraak, 2022). Conventional schemes like day-rate contracts tend to distribute the risks unevenly and encourage the contractor to focus on compliance rather than on the performance results (Kaiser & Liu, 2021). Other more innovative solutions such as performance-based and alliance contracts also seek to put incentives into line, rewarding efficiency and the creation of shared value (Cruz & Kraak, 2022; Garcia et al., 2023). Contracting frameworks can be selected in offshore drilling to have a significant impact on the level of collaboration, the distribution of risks, and the responsiveness to unexpected disruptions (Bai et al., 2022). Weak contracts will unwillingly strengthen silos, increase conflict, and extend NPT (Shafiee et al., 2021).

In this case, integration is defined as systematizing the coordination of the supply chain activities with the contracting mechanisms in order to realize the efficiency objective collectively (Garcia et al., 2023). It involves incorporating the principles of supply chain, including collaboration, transparency, and agility, in to a contractual framework (Golan et al., 2020). As an example, joint performance metrics, shared digital platforms or shared risk management strategies may become a prerequisite of a contract (Cruz & Kraak, 2022). This integration makes sure that the contracting frameworks do not simply control relationships but instead can help to maintain seamless performance of the supply chain. Such integration in the offshore drilling industry where time is a cost factor turns contracts that were a static agreement into the dynamic tool to drive operational excellence and NPT reduction (Kaiser and Liu, 2021).

➢ *Theoretical/Conceptual Foundations*

Transaction Cost Economics (TCE) offers an insight to the reason why there should be integration (Williamson, 2008). The contract arrangement and supply arrangements in offshore drilling is fragmented, making transaction costs higher in terms of monitoring, dispute resolution, and opportunistic behaviour (Kaiser and Liu, 2021). The unification of the supply chain and contracting systems decreases those costs by promoting trust, simplifying the governance, and aligning incentives (Cruz & Kraak, 2022). TCE, therefore, rationalizes the establishment of unified structures as one of the means of minimizing inefficiencies related to contractual fragmentation. The Resource-Based View (RBV) brings out the strategic significance of both the internal and networked capabilities in the attainment of competitive advantage (Barney, 1991). The ability to organize logistics, risk, and technological implementation are shared among various stakeholders in drilling projects (Golan et al., 2020). Implemented in the form of a contract, ISCM can enable companies to share complementary resources and use unique strengths in order to minimise flatteners (Garcia et al., 2023). The RBV therefore highlights integration as a means of tapping and utilizing the combined strengths towards better performance.

The Systems Theory considers drilling projects to be constituted by interdependent subsystems where minor disturbances in any of the elements can trickle down to the whole operation such as delays in the logistics (Bertalanffy, 1968). Using this lens, NPT is not a singular phenomenon but rather a system effect of the lack of alignment of the processes, a failure in communication, or contractual silos (Shafiee et al., 2021). Integration tackles these systemic weaknesses by establishing feedback, common platforms, and adaptive governance structures that make it possible to manage performance holistically (Garcia et al., 2023). The principles of lean supply chain are concerned with minimizing waste whereas agile involve sensitivity and adaptability (Christopher, 2016). Offshore drilling will necessitate the combination of both where waste in the procurement and logistics will have to be removed and the ability to adjust to dynamic operational environments will have to be preserved (Golan et al., 2020). This balance is provided through integrated contracting frameworks, which entail integrating lean and agile principles, including just-in-time delivery and risk-sharing provisions, into the binding contracts (Cruz & Kraak, 2022). This makes efficiency and adaptability institutionalised as opposed to being arbitrary.

Together, these theoretical views support the thesis that it is not just desirable but it is necessary to integrate. TCE focuses on cost-efficiency, RBV focuses on strategic capability sharing, Systems Theory shows that there should be a holistic alignment, and lean/agile principles offer strategies to operate. These collectively constitute the conceptual base of a framework that combines supply chain and contracting practices in order to reduce NPT in offshore drilling projects.

II. LITERATURE REVIEW

The conventional approach to minimizing Non-Productive Time (NPT) in offshore drilling has been to resort to operational and technical interventions. These are predictive maintenance, automation of drilling, real-time monitoring, and better well planning (Shafiee et al., 2021). Although these measures have brought about marginal benefits, they tend to address NPT as a technical problem and not a structural effect of disintegrated organisational and contractual frameworks. As a result, their effects are minimal, especially in case coordination among the various stakeholders is poor (Kaiser and Liu, 2021). The supply chains of offshore drilling are highly complex, have lengthy lead times, and require the use of specialised equipment and services (Golan et al., 2020). Issues like low visibility, slow procurement, and lack of information sharing and mismatched schedules often lead to idle rigs and wastage of resources (Briggs and Davidson, 2022). Moreover, oil and gas supply chains are vulnerable to disruptions like shipping delays, regulatory shifts and geopolitical tensions due to their global nature (IEA, 2023). The factors can frequently appear in the form of NPT when essential resources are no longer delivered in time or in appropriate states (Shafiee et al., 2021). Traditional contracting schemes, especially day-rate contracts, tend to bring disalignment of incentives by giving contractors rewards based on time instead of the performance output (Kaiser & Liu, 2021). Risk sharing, including turnkey contract, can also, inadvertently, hinder teamwork, trying to delegate instead of sharing the risk (Cruz & Kraak, 2022). Solutions that are alternatives to this are the contract of alliance and performance-based contracts with a focus on common objectives and responsibility (Garcia et al., 2023). Nevertheless, they are not widely used in offshore drilling because of industry traditions, lack of trust between stakeholders, and the challenges of assessing performance on a fair basis (Cruz & Kraak, 2022; Kaiser and Liu, 2021).

- *Gaps in Literature: Lack of Integrated Frameworks*

The literature that exists proves to be resourceful in the knowledge of supply chain optimisation and contracting innovations, but seldom dwells in their combination. A research usually analyses these areas separately without considering that supply chain effectiveness and contracting designs are highly interdependent. Supply chain visibility tools, as an example, might not work when contracts lack incentives to share data, and performance-based contracts might not work without effective supply chain coordination. The above conceptual gap is important because it highlights the necessity of having a holistic concept that can be used to systematically unify the principles of supply chain management with the contracting mechanisms in order to manage NPT both at the operation level and the governance level.

- *Proposed Conceptual Framework*

The suggested framework brings together supply chain and contracting practices into one system with the aim of minimizing Non-Productive Time (NPT) during the offshore drilling. In its essence, it focuses on teamwork whereby it promotes trust and problem-sharing among operators, contractors, and suppliers. This collaborative style helps in minimizing the adversarial nature of relationships and keeps every stakeholder in such a relationship dedicated to the common efficiency objectives.

As illustrated in Fig 1, the framework establishes clear interactions among the Operator, Drilling Contractor, Service Companies, Digital Platform, and Suppliers. The circular flow emphasizes continuous feedback, collaboration, and alignment.

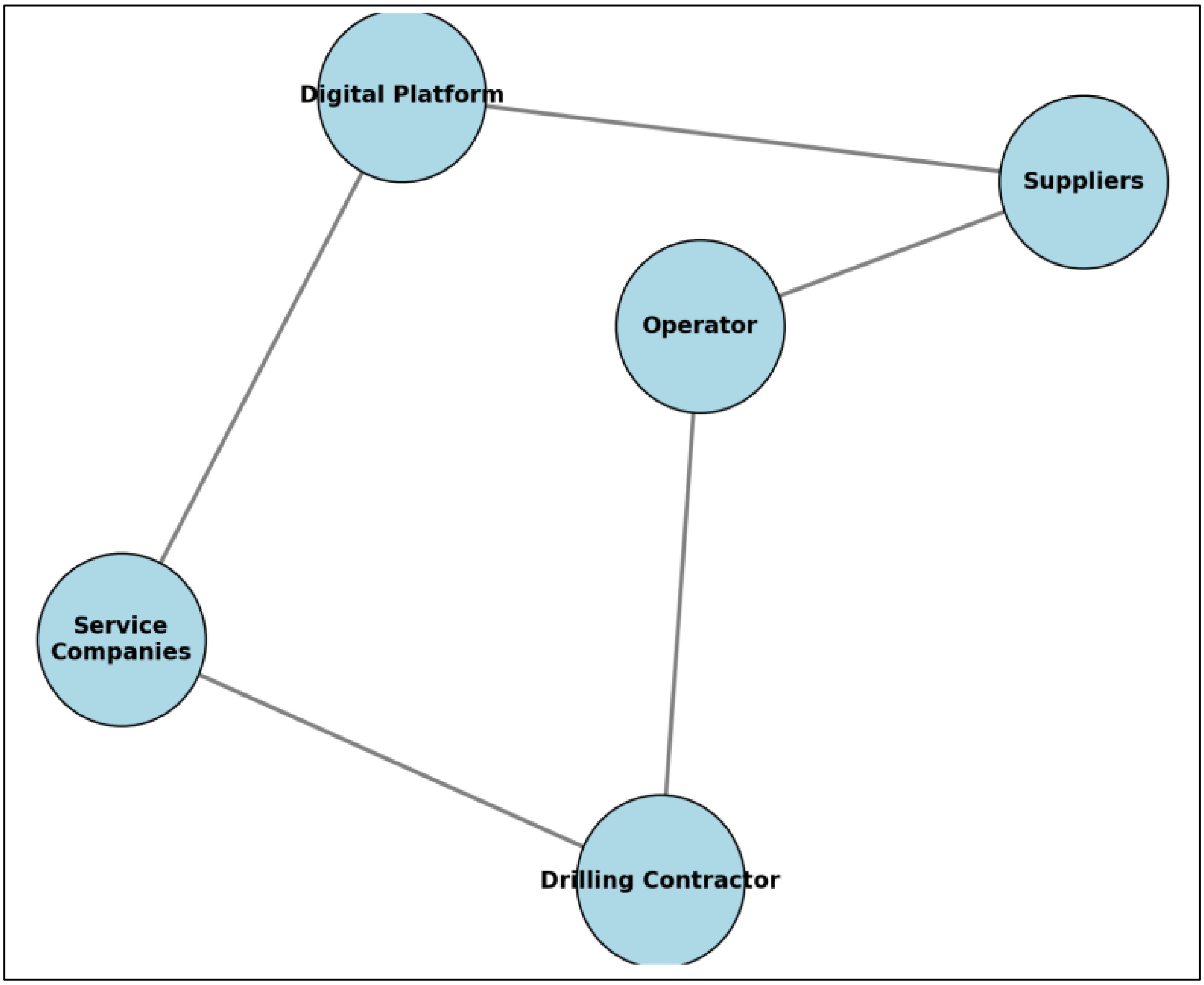

Fig 1 Integrated Supply Chain-Contracting Framework

➢ *Operator ↔ Drilling Contractor ↔ Service Companies ↔ Digital Platform ↔ Suppliers*

- *Operator:*
  Oversees governance, approves plans, and ensures alignment with project objectives.

- *Drilling Contractor:*
  Provides rig services, performance execution, and data reporting.

- *Service Companies:*
  Supply operational and technical services.

- *Digital Platform:*
  Enables real-time data sharing, analytics, and transparency.

- *Suppliers*:
  Provide materials, logistics, and equipment with synchronized schedules.

The second element is information sharing which is implemented using digital platforms which offer real-time visibility and coordination throughout the supply chain. It is backed by the concept of digitalization that utilizes analytics and monitoring tools to predict delays and streamline the sources flow. By using performance-based contracts, the framework becomes even stronger as it aligns the incentives to measurable efficiency results and less downtime so that all parties are compensated based on value delivery as opposed to adherence to the contractual terms.

This concept can be operationalized through performance-based contract clauses. For example, a contractor's compensation may be linked directly to NPT reduction as shown below:

- *Example Contract Clause*
  Total Payment = Base Day Rate × (1 + Performance Index)

  Performance Index = (NPT Baseline – NPT Achieved) / NPT Baseline

✓ Bonus:
NPT reduction > 10% → +5% contract value.

✓ Penalty:
NPT above baseline → deductions up to 10%.

To operationalize the framework, Table 1 outlines a set of Key Performance Indicators (KPIs) that enable measurable tracking of efficiency, downtime reduction, and safety compliance.

Table 1 Key Performance Indicators (KPIs)

KPI	Definition	Target/Metric
NPT Hours per 100 Rig Hours	Measure downtime as % of rig operating hours	< 5%
Logistics Lead-Time Variance	Deviation from planned delivery times	< 10%
Right-First-Time Jobs	Jobs successful on first attempt	> 95%
Real-Time Data Latency	Lag between rig event and visibility	< 5 mins
HSE Compliance Rate	Compliance with safety standards	100%

While most operators typically benchmark NPT around 10%, this framework adopts a more ambitious threshold of < 5% to demonstrate performance improvement potential and alignment with best-in-class drilling efficiency

Lastly, sharing risk fairly makes sure that there is a fair distribution of responsibility and that there is collective ownership of the problems and solutions. All these factors result in a loop of ongoing feedback and alignment and entrenching supply chain practices into contractual forms. The integration allows alleviating logistical delays, minimizing opportunistic behaviour, encouraging problem-proactive solutions, and making the drilling operations more robust, responsive, and efficient with much lesser non-productive costly intervals.

Table 2 illustrates how responsibilities and risks may be fairly allocated across stakeholders, ensuring collective ownership and alignment with contractual incentives.

Table 2 Risk Sharing Matrix

Risk Item	Owner	Mitigation	Contractual Impact
Mechanical Breakdown	Contractor	Preventive maintenance	Deduction/bonus tied to uptime
Logistics Delay	Supplier/Operator	Digital tracking & planning	Shared penalties
HSE Incident	All Parties	Joint safety programs	Shared liability clauses
Data Unavailability	Operator/Platform	Redundant systems & SLA	Service credits/penalties
Regulatory Delay	Operator	Early regulator engagement	Force majeure clause

The risks illustrated in Table 2 reflect the primary categories most directly tied to operational performance and contracting mechanisms. However, in practice, additional risks such as reservoir uncertainties, weather-related disruptions, and financial or geopolitical risks also influence drilling and completion projects. These can be incorporated into a more detailed risk allocation matrix depending on project scope and context.

III. DISCUSSION

The integrated framework proposed further advances the knowledge, uniting two fields that are usually examined separately: the supply chain management field and the contracting framework field (Garcia et al., 2023). It is observed that current literature views NPT reduction more of a technical or logistical issue and not much of a concern on how governance systems influence the performance of operations (Kaiser and Liu, 2021). This framework shows that efficiency and resilience are the results of the socio-technical fit and not the process optimisation, as they are incorporated into the contractual mechanisms by including supply chain principles, including collaboration, transparency, and agility (Cruz & Kraak, 2022). It is theoretically an elaboration of the Transaction Cost Economics as it demonstrates how integrated governance can reduce opportunism and monitoring costs (Williamson, 2008), and the Resource-Based View as it illustrates the ability to utilise distributed capabilities through contractual incentives (Barney, 1991; Golan et al., 2020). It also relies on Systems Theory to describe NPT as a dysfunction in the entire system (Bertalanffy, 1968; Shafiee et al., 2021) and operationalises waste minimisation and flexibility (Christopher, 2016) through lean/agile concepts. In this way, the framework will add to a conceptual perspective of efficiency in offshore drilling by multidisciplinary means. To operators, the framework will offer a systematic blueprint on how drilling contracts can be aligned to the supply chain processes so that the providers of services can be motivated not only to provide the inputs but also to help in the ongoing process of process improvement (Garcia et al., 2023). Performance-based clauses that would encourage innovation and efficiency, instead of the compliance with specifications that must be followed exactly, would be of benefit to the contractors, and suppliers would enjoy more visibility and joint planning, decreasing the uncertainty of demand variations (Cruz & Kraak, 2022). The use of digital platforms to enable real-time exchange of information in the industry would enhance these relationships, and responses to disruptions may occur at a faster rate (Golan et al., 2020). In addition, fair risk distribution helps all stakeholders to develop a problem-solving attitude where the culture is no longer adversarial but rather collaborative (Kaiser and Liu, 2021). Taken together, these practices not only decrease NPT but also make industries more trustworthy, safe, and more cost-competitive as the environment and market pressure start to mount even higher (Briggs and Davidson, 2022; IEA, 2023).

➢ *Possible Limitations*

Although the structure is conceptually sound, there are limitations to the framework. First, it involves certain level of trust and cooperation that might prove hard to reach in an industry that has been characterized by competition and risk avoidance. Second, the establishment of digital platforms and performance-based monitoring systems is costly and this may not appeal to smaller companies or projects in less financially buoyant settings. Third, the framework can simplify the international offshore projects which are complex in nature where regulations, cultural differences, and geopolitical risks have a way of derailing integration practices. Lastly, as a conceptual model, it has to be empirically tested to confirm its viability in real world situations. Such limitations imply an orientation to the contextual adaptation and additional research.

IV. CONCLUSION

This paper has developed a conceptual model of integrating a supply chain contracting model towards the minimization of Non-Productive Time in offshore drilling. The review shows that NPT is a systemic issue that must be addressed holistically by synthesizing theories from economics, systems thinking, and supply chain management. The framework makes a theoretical contribution by connecting governance and operations, and a practical one by offering a guide towards collaboration, digitalisation, and incentive alignment. To policymakers and managers, the findings recommend encouraging alliance-based contracts, incentivizing the integration of digital supply chains, and creating performance measures to equitably reflect efficiency. To determine the applicability of the framework in various offshore drilling settings, future studies should pilot the framework using case studies, simulation models, or pilot projects to assess its usefulness. Comparative studies would also enable the evaluation of the framework's performance in various regulatory and cultural contexts, providing insight into its adaptability and scalability.

RECOMMENDATIONS

Offshore drilling operators need to embrace the use of alliance or performance-based contracts to enhance teamwork and accountability, reduce Non-Productive Time (NPT), and increase efficiency. Digital supply chain platforms need to be invested in to enable real-time visibility, synchronization, and responsiveness. They should also incorporate fair terms of risk sharing in contracts to foster rapid joint problem-solving. There must be cultural changes and training programs that promote trust, transparency, and cooperation among stakeholders. Through policies and incentives that break structural barriers, regulators and industrial bodies should also attempt to integrate. Lastly, the framework should be piloted and simulated in diverse settings to demonstrate its effectiveness. All these steps would provide a clear roadmap to reduced downtime and sustainable operational excellence in offshore drilling.

REFERENCES

[1]. Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120.

[2]. Bertalanffy, L. von. (1968). *General system theory: Foundations, development, applications*. George Braziller.

[3]. Briggs, J., & Davidson, S. (2022). Cost management and operational efficiency in deepwater drilling. *Energy Policy, 160*, 112681.

[4]. Christopher, M. (2016). *Logistics & supply chain management* (5th ed.). Pearson UK.

[5]. Cruz, J. M., & Kraak, J. M. (2022). Incentivizing performance and collaboration in offshore drilling contracts: A review and analysis of alliance models. *The Engineering Economist, 67*(2), 127–152.

[6]. Garcia, F. J., Mota, B. P., & de Oliveira, R. C. (2023). Integrated project management and contracting strategies for reducing non-productive time in offshore oil and gas projects. *Journal of Petroleum Science and Engineering, 220*, 111202.

[7]. Golan, M. S., Jernegan, L. H., & Linkov, I. (2020). Trends and applications of resilience analytics in supply chain modeling: Systematic literature review in the context of the COVID-19 pandemic. *Environment Systems and Decisions, 40*(2), 222–243.

[8]. International Energy Agency. (2023). *Oil 2023: Analysis and forecast to 2028*. OECD Publishing.

[9]. Kaiser, M. J., & Liu, M. (2021). *Offshore drilling and production operations: Management, economics and equipment*. PennWell Books.

[10]. Shafiee, M., Enjema, E., & Kolios, A. (2021). A systematic review of non-productive time in offshore drilling. *Journal of Loss Prevention in the Process Industries, 69*, 104385.

[11]. Williamson, O. E. (2008). *The economic institutions of capitalism*. Free Press.