International Journal of Education and Social Science; Vol. 7 No. 5; October 2025
ISSN: 5778-6990 (Online), ISSN: 6790-5577 (Print)
Published by International Institute for Global Development (IIGD)

Resilient Energy Supply Chains: Policy and Technological Pathways for Efficient Storage and Transportation of Crude Oil and Natural Gas in Emerging Economies

[1]Kaaka Fegalo J. D.
[1]Department of Geography and Environmental Studies,
Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Nigeria.
feghalo.kaaka@iaue.edu.ng
https://orcid.org/0009-0007-4906

Abstract

Emerging economies have complex issues with supplies of crude oil and natural gas. Resilient supply chains of these two produce energizing goods which are critical to industrialization and economic growth. Flaws happen because of weak infrastructure, geopolitical risks, climate disruptions, and uncertain global energy situation. This study looks into policies and technologies to improve resilience, with an emphasis on storage and transportation. Based on a literature review, case studies, and simulation-based modeling, the findings emphasize how regulatory oversight, investment incentives, and digital innovations like IoT, AI, digital twins, and predictive maintenance can improve the supply chain performance. Working with advanced storage solutions such as liquefied natural gas (LNG) terminals and modular tanks, and enhancing microgrid integration will allow for greater flexibility and operations. Coordinated policies and technological interventions can bring down the risk of disruptions, improve costs and strengthen energy security. Policy suggestions comprise standardized regulations, promotion of public–private partnerships, and development of new resilience metrics in developing countries. The study which blends technological advancements with policy frameworks provides a model to strengthen energy supply chain and aid sustainable energy transition objectives in developing economics.

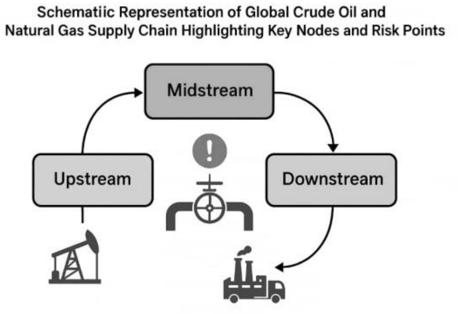
Keywords: *Energy Supply Chain, Resilience, Emerging Economies, Storage and Transportation, Technological Pathways.*

1. Introduction

Energy supply chains support the economic development, industrialization and national security of emerging economies with rising energy demand (Scholastica & Falcone, 2020). The processes of extraction, processing, storage, carriage and distribution of crude oil and natural gas linking the domestic markets with the global supplier is called as petroleum engineering.

The core supply chains may have structural fragility such as insufficient infrastructure, lack of a supportive regulatory environment, and slow adoption of technology (Tan & Burton, 2015). When supply chains can expect a disruption and still continue business with as little operational and economic loss as possible, we refer to that as resilience. Emerging economies have been experiencing great risks from multiple dimensions constituting geopolitical instability, climate-related hazards, market volatility and social or labour disruptions. They may impact the pipelines, storage facilities and governing mechanisms (Shaopeng & Fu, 2025).

This paper looks at storage and transportation, which are two aspects that can improve any supply chain's resistance. Specific objectives are to: Examine the existing laws and rules that shape supply chain resilience; Assess how technology and digital solutions help in storage, transport and running of things; Develop a framework to consider physical events and socio-economic vulnerabilities in the analysis of disruption events.



This illustration shows how energy goes from extraction to storage, transportation and distribution. The critical areas of risk such as pipeline clogging, limited storage and transport vulnerability were highlighted. The diagram shows in the midstream storage, there is a lot of vulnerability. The pipeline transportation also has a lot of vulnerability. If bottlenecks happen, it can negatively affect the downstream supply career and energy security.

As Nigeria is still developing, vandalism and equipment faults may disrupt operations here which will affect national energy reliability. Insights from Brazil and Qatar show that strategic redundancy, monitoring, and enforcement reduce vulnerabilities to such pressure. The figure shows the need for combined risk mitigation policies along with infrastructure investment.

Table 1: Key Supply Chain Challenges in Emerging Economies

Challenge Category	Description	Implication for Resilience
Infrastructure Deficits	Aging pipelines, limited storage	Increased downtime and supply interruptions
Regulatory Fragmentation	Inconsistent safety and operational standards	Difficulty enforcing safety and response protocols
Technological Gaps	Lack of monitoring, predictive maintenance	Limited early warning and disruption management
Climate Risks	Floods, storms, environmental hazards	Physical damage and operational delays
Market Volatility	Oil price swings, geopolitical instability	Financial instability and investment risk

Emerging economies face various structural issues related to energy supply chains. Old equipment and limited storage means that an area is more prone to breakdowns. When regulations are all different, they make it easy for people to get away with things. Because of technological gaps like limited monitoring and predictive maintenance, early warning & proactive disruption management are hampered. Climate risks and market instability worsen both physical and financial vulnerabilities. All of these challenges highlight the need to have integrated policy and operational strategies to strengthen supply chain resilience.

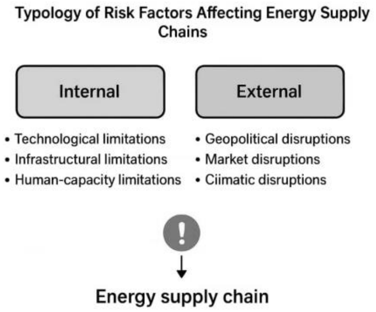
2. Literature Review

Conceptualizing Energy Supply Chain Resilience

According to Scholastica & Falcone (2020) and Sawik (2013), resilience is now a significant metric in the energy supply chain, where one anticipates uncertain disruptions and incorporates redundancy and adaptability. Integration of operational, structural, and strategic dimensions affects overall performance (Goh et al., 2007).

Identifying Risks and Vulnerabilities

Emerging economies face both internal and external risks. Internal reliability is compromised by infrastructure deficiencies, limited storage, deteriorating pipelines, and lack of monitoring (Farzaneh-Gord et al., 2016). External elements such as geopolitical disruptions, market fluctuations, and climate threats like floods or sabotage create extra uncertainties (Yang et al., 2020; Gao & Sun, 2022). If these risks are not addressed, the outcomes may be supply interruption and financial losses.



This illustration highlights the internal (infrastructure, technological weakness) and external (geopolitical, market, climate) risks and their relationship. The damage to the pipeline and other infrastructure has been estimated to be worth millions of dollars. Further progress cannot be made till investigations are complete. The image makes it clear how internal shortcomings amplify exposure to shocks from the outside.

Policymakers can prioritize interventions by understanding risk types. For example, monitoring enabled by the IoT can help address internal issues while strategic petroleum reserves and cross-border deals can reduce the threat from external shocks. Emerging economies benefit from targeted investment, particularly in high-risk nodes identified in the figure.

Table 2: Comparative Risk Exposure in Selected Emerging Economies

Country	Infrastructure Risk	Climate Risk	Geopolitical Risk	Market Volatility
Nigeria	High	Medium	High	High
Brazil	Medium	High	Medium	Medium
Qatar	Low	Low	Medium	Medium

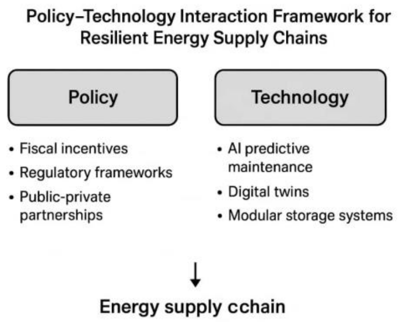
Risk exposure differs considerably in emerging economies. Nigeria displays high levels of infrastructure and geopolitical risk. This creates operational fragility and market vulnerability. Brazil experiences higher risks from climate-related events because of flooding and storms. On the other hand, because of their strong infrastructures, the rest of the risks cannot affect Qatar. To design appropriate resilience measures and investment for mitigation, it will be useful to learn the country risks.

Policy Frameworks for Resilience

Governance and regulatory oversight mitigate risks. Making sure we have a good stock of oil and making sure that it is safely transferred from one country to another helps save nations from unwanted attacks. Encouragement of technological adoption and strengthening of infrastructure resilience through fiscal incentives, investment support and public-private partnership. Policies are effective when they are flexible, context-relevant and anticipatory in nature.

Technological Pathways

Digital technologies enhance resilience. Hussain et al. (2019) claim that using IoT-enabled sensors allows real-time monitoring of pipelines and storage to avoid incidents. Digital twins help in creating virtual replicas of networks capable of simulating disruptions while optimizing operational decisions. LNG terminals and modular tanks are advanced storage solutions that improve flexibility and continuity (Ríos-Mercado and Borraz-Sánchez 2015).



The framework illustrates the interaction of the policy instruments (for example, fiscal incentives, regulatory standards, and public–private partnerships) with the technology (for example, AI predictive maintenance, digital twins, and modular storage) to foster supply chain resilience. The system has shown that policy and technology are not enough. When regulations, investment incentives and technical interventions work together, they help facilitate effective resilience.

Through regulatory reform as well as AI Internet of Things Implementation, Nigeria can achieve pipeline and storage management. Lessons learned from Brazil suggest that better alignment of policy and technology enhance continuity and risk reduction. The framework offers strategies for improving resilience in developing economies and their implementation.

Table 3: Technological Innovations and Applicability

Technology	Function	Benefit	Applicability to Emerging Economies
IoT Sensors	Real-time monitoring	Early detection of leaks/faults	Medium-high; requires network infrastructure
AI-based Predictive Maintenance	Forecasts failures	Reduces downtime	High; requires trained personnel
Digital Twins	Simulates scenarios	Optimizes operations	Medium; capital intensive
Modular Storage	Flexible storage	Reduces disruption impact	High; easily scalable

LNG Terminals	Large-volume storage	Ensures continuity	High; requires significant investment

Many IoT Sensors that need impactful network infrastructure for real-time monitoring may not be acceptable. Predictive maintenance based on AI has high potential to reduce downtimes and operational risks. Digital twins allow for simulation of scenarios for optimization, but are costly. Having LNG terminals and modular storage can ensure flexibility and continuity in a resource-limited environment. The adoption of these technologies should depend on local abilities and investment capacities.

3. Methodology

Research Design

Mixed-methods combine qualitative policy analysis with quantitative simulation model. You will get a thorough evaluation of governance frameworks, technology intervention and operational resilience (Ríos-Mercado & Borraz-Sánchez, 2015).

Data Sources

The IEA, BP, and IHS CERA databases, as well as knowledgeable industry experts and sources. Studies of simulated performance, pipeline performance reports and case studies of LNG and crude operations in developing countries constitute the secondary data.

Analytical Tools

Pipeline flow and storage performance is assessed through a simulated model. Multi-objective optimization techniques allow evaluating trade-offs of operational cost, risk reduction and continuity of supply (Tan & Barton, 2015; Azadeh et al., 2015).

Resilience Metrics

Key metrics for assessment include supply continuity, recovery time, operational efficiency, and costs avoided. These metrics will assess how well combined policy and technology initiatives perform.

Figure 4: Methodology Flowchart Illustrating Data Collection, Modeling, and Resilience Assessment

The methodology flowchart outlines the process of assessing energy supply chain resilience. We collect data from field surveys, operations and other sources. Modeling involves risk exposure, technology adoption and storage capacity to simulate operations. Assessment of resilience examines the continuous supply, time to recover, the economic impact of an event. This type of approach helps in carrying out well-structured policy recommendations that help in increasing its reliability.

Table 4: Resilience Metrics Operationalization

Metric	Definition	Measurement	Interpretation
Supply Continuity	Ability to maintain flow during disruption	% of uninterrupted supply	Higher % indicates better resilience

Recovery Time	Time to restore full operation after disruption	Days	Shorter recovery indicates stronger resilience
Operational Efficiency	Output relative to capacity under stress	% of optimal throughput	Higher % indicates effective mitigation
Economic Cost Avoidance	Losses prevented due to resilience measures	USD	Higher value indicates cost-effective resilience investment

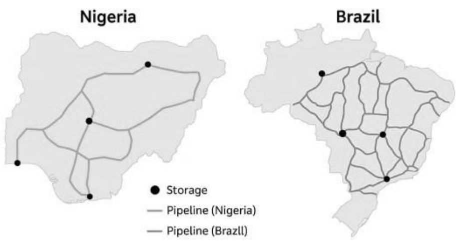
Resilience metrics operationalize performance under stress. Supply continuity describes how the flow can be maintained. Recovery time measures how responsive are the system. Operational efficiency assesses how well mitigation strategies perform under stress. Economic cost avoidance provides a financial assessment of resilience. Together, these metrics allow policymakers and operators to quantify resilience and identify solutions.

Results

Structural and Operational Evaluation of Energy Supply Chains

The analysis highlights major problem in the gas supply chain in the country. Nigeria has a centralized pipeline network that gets vandalized a lot. Also, pipeline theft is a big problem. Finally, maintenance is almost impossible with delays. Meanwhile, Brazil uses distributed networks to supply oil. Plus, they leverage LNG terminals' integration. In turn, it improves redundancy and resilience. Economic modeling shows that delays in supply in Nigeria will take time to recover and cost more to restart operations. This reinforces the need for upgrading technology and supporting policies.

Figure 5: Pipeline and Storage Network Maps for Nigeria and Brazil



The maps show where in the world the pipelines and storage are both geographically distributed emphasized density and redundancy, and key bottlenecks. The data reveals a stark contrast in the pipeline networks of Nigeria and Brazil. Nigeria's pipeline network is multi-layered and concentrated, making it vulnerable to local disruptions. In contrast, Brazil has distributed pipelines with redundancy, allowing the system to remain operational even when part of the system fails. Nigeria's infrastructure is concentrated, which makes investment in security, monitoring and different storage practical. The Brazilian experiences show us that distribution and modular storage usage increases flexibility and responsiveness.

Table 5: Comparative Storage and Transportation Capacities in Selected Emerging Economies

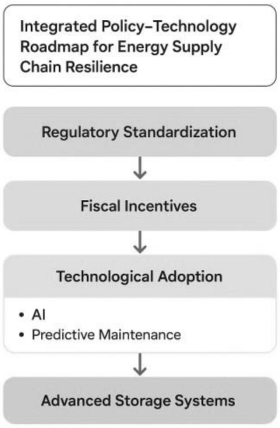
Country	Storage Capacity (million barrels)	Pipeline Length (km)	Port Handling Capacity (million barrels/year)
Nigeria	40	5000	120
Brazil	55	4500	100

Qatar	80	2000	200

Storage and transportation capacities directly influence supply chain resilience. Thanks to the large storage and port handling capacity, Qatar enjoys considerable operational flexibility in withstanding supply shocks. Brazil has moderate capacities and is more exposed to climate risks. Nigerian pipelines have been proven effective over the years. Investing modular and scalable storage solutions can help to mitigate that gap and support supply reliability.

Increasing Resilience through Technological Effectiveness

An integrated approach to policies, incentives and technology adoption can improve business continuity measurably. Enhancing throughput and reducing downtime are two capabilities the latest technologies offer. The use of modular LNG storage in microgrids ensures operational flexibility and risk mitigation. A coordinated approach to policy and technology will ensure costs are worthwhile and lessen disruption risk.



This roadmap details plans to incorporate policy, technology and operational approaches to ensure resilience in energy supply chain Includes regulatory standardization, investment incentives, digital monitoring, predictive maintenance, and advanced storage solutions. Sequential and coordinated implementation enhances resilience, according to the roadmap. When policies are implemented early enough, they enhance the uptake of a new technology, which gives rise to an improvement in physical and economic viability.

This roadmap gives a workable plan for developing countries. Changes in policy create a good condition, while targeted technology investments reduce weaknesses. Studies conducted in Brazil, Nigeria, and Qatar suggests that following through on such plans will reduce recovery time and operational costs, as well as vulnerability to market and climate shocks. It is shown that interdependencies in systems must be managed for supply chain resilience in the figure.

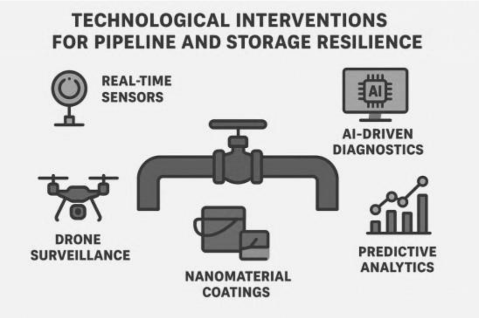
4. Discussion

Policy–Technology Synergies for Resilient Supply Chains

If something has a policy measure, then something lies in technological position and vice-versa. Emerging economies' ability to bounce back is limited by these two factors: a lack of finances and poor governance and our skill gaps. Strategic investment, predictive technologies and enabling regulation enhance operational continuity. Regulatory gaps in Nigeria constrain the adoption of technology, while Brazil and Qatar have integrated governance frameworks.

Suggestions to be Operational and Economically Resilient

Prioritize updating infrastructure and providing a better service by diversifying the network, introducing better storage, deploying e-monitoring and coordinating across the border. Periodic risk assessment and multi-stakeholder dialogue is pertinent for effective functioning and continuity of operations. If you align technology and policy, you might enhance energy security and reduce disruption risk.



This figure shows the key technology for enhancing the resilience of a pipeline and storage which real-time sensors and AI. The use of smart digital and AI tools, in my opinion, represents an evolution from corrective to preventive.

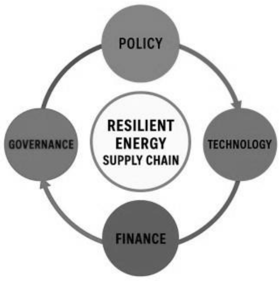
Highly skilled personnel, strong institutions, and policy supports can ease the implementation of such technologies but strengthen energy security.

5. Conclusion

To sharpen resilient energy supply chains in emerging economies, technology, infrastructure and policy should to be aligned. The strategic investment in digital monitoring, predictive maintenance and modular storage can foster operational reliability. Moreover, coordinated regulatory frameworks and public–private collaboration can enhance strategic resilience. Tackling tech gaps, climate weaknesses, and market unpredictability will help to sustain continuity and reduce economic losses. Ultimately, resilience is achieved through complementary physical strength and adaptive, data-driven, and governance-aligned strategies that anticipate and manage multi-dimensional risks.

Future Research Directions

Future studies should explore how using AI-powered prediction technology might improve real-time operational foresight. Also, research should look at the role of hydrogen and decarbonised storage in clean, sustainable energy supply chains and cross-sectoral resilience modelling that captures interdependencies between energy, transport and climate systems. Also, studies on the harmonization of policies and innovative financing mechanisms (e.g., public–private partnerships and green investment instruments) can inform concrete interventions to strengthen energy security as well as long-term supply chain sustainability in developing economies.



CONCEPTUAL MODEL OF A
RESILIENT ENERGY SUPPLY CHAIN FOR EMERGING ECONOMIES

The figure shows how technology, policy, finance and governance come together to build resilient supply chains. It shows resilience as a function of the system achieved through coordination and innovations and adaptations of policy. The model emphasizes that the most important aspects for building reliable, low-carbon, shock-proof energy systems are integrated planning and flexible regulation.

Table 6: Identified Research Gaps and Directions for Future Studies

Research Gap	Suggested Focus
Limited integration of AI for predictive analytics	Development of AI-based forecasting and maintenance models
Hydrogen and decarbonized energy integration	Feasibility studies and techno-economic assessments
Cross-sectoral resilience modeling	Multi-sector simulations incorporating energy, transport, and climate risks
Policy and regulatory harmonization	Comparative studies on governance frameworks and best practices
Financial mechanisms for resilience investment	Evaluation of public-private partnerships and green finance instruments

The analysis highlights several gaps in the literature. Use AI to predict when machines need servicing. Look at East Africa to see how the predictive maintenance market is unexplored. Hydrogen filling and carbon dioxide storage solutions are technologies that offer low-carbon opportunities in the long term, techno-economic evaluation. Cross-sectoral modeling can enhance the understanding of resilience to compound risks. The connection between technology, governance and financing must be emphasised for effective investments, with a focus on policy harmonization and financial mechanisms.

References

Abdin, Z., Al Khafaf, N., McGrath, B., & Catchpole, K. (2023). A review of renewable hydrogen hybrid energy systems towards a sustainable energy value chain. Sustainable Energy & Fuels, 7, 2042–2062. https://doi.org/10.1039/D3SE00012A

Abdin, Z., Zafaranloo, A., Rafiee, A., Mérida, W., Lipiński, W., & Khalilpour, K. R. (2020). Hydrogen as an energy vector. Renewable and Sustainable Energy Reviews, 120, 109620. https://doi.org/10.1016/j.rser.2019.109620

Abdulraheem, A. O. (2018). Just-in-time manufacturing for improving global supply chain resilience. International Journal of Engineering Technology Research and Management, 2(11), 58.

Ahmed, R., et al. (2023). Inflation, oil prices, and economic activity in recent crisis: Evidence from the UK. Energy Economics. https://doi.org/10.1016/j.eneco.2023

Akyildirim, E., et al. (2022). Connectedness of energy markets around the world during the COVID-19 pandemic. Energy Economics. https://doi.org/10.1016/j.eneco.2022.

Al-Haidous, S., Govindan, R., Elomri, A., & Al-Ansari, T. (2022). An optimization approach to increasing sustainability and enhancing resilience against environmental constraints in LNG supply chains: A Qatar case study. Energy Reports, 8, 9742–9756. https://doi.org/10.1016/j.egyr.2022.06.093

Al-Sobhi, S. A., Elkamel, A., & Erenay, F. S. (2018). Simulation-optimization framework for synthesis and design of natural gas downstream utilization networks. Energies, 11(2), 362. https://doi.org/10.3390/en11020362

Azadeh, A., Olfati, A., & Saberi, M. (2015). A multi-objective fuzzy linear programming model for optimization of natural gas supply chain through a greenhouse gas reduction approach. Journal of Natural Gas Science and Engineering, 27, 1133–1145. https://doi.org/10.1016/j.jngse.2015.09.021

Blakers, A., Stocks, M., Lu, B., & Cheng, C. (2021). A review of pumped hydro energy storage. Progress in Energy, 3(1). https://doi.org/10.1088/2516-1083/abeb5b

Bittante, A., & Saxén, H. (2020). Design of small LNG supply chain by multi-period optimization. Energies, 13(24), 6704. https://doi.org/10.3390/en13246704

BP. (2023). BP energy outlook 2023. BP. https://www.bp.com

Carley, S., & Konisky, D. M. (2020). The justice and equity implications of the clean energy transition. Nature Energy, 5, 569–577. https://doi.org/10.1038/s41560-020-0641-6

Carvalho, H., Azevedo, S. G., & Cruz-Machado, V. (2012). Supply chain redesign for resilience using simulation. Computers & Industrial Engineering, 62(1), 329–341. https://doi.org/10.1016/j.cie.2011.09.007

Centobelli, P., Cerchione, R., & Esposito, E. (2018). Environmental sustainability and energy-efficient supply chain management: A review of research trends and proposed guidelines. Energies, 11(2), 275. https://doi.org/10.3390/en11020275

Christopher, M., & Holweg, M. (2017). Supply chain 2.0 revisited: A framework for managing volatility-induced risk in the supply chain. International Journal of Physical Distribution & Logistics Management, 47(1), 2–17. https://doi.org/10.1108/IJPDLM-02-2016-0043

Dang, T. H. N., et al. (2023). Measuring the energy-related uncertainty index. Energy Economics. https://doi.org/10.1016/j.eneco.2023

Davies, R., Coole, T., & Smith, A. (2017). Review of socio-technical considerations to ensure successful implementation of Industry 4.0. Procedia Manufacturing, 11, 1288–1295. https://doi.org/10.1016/j.promfg.2017.07.240

Emenike, S. N., & Falcone, G. (2020). A review on energy supply chain resilience through optimization. Renewable and Sustainable Energy Reviews, 134, 110088. https://doi.org/10.1016/j.rser.2020.110088

Farzaneh-Gord, M., Safaei, M., & Farzaneh-Gord, M. (2015). Effects of natural gas compositions on CNG (compressed natural gas) reciprocating compressors performance. Energy, 93, 1270–1279. https://doi.org/10.1016/j.energy.2015.10.038

Farzaneh-Gord, M., Safaei, M., & Farzaneh-Gord, M. (2016). Unsteady natural gas flow within pipeline network, an analytical approach. Journal of Natural Gas Science and Engineering, 35, 1166–1176. https://doi.org/10.1016/j.jngse.2016.09.007

Feng, P., et al. (2022). The impact of trade policy on global supply chain network equilibrium: A new perspective of product-market chain competition. Omega. https://doi.org/10.1016/j.omega.2022.

Gabler, C. B., Richey Jr, R. G., & Stewart, G. T. (2017). Disaster resilience through public–private short-term collaboration. Journal of Business Logistics, 38(2), 130–144. https://doi.org/10.1111/jbl.12150

Goh, M., Lim, A., & Meng, F. (2007). A stochastic model for risk management in global supply chain networks. European Journal of Operational Research, 182(1), 164–173. https://doi.org/10.1016/j.ejor.2006.06.008

Goldthau, A., & Hughes, L. (2020). Protect global supply chains for low-carbon technologies. Nature, 585, 28–30. https://doi.org/10.1038/d41586-020-02499-8

Hamedi, M., Gohari, S., & Ardestani, M. S. (2009). A distribution planning model for natural gas supply chain: A case study. Energy Policy, 37(8), 3208–3216. https://doi.org/10.1016/j.enpol.2009.03.028

Helveston, J., He, G., & Davidson, M. R. (2022). Quantifying the cost savings of global solar photovoltaic supply chains. Nature, 612, 83–87. https://doi.org/10.1038/s41586-022-05316-6

Hussain, A., Zameer, H., & Rehman, A. (2019). Microgrids as a resilience resource and strategies used by microgrids for enhancing resilience. Applied Energy, 235, 380–394. https://doi.org/10.1016/j.apenergy.2018.10.075

Kabirian, A., Haghifam, M.-R., & Hosseinian, S. H. (2007). A strategic planning model for natural gas transmission network. Energy Policy, 35(7), 3835–3843. https://doi.org/10.1016/j.enpol.2006.10.012

Kimura, F., Thangavelu, S. M., Narjoko, D., & Findlay, C. (2020). Pandemic (COVID-19) policy, regional cooperation and the emerging global production network. Asian Economic Journal, 34(1), 3–27. https://doi.org/10.1111/asej.12198

Klumpp, M. (2018). Automation and artificial intelligence in business logistics systems: Human reactions and collaboration requirements. International Journal of Logistics Research and Applications, 21(3), 224–242. https://doi.org/10.1080/13675567.2017.1348584

Li, K., Qi, S., & Shi, X. (2022). The COVID-19 pandemic and energy transitions: Evidence from low-carbon power generation in China. Journal of Cleaner Production, 368, 132994. https://doi.org/10.1016/j.jclepro.2022.132994

Overland, I. (2019). The geopolitics of renewable energy: Debunking four emerging myths. Energy Research & Social Science, 49, 36–40. https://doi.org/10.1016/j.erss.2018.10.018

Purvis, L., Spall, S., Naim, M., & Spiegler, V. (2016). Developing a resilient supply chain strategy during ‘boom’ and ‘bust’. Production Planning & Control, 27(7–8), 579–590. https://doi.org/10.1080/09537287.2015.1082220

Riera, J. A., Lima, R. M., & Knio, O. M. (2023). A review of hydrogen production and supply chain modeling and optimization. International Journal of Hydrogen Energy, 48, 13731–13755. https://doi.org/10.1016/j.ijhydene.2023.02.043

Scholastica, N. E., & Falcone, G. (2020). A review on energy supply chain resilience through optimization. Renewable and Sustainable Energy Reviews, 134, 110088. https://doi.org/10.1016/j.rser.2020.110088

Shaopeng Yang, & Fu, Y. (2025). Interconnectedness among supply chain disruptions, energy crisis, and oil market volatility on economic resilience. Energy Economics, 143, 108290

Tan, S. H., & Barton, P. I. (2015). Optimal dynamic allocation of mobile plants to monetize associated or stranded natural gas, Part I: Bakken shale play case study. Energy, 93, 1581–1594. https://doi.org/10.1016/j.energy.2015.10.057

Tan, S. H., & Barton, P. I. (2016). Optimal dynamic allocation of mobile plants to monetize associated or stranded natural gas, Part II: Dealing with uncertainty. Energy, 96, 461–467. https://doi.org/10.1016/j.energy.2015.11.010

Vasconcelos, C. D., Mello, L. C. B., & Lemos, F. (2013). Network flows modeling applied to the natural gas pipeline in Brazil. Journal of Natural Gas Science and Engineering, 15, 83–92. https://doi.org/10.1016/j.jngse.2013.02.007

Woldeyohannes, A. D., & Zobel, C. W. (2011). Simulation model for natural gas transmission pipeline network system. Simulation Modelling Practice and Theory, 19(10), 2207–2220. https://doi.org/10.1016/j.simpat.2011.05.011

Yusuf, N., Govindan, R., Al-Fagih, L., & Al-Ansari, T. (2023). Strategic and flexible LNG production under uncertain future demand and natural gas prices. Heliyon, 9, e16358. https://doi.org/10.1016/j.heliyon.2023.e16358

Yusuf, N., Almomani, F., & Al-Sobhi, S. A. S. (2023). Onshore hydrogen production from boil-off gas (BOG) via natural gas steam reforming process: Process simulation and techno-economic analysis. International Journal of Hydrogen Energy, in press. https://doi.org/10.1016/j.ijhydene.2023.xxxxx

Zhang, B., Zhang, H., Long, Y., Fang, K., Xu, N., Li, Z., & Liang, Y. (2020). Economic and environmental co-benefit of natural gas supply chain considering the risk attitude of designers. Journal of Cleaner Production, 272, 122681. https://doi.org/10.1016/j.jclepro.2020.122681

Zhong, Y., et al. (2024). The nexus among artificial intelligence, supply chain and energy sustainability: A time-varying analysis. Energy Economics. https://doi.org/10.1016/j.eneco.2024