© AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV3I2-1713124

Supply Chain Risk Management Model for EPC and Gas Processing Projects

JIBRIL AGBABIAKA[1], CHINEME SCHOLAR OKONKWO[2], OLUFUNMILAYO OGUNWOLE[3], WINNER MAYO[4], OBINNA THANKGOD OKEKE[5]
[1]*Babban Gona Farmer Services, Lagos, Nigeria*
[2]*PESO Energy Services Limited, Lagos State, Nigeria*
[3]*Krones LCS Center West Africa Limited, Lagos, Nigeria*

Abstract- EPC (Engineering, Procurement, and Construction) and gas processing projects operate within highly complex, capital-intensive, and technically demanding environments where supply chain disruptions can significantly impact project timelines, costs, and operational safety. This paper presents a Supply Chain Risk Management Model specifically designed to enhance resilience, mitigate operational uncertainties, and optimize resource allocation in EPC and gas processing contexts. The model integrates systematic risk identification, assessment, mitigation, monitoring, and contingency planning to address the multifaceted risks inherent in these projects. The framework emphasizes risk identification and assessment through mapping of supply chain nodes, profiling of suppliers and subcontractors, and classification of risks into operational, financial, regulatory, environmental, and reputational categories. Risk mitigation strategies include supplier diversification, dual sourcing, performance-based contractual safeguards, inventory optimization, and the integration of predictive maintenance and technological tools. Monitoring and control mechanisms leverage digital solutions such as Enterprise Resource Planning (ERP) systems, Internet of Things (IoT) devices, and blockchain-enabled tracking to provide real-time visibility, enforce compliance, and ensure proactive decision-making. Contingency planning and recovery protocols are incorporated to maintain operational continuity during disruptions, including scenario analysis, emergency sourcing strategies, and business continuity plans aligned with project schedules. The model's implementation supports multiple strategic benefits, including reduced project delays and cost overruns, enhanced supplier reliability and accountability, strengthened compliance with regulatory and ESG standards, and long-term operational sustainability. By combining proactive risk management with integrated supply chain oversight, the framework transforms supply chain management into a strategic, value-creating function that mitigates uncertainties while improving project efficiency and resilience. This Supply Chain Risk Management Model provides a structured, evidence-based approach for managing the complex and high-risk supply chains of EPC and gas processing projects, ensuring both operational efficiency and strategic advantage in dynamic project environments.

Keywords: Supply Chain Risk Management; EPC Projects; Gas Processing; Supplier Reliability; Contingency Planning; Inventory Optimization; Contractual Safeguards; Operational Resilience; Regulatory Compliance; Project Efficiency.

I. INTRODUCTION

Engineering, Procurement, and Construction (EPC) and gas processing projects represent some of the most complex and capital-intensive undertakings in the energy and industrial sectors (Agenda, 2016; Johnsen *et al*., 2018). These projects involve the coordination of multiple stakeholders, including contractors, suppliers, subcontractors, and regulatory agencies, across geographically dispersed locations. Supply chains in such projects are highly intricate, encompassing the procurement and transportation of specialized equipment, critical spares, consumables, and construction materials (Simatupang and Sridharan, 2016; Thunberg *et al*., 2017). The technical complexity of gas processing facilities, coupled with the reliance on precise engineering specifications and regulatory compliance, amplifies the potential for disruptions at any stage of the supply chain. Even minor delays in the delivery of key components can lead to cascading operational impacts, resulting in schedule overruns, cost escalations, and potential safety risks (Kadry *et al*., 2017; Boateng *et al*., 2017). Therefore, understanding and managing supply chain complexities is essential for ensuring project success.

Given these challenges, supply chain risk management emerges as a strategic imperative in EPC and gas processing projects. Risk management encompasses the identification, assessment, mitigation, and monitoring of potential disruptions that could adversely affect project delivery, operational continuity, and financial performance (Supriadi and Pheng, 2018; Siemaszko *et al*., 2018). Effective risk management not only ensures that projects are completed on schedule and within budget but also safeguards the safety and integrity of personnel, equipment, and infrastructure. Strategic management of supply chain risks, including supplier reliability, logistical constraints, quality assurance, and regulatory compliance, enables project managers to anticipate potential failures, implement mitigation strategies, and maintain operational resilience. By embedding risk management into procurement and supply chain decision-making processes, organizations can reduce uncertainty, optimize resource allocation, and enhance overall project performance (Samson and Gloet, 2018; Tseng *et al*., 2018).

The purpose of the proposed Supply Chain Risk Management Model is to provide a structured and systematic approach to identifying, mitigating, and monitoring supply chain risks specific to EPC and gas processing projects. The model seeks to integrate risk assessment methodologies, supplier and subcontractor governance, inventory optimization, and contingency planning into a unified framework that supports both operational and strategic decision-making.

The scope of the model covers end-to-end supply chain processes, including procurement, logistics, supplier management, and project delivery coordination. It emphasizes proactive risk identification, performance monitoring, and scenario-based contingency planning to minimize disruptions, reduce cost overruns, and enhance project efficiency. By addressing the multifaceted risks inherent in EPC and gas processing supply chains, the model aims to support reliable project execution, operational safety, and long-term organizational resilience.

II. METHODOLOGY

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology was applied to systematically identify, evaluate, and synthesize evidence supporting the development of a Supply Chain Risk Management Model for EPC and gas processing projects. This approach ensures methodological rigor, transparency, and reproducibility, allowing for a structured synthesis of both academic research and industry best practices relevant to complex, capital-intensive project environments.

A comprehensive literature search was conducted across multiple electronic databases, including Scopus, Web of Science, ScienceDirect, and Google Scholar, as well as industry publications, technical reports, and white papers from energy and engineering organizations. The search strategy combined keywords and Boolean operators such as “supply chain risk management,” “EPC projects,” “gas processing,” “supplier performance,” “logistics risk,” “contingency planning,” and “project delivery.” The search was limited to studies published within the last fifteen years to ensure applicability to current practices, technologies, and regulatory environments.

Following identification, records were screened to remove duplicates and assess relevance based on titles and abstracts. Inclusion criteria focused on studies that addressed supply chain risk assessment, mitigation strategies, vendor and contractor management, logistical optimization, and contingency planning in EPC or industrial project contexts. Exclusion criteria eliminated publications lacking empirical data, methodological rigor, or practical applicability to project supply chain management. Full-text assessment was conducted to ensure alignment with the objectives of the proposed model, emphasizing the integration of risk management, operational continuity, and strategic project outcomes.

Data extraction involved systematically capturing information on risk identification methodologies, mitigation strategies, monitoring mechanisms, digital tools, and performance measurement approaches. Best practices, case studies, and technological enablers were collated to inform the model’s design. The synthesis focused on linking supply chain risk management practices to measurable outcomes such as reduced project delays, cost optimization, enhanced supplier reliability, and compliance with regulatory standards.

The resulting model is grounded in systematically reviewed, high-quality evidence, providing a robust framework for identifying, assessing, mitigating, and monitoring supply chain risks in EPC and gas processing projects. By following the PRISMA methodology, the model ensures that risk management strategies are evidence-based, practically relevant, and capable of supporting operational efficiency and strategic project success.

2.1 Conceptual Foundations

Effective supply chain risk management in EPC (Engineering, Procurement, and Construction) and gas processing projects requires a clear understanding of the underlying conceptual foundations. These projects operate in highly complex and capital-intensive environments where the failure of a single supply chain node can have cascading impacts on project timelines, costs, and operational safety. By defining key concepts and establishing clear objectives, a structured framework can be developed to proactively identify, assess, mitigate, and monitor risks while ensuring alignment with project and organizational goals (Thekdi and Aven, 2016; Force, 2018).

Supply chain risk refers to any potential disruption that affects the flow of materials, equipment, and services required for project execution. In EPC and gas processing projects, these risks can manifest in multiple forms, including delayed delivery of critical equipment, supplier insolvency, transportation bottlenecks, quality deviations, geopolitical instability, and regulatory non-compliance. Given the high stakes of these projects, even minor supply chain disruptions can result in schedule overruns, increased operational costs, and compromised safety standards (Chigonyati, 2016; Lessing *et al*., 2017). Recognizing the diverse sources and potential impacts of supply chain risks is foundational to developing effective management strategies.

Risk management is the systematic process of identifying, assessing, mitigating, and monitoring risks to minimize their impact on project objectives. In the context of EPC and gas processing projects, risk management encompasses proactive measures such as supplier evaluation, contract structuring, inventory optimization, contingency planning, and compliance monitoring. Effective risk management requires both strategic foresight and operational discipline, integrating quantitative assessments with qualitative insights to anticipate potential failures and implement mitigation strategies (Werther, 2017; Jahangiri *et al*., 2017).

The EPC and gas processing context adds additional layers of complexity. These projects are capital-intensive, often involving investments of hundreds of millions or even billions of dollars. They are technically complex, requiring precise engineering, specialized equipment, and highly coordinated construction and commissioning activities. Regulatory requirements are stringent, covering environmental, health, safety, and operational standards that must be strictly adhered to (Hashmi *et al*., 2016; Okoye *et al*., 2016). These factors collectively elevate the potential consequences of supply chain disruptions, making robust risk management essential to project success.

The primary objective of the proposed Supply Chain Risk Management Model is to minimize supply chain disruptions that could compromise project schedules, budgets, and operational safety. By systematically mapping supply chain nodes, identifying potential failure points, and assessing risk probability and impact, the model enables organizations to anticipate and address vulnerabilities before they materialize (Linnenluecke, 2017; Bugert and Lasch, 2018).

A second objective is to optimize inventory and logistics planning. Strategic inventory management, including the identification of critical spares and consumables, buffer stock levels, and delivery schedules, ensures that materials and equipment are available when and where they are needed. Optimized logistics planning reduces delays, lowers storage costs, and enhances operational efficiency, directly contributing to project cost control and schedule adherence.

The model also seeks to enhance contractor and vendor reliability. Through supplier performance evaluation, tiered segmentation, audits, and continuous improvement programs, the framework ensures that contractors and vendors consistently meet quality, delivery, and compliance expectations.

Reliable suppliers reduce the risk of operational interruptions, rework, and emergency procurement, providing predictability and stability to complex project supply chains (Paul *et al*., 2016; Song *et al*., 2018).

Finally, the model emphasizes regulatory and safety compliance. Adherence to industry standards, environmental regulations, and safety protocols is integrated into supplier selection, contract terms, and monitoring processes. Regulatory compliance not only mitigates legal and financial risks but also safeguards personnel, assets, and the environment, supporting sustainable and responsible project execution.

The conceptual foundations of the Supply Chain Risk Management Model are grounded in the definitions of supply chain risk, risk management, and the unique characteristics of EPC and gas processing projects. By clarifying these concepts and establishing objectives focused on minimizing disruptions, optimizing logistics, enhancing supplier reliability, and ensuring regulatory compliance, the model provides a structured approach to managing the complexities of high-stakes projects (Chowdhury and Quaddus, 2016; Perboli *et al*., 2018). These foundations guide the development of systematic, evidence-based strategies that enhance operational resilience, reduce project risk, and support successful project delivery.

2.2 Key Drivers of Supply Chain Risk

Supply chain risk in EPC (Engineering, Procurement, and Construction) and gas processing projects is influenced by multiple interrelated factors that can disrupt operations, increase costs, and compromise project timelines and safety. Understanding the key drivers of supply chain risk is critical to designing robust risk management strategies that ensure operational continuity, financial efficiency, and regulatory compliance (Simba *et al*., 2017; Sáenz *et al*., 2018). The following sections explore the primary drivers of supply chain risk in the context of EPC and gas processing projects, highlighting their implications for project execution and overall organizational resilience.

Supplier reliability is a cornerstone of supply chain stability. Variability in supplier performance, including delays in delivery, quality deviations, or inconsistent responsiveness, represents a significant source of operational risk. In EPC and gas processing projects, where specialized equipment, high-value components, and precise materials are essential, even minor lapses in supplier reliability can cause cascading delays and cost overruns. Performance variability may stem from financial instability, capacity limitations, inadequate quality control processes, or operational inefficiencies at the supplier level. Effective risk management necessitates rigorous supplier assessment, segmentation into strategic, critical, and transactional categories, and ongoing performance monitoring through KPIs such as on-time delivery, defect rates, and responsiveness to change requests.

External factors such as geopolitical tensions, trade restrictions, environmental events, and market price fluctuations significantly impact supply chain stability. Geopolitical instability can result in sanctions, border closures, or transportation disruptions, while environmental events such as hurricanes, floods, or seismic activity can damage infrastructure or impede logistics. Market volatility, particularly in commodity prices, can increase procurement costs and affect project budgets. The dynamic nature of these external factors introduces uncertainty into procurement planning, necessitating scenario analysis, flexible sourcing strategies, and contingency planning to maintain operational continuity and financial predictability (He *et al*., 2018; Ketkar and Vaidya, 2018).

The complexity of transporting equipment and materials to remote or constrained project sites introduces logistical challenges. Transportation risks include delays due to port congestion, customs clearance issues, limited infrastructure, or accidents during transit. In gas processing and EPC projects, critical components are often large, heavy, or sensitive, requiring specialized handling, storage, and transportation equipment. Inefficient logistics can result in stock-outs, work stoppages, and increased costs due to expedited shipments. Proactive logistics planning, route optimization, and collaboration with reliable transportation providers are essential to mitigate these risks.

EPC and gas processing projects are inherently technically complex, involving highly specialized

© AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV3I2-1713124

equipment and materials with precise engineering specifications. Supply chain risks arise from dependence on niche suppliers, long lead times for custom-manufactured components, and integration challenges across multidisciplinary systems. Any delay, defect, or mismatch in technical specifications can disrupt project schedules, increase rework, and elevate costs. Mitigation strategies include dual sourcing of critical components, rigorous technical validation of suppliers, and alignment of procurement timelines with project engineering and construction schedules (Deacon and Smallwood, 2017; Johnsen *et al*., 2018).

Adherence to regulatory standards and ESG obligations is a critical driver of supply chain risk. Non-compliance with environmental regulations, safety protocols, labor laws, or ethical sourcing standards can result in fines, legal liabilities, reputational damage, or project shutdowns. Increasingly, investors, clients, and governments require demonstration of ESG compliance across supply chains, including environmental sustainability, social responsibility, and corporate governance practices. Integrating regulatory and ESG considerations into supplier selection, contract clauses, and monitoring mechanisms reduces exposure to legal and reputational risks while promoting sustainable operations.

The key drivers of supply chain risk in EPC and gas processing projects supplier reliability, external volatility, logistical constraints, technical complexity, and regulatory/ESG requirements highlight the multifaceted nature of supply chain management in high-stakes environments. Each driver introduces potential vulnerabilities that can compromise project timelines, increase costs, and threaten operational safety. Effective risk management requires a holistic approach that combines rigorous supplier evaluation, contingency planning, logistics optimization, technical validation, and compliance monitoring. By understanding and addressing these drivers, organizations can enhance supply chain resilience, mitigate disruptions, and ensure reliable project delivery. A proactive, integrated strategy enables project teams to anticipate risks, implement mitigation measures, and maintain operational continuity, thereby supporting both financial efficiency and long-term strategic objectives (Kontogiannis *et al*., 2017; Aduma and Kimutai, 2018).

2.3 Model Structure

A robust Supply Chain Risk Management Model for EPC (Engineering, Procurement, and Construction) and gas processing projects provides a systematic approach to identifying, assessing, mitigating, and monitoring risks, while ensuring operational resilience and project continuity. Given the high capital intensity, technical complexity, and regulatory requirements of these projects, a structured framework is essential to manage potential disruptions, reduce cost overruns, and maintain safety and compliance standards (Asiedu *et al*., 2017; Gao *et al*., 2018). The model is composed of four interrelated components: risk identification and assessment, risk mitigation strategies, monitoring and control mechanisms, and contingency planning and recovery. Each component integrates proactive, evidence-based strategies to ensure supply chain reliability and project success.

The first step in the model involves the comprehensive identification and assessment of potential supply chain risks. This begins with mapping supply chain nodes and critical paths, which includes suppliers, subcontractors, logistics channels, and key material flows. By visualizing the entire supply chain network, project managers can pinpoint high-risk areas that could disrupt project execution. Supplier and subcontractor risk profiling is conducted to evaluate factors such as financial stability, capacity, quality control processes, delivery performance, and compliance history. Risk classification is applied to categorize threats into operational, financial, regulatory, environmental, and reputational risks. Operational risks involve delays, quality deviations, or capacity constraints; financial risks include supplier insolvency or market volatility; regulatory risks relate to non-compliance with industry standards; environmental risks cover natural disasters or environmental incidents; and reputational risks arise from supplier misconduct or project failures. Systematic risk assessment allows organizations to prioritize interventions based on the potential impact and likelihood of each identified risk.

Once risks are identified, targeted mitigation strategies are applied. Supplier diversification and dual sourcing reduce dependency on single suppliers, minimizing the impact of disruptions from any one source. Contractual safeguards and performance-based agreements incentivize timely delivery, quality adherence, and regulatory compliance while clearly defining penalties for non-performance. Inventory optimization and strategic stockpiling ensure critical materials and components are available when needed, reducing the risk of project delays caused by supply shortages. Additionally, predictive maintenance and technology integration enhance operational reliability by forecasting equipment failures and aligning maintenance schedules with supply availability, thereby preventing unscheduled downtime (Kumar and Galar, 2017; Temer and Pehl, 2017). These mitigation strategies collectively strengthen supply chain resilience, reduce uncertainty, and provide operational predictability.

Continuous monitoring is essential for maintaining supply chain stability. The model employs Key Performance Indicators (KPIs) for supply chain resilience, including on-time delivery rates, stock-out frequency, supplier defect rates, and compliance adherence. Real-time tracking using digital tools such as ERP systems, IoT devices, and blockchain platforms provides immediate visibility into supplier performance, logistics, and inventory levels. This integration allows early detection of potential disruptions and enables proactive interventions. Audits, compliance checks, and risk dashboards facilitate ongoing oversight, ensuring adherence to contractual, regulatory, and internal standards while providing actionable insights for decision-making.

Despite proactive mitigation and monitoring, supply chain disruptions can still occur. Scenario planning is employed to anticipate potential disruption events and model their impact on project timelines and costs. Alternative sourcing and emergency response protocols ensure rapid deployment of substitute suppliers or logistical solutions, minimizing downtime. Business continuity plans aligned with project timelines integrate all mitigation measures into a coherent strategy, maintaining operational flow and ensuring that critical project milestones are met. Contingency planning fosters organizational resilience, enabling EPC and gas processing projects to absorb shocks and maintain progress under challenging conditions (Seville, 2016; Bijaoui, 2017).

The Supply Chain Risk Management Model's structure integrates systematic risk identification, targeted mitigation, continuous monitoring, and contingency planning to manage the complex supply chains of EPC and gas processing projects. By mapping critical nodes, profiling suppliers, and classifying risks, organizations can prioritize interventions effectively. Mitigation strategies such as supplier diversification, contractual safeguards, inventory optimization, and predictive maintenance reduce vulnerabilities, while real-time monitoring, KPIs, and audits enable ongoing control and responsiveness. Contingency planning ensures rapid recovery from disruptions, preserving project continuity and minimizing financial and operational impacts. Together, these interrelated components create a proactive, resilient, and data-driven framework that enhances supply chain reliability, supports regulatory compliance, and ensures successful project delivery.

2.4 Integration with Project and Organizational Systems

Effective supply chain risk management in EPC (Engineering, Procurement, and Construction) and gas processing projects requires more than isolated mitigation strategies; it necessitates integration with project and organizational systems. The interconnected nature of project execution, procurement, finance, and operational oversight means that supply chain risks cannot be managed in isolation. Integration ensures that risk identification, mitigation, monitoring, and recovery measures are systematically aligned with project objectives, financial planning, and operational priorities (Mojtahedi and Oo, 2017; Sols, 2018). This alignment enhances coordination across functions, promotes data-driven decision-making, and fosters a culture of continuous improvement.

The first dimension of integration involves ensuring that supply chain risk management is closely linked to project management frameworks. EPC and gas processing projects typically follow structured methodologies such as PMBOK or PRINCE2, which provide defined processes for scheduling, resource allocation, and risk management. Aligning supply chain risk activities with these frameworks ensures that procurement, logistics, and supplier management are synchronized with project milestones, critical paths, and timelines. For instance, identifying potential supply delays can directly inform project scheduling decisions, enabling adjustments to construction or commissioning phases to mitigate impact.

Integration with procurement and finance functions is equally critical. Risk mitigation strategies such as supplier diversification, dual sourcing, and strategic stockpiling require coordinated financial planning to allocate budgets effectively. Financial oversight ensures that investments in buffer inventory, alternative suppliers, or technology solutions are justified by risk reduction potential. Procurement alignment ensures that supplier contracts, performance metrics, and compliance requirements are consistent with overall project goals, while finance alignment guarantees that risk mitigation measures are incorporated into cost forecasts and cash flow planning (Brewer and Arnette, 2017; Selviaridis and Spring, 2018). This holistic approach reduces the likelihood of conflicts between operational needs and financial constraints, ensuring seamless project execution.

Digital integration enables data-driven decision-making, which is essential for timely and effective supply chain risk management. Enterprise Resource Planning (ERP) systems, project management software, and digital procurement platforms consolidate information on supplier performance, inventory levels, logistics status, contract compliance, and financial metrics. Real-time dashboards allow project managers and procurement teams to monitor KPIs such as on-time delivery rates, stock-out incidents, cost variances, and supplier reliability (Nawzar and Karlsson, 2016; Kepczynski *et al*., 2018). Advanced analytics and predictive modeling can identify emerging risks, forecast potential disruptions, and suggest corrective actions before problems materialize. For example, predictive analytics may highlight a supplier at risk of failing to meet a critical delivery deadline, allowing preemptive engagement with alternative vendors or adjustments to the project schedule.

Digital integration also facilitates cross-functional visibility, ensuring that project managers, procurement teams, finance officers, and executives operate from a common data set. This alignment enhances communication, reduces information silos, and improves the accuracy and speed of decision-making. Real-time data supports scenario planning, enabling teams to evaluate the impact of different risk mitigation strategies on project timelines, costs, and operational outcomes.

Integration with organizational systems enables the implementation of feedback loops, which are critical for continuous improvement. Performance data collected through ERP systems, supplier audits, and project management platforms is analyzed to assess the effectiveness of risk mitigation strategies. Insights from this analysis are fed back into procurement, project planning, and supply chain management processes, allowing iterative refinement of supplier selection, inventory policies, and logistical planning (Kumar *et al*., 2016; Wilhelm and Sydow, 2018).

Iterative risk reassessment ensures that the framework remains adaptive to changing conditions, such as shifts in market dynamics, regulatory updates, environmental factors, or project scope modifications. Continuous improvement cycles strengthen organizational resilience by incorporating lessons learned from past disruptions, near misses, and performance deviations (McMillan and Overall, 2017; Woods, 2018). Over time, these feedback loops enable the organization to optimize supply chain efficiency, reduce vulnerabilities, and achieve sustained operational and financial benefits.

Integration with project and organizational systems is fundamental to effective supply chain risk management in EPC and gas processing projects. By aligning risk management activities with project management frameworks, procurement processes, and financial planning, organizations ensure that mitigation strategies are both operationally feasible and financially justified (Ajayi *et al*., 2017; Moretto *et al*., 2017). Data-driven decision-making through ERP and project management software enhances visibility, enables predictive insights, and supports timely interventions. Feedback loops and iterative risk reassessment promote continuous improvement,

© AUG 2019 | IRE Journals | Volume 3 Issue 2 | ISSN: 2456-8880
DOI: https://doi.org/10.64388/IREV3I2-1713124

allowing the supply chain to adapt to evolving risks, market conditions, and project requirements. Collectively, these integration measures create a resilient, agile, and evidence-based approach to supply chain risk management, supporting successful project delivery, operational continuity, and long-term organizational sustainability.

2.5 Expected Outcomes and Strategic Benefits

Implementing a structured Supply Chain Risk Management Model in EPC (Engineering, Procurement, and Construction) and gas processing projects offers significant operational, financial, and strategic benefits. Given the capital-intensive nature of these projects, their technical complexity, and the high risks associated with supply chain disruptions, an integrated approach to risk identification, mitigation, monitoring, and contingency planning is essential (Arroyo and Grisham, 2017; Ghasemzadeh *et al*., 2017). The expected outcomes and strategic benefits of such a model extend beyond immediate risk reduction to long-term value creation, operational sustainability, and enhanced organizational resilience.

One of the most immediate and tangible benefits of the model is the reduction of project delays and associated cost overruns. By proactively identifying supply chain risks, mapping critical paths, and assessing supplier and subcontractor vulnerabilities, project managers can implement targeted mitigation strategies such as dual sourcing, inventory optimization, and predictive maintenance (Trkman *et al*., 2016; Sahu *et al*., 2017). These interventions prevent disruptions in the flow of critical materials and equipment, ensuring that construction, commissioning, and operational activities proceed according to schedule. Timely delivery and reduced downtime directly translate to lower costs, as projects avoid expensive emergency procurement, expedited shipments, or penalties associated with missed milestones. By enhancing schedule reliability, the model strengthens financial planning and enables more accurate budget forecasting, reinforcing the overall economic viability of complex EPC and gas processing projects.

The model improves the resilience and reliability of supply chains by integrating proactive monitoring, digital tools, and contingency planning. Real-time tracking through ERP systems, IoT devices, and blockchain-enabled platforms provides visibility into inventory levels, supplier performance, and logistical status. Predictive analytics allow early detection of potential disruptions, while scenario-based contingency planning ensures rapid response through alternative sourcing, stockpiling, or logistical rerouting. This proactive approach minimizes the likelihood and impact of supply chain failures, enabling projects to maintain operational continuity even under volatile market, environmental, or geopolitical conditions (Giannakis and Papadopoulos, 2016; Fernando *et al*., 2018). Enhanced resilience reduces vulnerability to unplanned events, providing greater confidence in project execution and asset reliability.

A core component of the model is robust contractor and vendor governance, which fosters accountability and performance consistency. Through tiered supplier segmentation, performance monitoring, and contractual safeguards, suppliers are incentivized to meet delivery schedules, quality standards, and compliance requirements. Audits, compliance checks, and feedback loops further reinforce accountability, ensuring that deviations are identified and corrected promptly. By holding contractors and vendors responsible for their performance, organizations reduce the risk of operational delays, improve the predictability of supply chain outcomes, and foster stronger, collaborative relationships that support long-term project success.

Regulatory compliance and adherence to environmental, social, and governance (ESG) standards are increasingly critical drivers of organizational performance and stakeholder trust. The model embeds compliance requirements into supplier selection, contract terms, and performance monitoring processes. Environmental safeguards, occupational health and safety protocols, and ethical sourcing requirements are systematically tracked, reducing the likelihood of fines, legal liabilities, and reputational damage (Cooney, 2016; Patel and David, 2016). Aligning supply chain operations with ESG principles also supports sustainable development objectives, enhances corporate social responsibility, and positions organizations favorably with regulators, investors, and clients.

Beyond immediate operational benefits, the model supports long-term value creation and operational sustainability. By optimizing procurement strategies, mitigating risks, and strengthening supplier performance, the organization achieves more predictable project outcomes, cost efficiencies, and resource utilization. The framework enables a proactive culture of continuous improvement, where feedback loops, performance metrics, and scenario-based planning inform iterative refinements to supply chain management processes. Over time, these practices enhance organizational learning, operational agility, and resilience, ensuring that supply chains remain robust against future uncertainties. Sustainable supply chain practices, coupled with regulatory and ESG compliance, contribute to enduring value creation for stakeholders and strengthen the organization's competitive advantage in complex, high-risk project environments (Salvioni and Gennari, 2017; Rezaee, 2018).

The expected outcomes and strategic benefits of a Supply Chain Risk Management Model in EPC and gas processing projects are multi-faceted and interrelated. Reduced project delays and cost overruns result from proactive risk identification and mitigation, while enhanced supply chain resilience ensures operational continuity under dynamic conditions (Shekhar, 2016; Revilla and Saenz, 2017). Improved contractor and vendor accountability fosters reliable performance and collaborative partnerships, and compliance with regulatory and ESG standards minimizes legal and reputational risks. Collectively, these outcomes contribute to long-term value creation, operational sustainability, and competitive advantage. By embedding risk management within integrated project and organizational systems, the model transforms supply chain management from a reactive, transactional function into a proactive, strategic capability that underpins successful project execution and long-term organizational success.

CONCLUSION

The Supply Chain Risk Management Model for EPC (Engineering, Procurement, and Construction) and gas processing projects demonstrates substantial strategic relevance, addressing the complex, high-stakes environment inherent in these industries. By systematically identifying, assessing, mitigating, and monitoring risks, the model ensures that supply chain disruptions are minimized, project schedules are maintained, and operational costs are controlled. The framework's comprehensive approach aligns procurement, logistics, supplier management, and contingency planning with project objectives, enhancing overall project delivery, financial performance, and operational safety. Its strategic value lies in transforming supply chain management from a reactive, ad hoc function into a proactive, value-creating capability that directly supports organizational goals.

A central strength of the model is its emphasis on proactive risk management and integrated supply chain planning. By mapping supply chain nodes, profiling suppliers, and classifying potential risks, project teams can anticipate vulnerabilities and implement mitigation strategies before disruptions occur. Integration with project management frameworks, procurement, and finance ensures that these strategies are actionable, operationally feasible, and financially justified. The inclusion of digital tools such as ERP systems, IoT-enabled monitoring, and analytics facilitates real-time visibility and data-driven decision-making, enabling rapid interventions that preserve continuity and maintain operational efficiency. By combining proactive risk assessment with integrated planning, the model fosters a resilient, adaptive supply chain capable of supporting the unique demands of EPC and gas processing projects.

Given the dynamic nature of project environments, the framework necessitates continuous monitoring, iterative adaptation, and alignment with evolving project objectives. Feedback loops and performance evaluation mechanisms allow project managers to assess the effectiveness of mitigation strategies, incorporate lessons learned, and adjust plans in response to emerging risks, market fluctuations, or regulatory changes. This iterative process ensures that the supply chain remains responsive, resilient, and strategically aligned, enhancing both immediate project outcomes and long-term organizational sustainability.

The model provides a structured, evidence-based, and integrated approach to supply chain risk management.

Its strategic relevance, focus on proactive risk mitigation, and emphasis on continuous adaptation equip EPC and gas processing projects with the tools to minimize disruptions, optimize resources, ensure compliance, and achieve reliable, sustainable project outcomes.

REFERENCES

[1] Aduma, L.K. and Kimutai, G., 2018. Project risk management strategies and project performance at the National Hospital Insurance Fund in Kenya. *International Academic Journal of Information Sciences and Project Management*, *3*(2), pp.80-110.

[2] Ajayi, S.O., Oyedele, L.O., Akinade, O.O., Bilal, M., Alaka, H.A. and Owolabi, H.A., 2017. Optimising material procurement for construction waste minimization: An exploration of success factors. *Sustainable materials and technologies*, *11*, pp.38-46.

[3] Arroyo, A. and Grisham, T., 2017. *Leading extreme projects: Strategy, risk and resilience in practice*. Routledge.

[4] Asiedu, R.O., Adaku, E. and Owusu-Manu, D.G., 2017. Beyond the causes: Rethinking mitigating measures to avert cost and time overruns in construction projects. *Construction Innovation*, *17*(3), pp.363-380.

[5] Bijaoui, I., 2017. Economic Involvement of International Organizations, MNCs and Local Business Leaders and Groups. In *Multinational Interest & Development in Africa: Establishing a People's Economy* (pp. 29-65). Cham: Springer International Publishing.

[6] Boateng, P., Chen, Z. and Ogunlana, S.O., 2017. Megaproject Risks Assessment Framework. In *Megaproject Risk Analysis and Simulation* (pp. 43-76). Emerald Publishing Limited.

[7] Brewer, B. and Arnette, A.N., 2017. Design for procurement: What procurement driven design initiatives result in environmental and economic performance improvement?. *Journal of Purchasing and Supply Management*, *23*(1), pp.28-39.

[8] Bugert, N. and Lasch, R., 2018. Supply chain disruption models: A critical review. *Logistics Research*, *11*(5), pp.1-35.

[9] Chigonyati, M., 2016. An investigation into the risk management strategies employed to minimise time and cost overruns in public sector investment projects: A case of the Ministry of Higher and Tertiary Education.

[10] Chowdhury, M.M.H. and Quaddus, M., 2016. Supply chain readiness, response and recovery for resilience. *Supply Chain Management: An International Journal*, *21*(6), pp.709-731.

[11] Cooney, J.P., 2016. Health and safety in the construction industry: a review of procurement, monitoring, cost effectiveness and strategy. *PQDT-Global*.

[12] Deacon, C.H. and Smallwood, J., 2017. *The effect of the integration of design, procurement, and construction relative to health and safety* (Doctoral dissertation, Nelson Mandela Metropolitan University).

[13] Fernando, Y., Walters, T., Ismail, M.N., Seo, Y.W. and Kaimasu, M., 2018. Managing project success using project risk and green supply chain management: A survey of automotive industry. *International Journal of Managing Projects in Business*, *11*(2), pp.332-365.

[14] Force, J.T., 2018. Risk management framework for information systems and organizations. *NIST Special Publication*, *800*, p.37.

[15] Gao, N., Chen, Y., Wang, W. and Wang, Y., 2018. Addressing project complexity: The role of contractual functions. *Journal of Management in Engineering*, *34*(3), p.04018011.

[16] Ghasemzadeh, F., Pishdar, M. and Antuchevičienė, J., 2017. Prioritization of petroleum supply chains' disruption management strategies using combined framework of BSC approach, fuzzy AHP and fuzzy Choquet integral operator. *Journal of Business Economics and Management*, *18*(5), pp.897-919.

[17] Giannakis, M. and Papadopoulos, T., 2016. Supply chain sustainability: A risk management approach. *International journal of production economics*, *171*, pp.455-470.

[18] He, Y., Li, S., Xu, H. and Shi, C., 2018. An in-depth analysis of contingent sourcing strategy for handling supply disruptions. *IEEE Transactions on Engineering Management*, *67*(1), pp.201-219.

[19] Jahangiri, K., Eivazi, M.R. and Mofazali, A.S., 2017. The role of Foresight in avoiding

systematic failure of natural disaster risk management. *International journal of disaster risk reduction*, *21*, pp.303-311.

[20] Johnsen, T., Howard, M. and Miemczyk, J., 2018. *Purchasing and supply chain management: A sustainability perspective*. Routledge.

[21] Kadry, M., Osman, H. and Georgy, M., 2017. Causes of construction delays in countries with high geopolitical risks. *Journal of construction engineering and management*, *143*(2), p.04016095.

[22] Kepczynski, R., Jandhyala, R., Sankaran, G. and Dimofte, A., 2018. How to Run IBP: Use Cases. In *Integrated Business Planning: How to Integrate Planning Processes, Organizational Structures and Capabilities, and Leverage SAP IBP Technology* (pp. 73-128). Cham: Springer International Publishing.

[23] Ketkar, M. and Vaidya, O.S., 2018. A flexible approach to mitigation of supply risk through scenario modelling. In *Flexibility in resource management* (pp. 203-214). Springer, Singapore.

[24] Kontogiannis, T., Leva, M.C. and Balfe, N., 2017. Total safety management: principles, processes and methods. *Safety science*, *100*, pp.128-142

[25] Kumar, A., Jain, V., Kumar, S. and Chandra, C., 2016. Green supplier selection: a new genetic/immune strategy with industrial application. *Enterprise information systems*, *10*(8), pp.911-943.

[26] Kumar, U. and Galar, D., 2017. Maintenance in the era of industry 4.0: issues and challenges. *Quality, IT and business operations: modeling and optimization*, pp.231-250.

[27] Lessing, B., Thurnell, D. and Durdyev, S., 2017. Main factors causing delays in large construction projects: Evidence from New Zealand. *Journal of Management, Economics and Industrial Organization*, *1*(2), pp.63-82.

[28] Linnenluecke, M.K., 2017. Resilience in business and management research: A review of influential publications and a research agenda. *International journal of management reviews*, *19*(1), pp.4-30.

[29] McMillan, C.J. and Overall, J.S., 2017. Crossing the chasm and over the abyss: Perspectives on organizational failure. *Academy of Management Perspectives*, *31*(4), pp.271-287.

[30] Mojtahedi, M. and Oo, B.L., 2017. Critical attributes for proactive engagement of stakeholders in disaster risk management. *International journal of disaster risk reduction*, *21*, pp.35-43.

[31] Moretto, A., Ronchi, S. and Patrucco, A.S., 2017. Increasing the effectiveness of procurement decisions: The value of big data in the procurement process. *International Journal of RF Technologies*, *8*(3), pp.79-103.

[32] Nawzar, R. and Karlsson Sheik, S.D., 2016. Improving Forecasting for the Aftermarket through Big Data-A Case Study at Volvo Group Master of.

[33] Patel, J. and David, S., 2016. Ethics in occupational health and safety: case studies from Gujarat. *Indian Journal of Medical Ethics*, *1*(4), pp.203-210.

[34] Paul, S.K., Sarker, R. and Essam, D., 2016. Managing risk and disruption in production-inventory and supply chain systems: A review. *Journal of Industrial and Management Optimization*.

[35] Perboli, G., Musso, S. and Rosano, M., 2018. Blockchain in logistics and supply chain: A lean approach for designing real-world use cases. *Ieee Access*, *6*, pp.62018-62028.

[36] Revilla, E. and Saenz, M.J., 2017. The impact of risk management on the frequency of supply chain disruptions: a configurational approach. *International Journal of Operations & Production Management*, *37*(5), pp.557-576.

[37] Rezaee, Z., 2018. Supply chain management and business sustainability synergy: A theoretical and integrated perspective. *Sustainability*, *10*(1), p.275.

[38] Sáenz, M.J., Revilla, E. and Acero, B., 2018. Aligning supply chain design for boosting resilience. *Business Horizons*, *61*(3), pp.443-452.

[39] Sahu, A.K., Datta, S. and Mahapatra, S.S., 2017. Evaluation of performance index in resilient supply chain: a fuzzy-based approach. *Benchmarking: An International Journal*, *24*(1), pp.118-142.

[40] Salvioni, D.M. and Gennari, F., 2017. CSR, sustainable value creation and shareholder

relations. *Symphonya. Emerging Issues in Management*, (1), pp.36-49.

[41] Samson, D. and Gloet, M., 2018. Integrating performance and risk aspects of supply chain design processes. *Production Planning & Control*, *29*(15), pp.1238-1257.

[42] Selviaridis, K. and Spring, M., 2018. Supply chain alignment as process: contracting, learning and pay-for-performance. *International Journal of Operations & Production Management*, *38*(3), pp.732-755.

[43] Seville, E., 2016. *Resilient organizations: How to survive, thrive and create opportunities through crisis and change*. Kogan Page Publishers.

[44] Shekhar, S.U.M.A.N., 2016. A critical examination of cross-industry project management innovations and their transferability for improving it project deliverables. *Quarterly Journal of Emerging Technologies and Innovafions*, *1*(1), pp.1-18.

[45] Simatupang, T.M. and Sridharan, R., 2016. A critical analysis of supply chain issues in construction heavy equipment. *International Journal of Construction Management*, *16*(4), pp.326-338.

[46] Simba, S., Kotzé, T., Agigi, A. and Niemann, W., 2017. Supply chain risk management processes for resilience: A study of South African grocery manufacturers. *Journal of Transport and Supply Chain Management*, *11*(1), pp.1-13.

[47] Sols, A., 2018. A comprehensive approach to dynamic project risk management. *Engineering management journal*, *30*(2), pp.128-140.

[48] Song, J.M., Chen, W. and Lei, L., 2018. Supply chain flexibility and operations optimisation under demand uncertainty: A case in disaster relief. *International Journal of Production Research*, *56*(10), pp.3699-3713.

[49] Supriadi, L.S.R. and Pheng, L.S., 2018. *Business continuity management in construction*. Springer Singapore.

[50] Thekdi, S. and Aven, T., 2016. An enhanced data-analytic framework for integrating risk management and performance management. *Reliability Engineering & System Safety*, *156*, pp.277-287.

[51] Thunberg, M., Rudberg, M. and Karrbom Gustavsson, T., 2017. Categorising on-site problems: A supply chain management perspective on construction projects. *Construction innovation*, *17*(1), pp.90-111.

[52] Trkman, P., Oliveira, M.P.V.D. and McCormack, K., 2016. Value-oriented supply chain risk management: you get what you expect. *Industrial Management & Data Systems*, *116*(5), pp.1061-1083.

[53] Tseng, M.L., Wu, K.J., Hu, J. and Wang, C.H., 2018. Decision-making model for sustainable supply chain finance under uncertainties. *International Journal of Production Economics*, *205*, pp.30-36.

[54] Werther, G.F.A., 2017. Improving finance and risk management foresight abilities: Growing past the 'black swan'mindset through integrative assessment. *Journal of Risk Management in Financial Institutions*, *10*(4), pp.353-364.

[55] Wilhelm, M. and Sydow, J., 2018. Managing coopetition in supplier networks–a paradox perspective. *Journal of Supply Chain Management*, *54*(3), pp.22-41.

[56] Woods, D.D., 2018. Resilience is a verb. *Domains of resilience for complex interconnected systems*, *2*, pp.167-173.

[57] Hashmi, M., Governatori, G. and Wynn, M.T., 2016. Normative requirements for regulatory compliance: An abstract formal framework. *Information Systems Frontiers*, *18*(3), pp.429-455.

[58] Okoye, P.U., Ezeokonkwo, J.U. and Ezeokoli, F.O., 2016. Building construction workers' health and safety knowledge and compliance on site. *Journal of Safety Engineering*, *5*(1), pp.17-26.

[59] Agenda, I., 2016, May. Shaping the future of construction a breakthrough in mindset and technology. In *World Economic Forum* (pp. 11-16).

[60] Temer, E. and Pehl, H.J., 2017, November. Moving toward smart monitoring and predictive maintenance of downhole tools using the industrial Internet of Things IIoT. In *Abu Dhabi International Petroleum Exhibition and Conference* (p. D031S065R004). SPE.

[61] Siemaszko, A., Grzyl, B. and Kristowski, A., 2018, June. A model for risk assessment and management of construction projects in urban

conditions. In *2018 Baltic Geodetic Congress (BGC Geomatics)* (pp. 7-11). IEEE.