© JAN 2020 | IRE Journals | Volume 3 Issue 7 | ISSN: 2456-8880

Integrating AI-Augmented CRM and SCADA Systems to Optimize Sales Cycles in the LNG Industry

PAUL UCHE DIDI[1], OLOLADE SHUKRAH ABASS[2], OLUWATOSIN BALOGUN[3]
[1, 2, 3]Independent Researcher, Lagos, Nigeria

Abstract- The Liquefied Natural Gas (LNG) industry operates within a complex ecosystem characterized by volatile market dynamics, long sales cycles, and high capital intensity. Traditional siloed approaches to sales, operations, and customer relationship management are increasingly inadequate for meeting modern market demands. This proposes a novel framework for integrating Artificial Intelligence (AI)-augmented Customer Relationship Management (CRM) systems with Supervisory Control and Data Acquisition (SCADA) platforms to optimize sales cycles, enhance customer engagement, and improve operational responsiveness in the LNG sector. CRM systems in the LNG industry are typically used for managing client portfolios, contract negotiations, and forecasting demand, while SCADA systems monitor and control physical infrastructure such as liquefaction plants, storage terminals, and distribution networks. Integrating these two systems with AI algorithms enables real-time data exchange between customer needs and operational capacities, allowing for dynamic sales strategies that are grounded in production realities. AI tools, including machine learning and natural language processing, can analyze historical sales data, customer interactions, and SCADA outputs to provide predictive insights, automate pricing models, and adjust delivery schedules proactively. Case studies and simulations demonstrate that such integration significantly reduces sales cycle durations, improves quote-to-cash timelines, and enhances customer satisfaction through personalized, responsive service. Furthermore, the integration facilitates more accurate demand forecasting, efficient contract management, and real-time decision-making, aligning commercial and technical operations in a unified digital ecosystem. However, challenges such as data silos, cybersecurity risks, and legacy infrastructure incompatibility must be addressed to fully realize the benefits. This contributes to the growing body of knowledge on digital transformation in the energy sector and offers practical guidance for LNG enterprises seeking to leverage AI and integrated systems to achieve greater market agility, efficiency, and resilience in an increasingly competitive global landscape.

Indexed Terms- Integrating, AI-augmented, CRM and SCADA systems, Sales Cycles, Optimization, LNG Industry

I. INTRODUCTION

The Liquefied Natural Gas (LNG) industry plays a critical role in the global energy landscape, offering a flexible, cleaner-burning alternative to other fossil fuels. The LNG value chain is a complex and capital-intensive process that includes natural gas extraction, liquefaction, storage, shipping, regasification, and delivery to end-users such as utilities, industries, and trading entities (Otokiti, 2019; SHARMA *et al*., 2019). Each stage of this chain is highly interdependent and sensitive to market fluctuations, operational inefficiencies, and contractual obligations. As LNG demand grows in response to decarbonization efforts and energy diversification strategies, optimizing this intricate chain—from production to customer delivery—has become a strategic imperative for industry stakeholders (Lawal *et al*., 2014; Amos *et al*., 2014).

In industrial and energy sectors, Customer Relationship Management (CRM) systems and Supervisory Control and Data Acquisition (SCADA) systems serve as foundational digital tools, albeit in largely isolated domains (Akinbola and Otokiti, 2012; Otokiti, 2017). CRM platforms are designed to manage customer information, sales cycles, contracts, and interactions, helping companies enhance customer engagement and improve commercial outcomes. In contrast, SCADA systems monitor and control physical infrastructure, enabling real-time oversight of processes such as liquefaction, pressure and temperature control, and asset performance (Ajonbadi *et al*., 2015; Otokiti, 2017). While both systems offer valuable insights, their potential is often underutilized due to siloed operation. CRM systems rarely incorporate operational data from SCADA platforms, and SCADA systems typically lack visibility into market dynamics or customer demand (Otokiti, 2017; Otokiti and Akorede, 2018).

This operational separation presents significant limitations. Disjointed systems hinder cross-functional collaboration, delay critical decision-making, and prevent real-time adaptation to shifting customer needs or production constraints (Otokiti and Akinbola, 2013; Ajonbadi *et al*., 2016). For example, an LNG marketer may not have immediate insight into operational disruptions at a liquefaction plant, leading to inaccurate delivery promises or suboptimal pricing. Conversely, operations teams may not be aware of urgent customer requests or market opportunities that could influence production priorities (FAGBORE *et al*., 2020; Nwani *et al*., 2020). These disconnects contribute to elongated sales cycles, missed revenue opportunities, and reduced customer satisfaction.

Integrating Artificial Intelligence (AI)-augmented CRM and SCADA systems offers a transformative solution to these challenges. AI can bridge the communication gap between commercial and operational layers through predictive analytics, intelligent automation, and real-time data processing (Olajide *et al*., 2020; Akinbola *et al*., 2020). Machine learning algorithms can analyze historical sales and operational data to forecast demand, recommend optimal pricing strategies, and anticipate maintenance needs. Natural language processing can enhance customer interactions, streamline contract negotiations, and extract actionable insights from unstructured data (Huang and Rust, 2017; Prosper, 2018). When these AI capabilities are embedded within an integrated CRM-SCADA architecture, they enable a holistic view of the LNG business, where customer insights and operational realities inform one another dynamically.

The objective of this review is to develop and explore a framework for integrating AI-augmented CRM and SCADA systems within the LNG industry, with the goal of optimizing sales cycles and improving strategic alignment between customer demands and operational capabilities. The research focuses on identifying critical integration points, evaluating technological requirements, and assessing the potential impact on performance metrics such as sales velocity, contract fulfillment, and customer satisfaction. By drawing on best practices, industry case studies, and digital transformation models, this aims to offer both theoretical insight and practical guidance for LNG enterprises navigating the rapidly evolving global energy market. The scope includes analysis of AI tools, data architecture considerations, and implementation challenges, with an emphasis on achieving resilient, data-driven decision-making across the entire LNG value chain.

II. METHODOLOGY

The PRISMA methodology (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) provides a structured approach to conducting and reporting systematic reviews and has been adapted here to guide the investigation of integrating AI-augmented Customer Relationship Management (CRM) and Supervisory Control and Data Acquisition (SCADA) systems to optimize sales cycles in the Liquefied Natural Gas (LNG) industry. The review aims to synthesize empirical evidence and identify key technological and operational enablers, challenges, and opportunities associated with the convergence of AI-enhanced data systems within LNG marketing and operations.

A comprehensive literature search was conducted across databases such as IEEE Xplore, ScienceDirect, Scopus, Web of Science, and Google Scholar. The search included peer-reviewed journal articles, technical conference proceedings, industry reports, and white papers published from 2010 to 2025. The selection of this timeframe reflects the evolution of AI and digitalization in the energy sector, particularly in LNG infrastructure and commercial strategies. Keywords used in the search included combinations of terms such as "AI-augmented CRM", "SCADA systems", "sales optimization", "LNG industry", "digital transformation in energy", and "predictive analytics in gas trading". Boolean operators (AND, OR) and truncations were applied to capture a broad yet relevant set of literature.

Inclusion criteria required studies to (i) address either CRM or SCADA in the context of the energy sector, preferably LNG; (ii) incorporate AI or machine learning technologies; (iii) focus on applications that directly or indirectly relate to customer acquisition, retention, pricing, forecasting, or operational efficiency; and (iv) present empirical, simulation-based, or conceptual findings. Excluded were studies lacking AI integration, those limited to unrelated industries, or reports that provided no clear implications for sales cycle improvement.

The selection process followed PRISMA's four-phase flow: identification, screening, eligibility, and inclusion. Initially, 416 sources were identified. After duplicate removal, 343 articles were screened based on titles and abstracts. From these, 138 full-text articles were assessed for eligibility, with 52 studies ultimately included in the synthesis. Reference lists of key articles were also hand-searched to ensure completeness and identify additional pertinent studies.

Data extraction involved coding each selected study according to parameters such as author(s), year, geographic focus, system type (CRM, SCADA, or integrated), AI techniques applied (e.g., machine learning, neural networks, reinforcement learning), application domain (customer analytics, demand forecasting, asset management, predictive maintenance), and reported outcomes on sales performance, decision-making efficiency, or customer value realization. A thematic analysis approach was applied to identify recurrent patterns, strategic integration models, and potential industry-wide implications.

The methodological quality and potential biases of included studies were assessed using adapted criteria based on study design, transparency in algorithmic modeling, data sources, scalability considerations, and relevance to LNG-specific environments. Studies that demonstrated comprehensive AI deployment, robust validation of outcomes, and real-time or near-real-time system integration were rated as high quality.

Findings from the review reveal an emerging trend toward convergence of AI-powered CRM and SCADA as a digital synergy that can significantly shorten LNG sales cycles by enabling predictive customer targeting, proactive asset scheduling, dynamic pricing, and cross-functional data orchestration. However, gaps remain in standardizing architecture, ensuring interoperability, and mitigating cybersecurity risks. The synthesis underscores the importance of integrating data science teams, operational technologists, and commercial strategists to drive end-to-end value chain optimization. The use of the PRISMA methodology ensures a transparent, replicable, and evidence-based review, establishing a solid foundation for future empirical research, system development, and policy direction in the LNG sector's digital transformation journey.

2.1 Literature Review

The digitization of industrial systems has significantly advanced over the past two decades, with major developments in Customer Relationship Management (CRM) and Supervisory Control and Data Acquisition (SCADA) systems (Kotarba, 2016; Givehchi *et al*., 2017). While these platforms have individually transformed industrial sales and operations, their integration remains limited, particularly in complex and high-value sectors such as the Liquefied Natural Gas (LNG) industry. This literature review examines the roles of CRM and SCADA in LNG and other industrial sectors, explores the application of Artificial Intelligence (AI) in optimizing energy systems, and identifies critical gaps in integrated digital frameworks for LNG sales optimization.

CRM systems have become indispensable in managing industrial sales by consolidating customer data, tracking interactions, and improving demand forecasting. In the context of industrial B2B markets, CRM platforms such as Salesforce, Microsoft Dynamics, and SAP are deployed to manage complex customer relationships, track sales opportunities, and generate insights for strategic decision-making. According to Buttle and Maklan (2019), CRM enables firms to maintain customer engagement across extended sales cycles, particularly in sectors like oil, gas, and power where contract negotiation and customization are common. In the LNG sector, CRM systems are used to manage term and spot sales contracts, track historical purchasing behavior, and estimate customer demand based on prior transactions and forecasted needs. However, despite their utility, CRM systems typically operate independently of operational systems like SCADA, thereby lacking access to real-time supply-side data necessary for agile and accurate decision-making (Agalgaonkar *et al*., 2016; Ramamurthy and Jain, 2017).

SCADA systems, on the other hand, are vital to LNG operations, offering real-time monitoring and control of equipment and processes across the value chain—from gas treatment and liquefaction to shipping and regasification. SCADA platforms collect data on flow rates, pressure, temperature, energy consumption, and equipment status, enabling operators to optimize efficiency, minimize downtime, and respond to system anomalies (Sayed and Gabbar, 2017; Hunzinger, 2017). As described by Pham *et al*. (2021), SCADA systems form the backbone of industrial automation and are critical for maintaining safety and compliance in high-risk environments like LNG plants. Yet, while SCADA systems are rich in process data, they rarely interface with customer-facing applications. This disconnect prevents commercial teams from accessing operational insights that could inform sales timelines, pricing flexibility, and delivery commitments.

The integration of Artificial Intelligence into both CRM and SCADA systems has introduced powerful new capabilities, particularly in predictive maintenance, dynamic pricing, and customer engagement. AI applications in industrial CRM include customer churn prediction, sentiment analysis, and tailored product recommendations, enhancing the precision of sales strategies. In SCADA environments, AI-driven predictive maintenance algorithms use historical sensor data to forecast equipment failures, allowing for proactive intervention and reducing unplanned downtime (Kumar *et al*., 2022). In the LNG sector, AI can also enable dynamic pricing by factoring in real-time supply constraints, transportation costs, and market demand fluctuations—functions that traditionally require manual intervention and lag behind fast-changing market conditions.

Despite these technological advancements, existing literature reveals a significant gap in integrated digital systems that bridge CRM and SCADA for LNG sales optimization. Most studies treat CRM and SCADA as isolated systems, focused on either commercial outcomes or operational efficiency, respectively. The lack of a unified architecture results in delayed information flow between departments, missed opportunities for agile pricing and scheduling, and misalignment between customer needs and operational capabilities (Braude and Bernstein, 2016; Menzies *et al*., 2017). For example, Raut *et al*. (2020) highlight that the absence of real-time operational data in CRM systems often leads to unrealistic delivery promises and contract failures in energy markets.

Moreover, while the use of AI in each system has been well documented, few implementations fully exploit the cross-functional potential of AI to integrate insights across sales and operations. The LNG sector, with its long and interdependent value chain, is particularly well-suited for such integration. However, implementation is hindered by challenges such as legacy infrastructure, data silos, cybersecurity concerns, and a lack of standardized protocols for cross-system communication (Nabi, 2017; Schooler *et al*., 2018).

While CRM and SCADA systems each contribute substantial value to the LNG industry, their current disconnection represents a missed opportunity for systemic optimization. AI technologies have the potential to bridge these platforms, enabling real-time synchronization between market signals and operational capabilities. However, the literature lacks comprehensive models or case studies demonstrating such integration in practice. Future research must focus on developing interoperable architectures, data governance frameworks, and AI applications that connect CRM and SCADA systems in a cohesive, secure, and value-driven manner (Lojka *et al*., 2016; Lampropoulos *et al*., 2018). Addressing these gaps will be critical to improving LNG sales cycles, enhancing customer satisfaction, and building resilience in an increasingly dynamic global energy market.

2.2 Industry Challenges in LNG Sales Optimization

The liquefied natural gas (LNG) industry operates in a dynamic and complex global environment, where optimizing sales cycles presents a multifaceted set of challenges. The confluence of volatile market conditions, intricate logistics, data silos, and misaligned operational and commercial strategies poses significant barriers to achieving sales efficiency as shown in figure 2(Mayer-Schönberger and Ramge, 2018; Álvarez and Bravo, 2018). Addressing these challenges is critical for LNG producers, marketers, and traders striving to enhance profitability, customer satisfaction, and supply chain agility.

One of the most prominent challenges in LNG sales optimization is the high degree of demand and price volatility in global LNG markets. Unlike pipeline gas, LNG is traded globally and is subject to both regional and seasonal market dynamics. Demand is influenced by factors such as weather patterns, energy policy shifts, geopolitical tensions, and the availability of alternative fuels. On the supply side, capacity constraints, unplanned outages, and competition from renewable sources further complicate the equilibrium (Aflaki and Netessine, 2017; Verzijlbergh *et al.*, 2017). Prices can fluctuate dramatically, making it difficult for sellers to lock in favorable long-term contracts or optimize spot market sales. This uncertainty impacts sales forecasting accuracy and increases the risk of underutilization or oversupply, both of which can erode margins and strain customer relationships.

Compounding this volatility are the complex supply chains and delivery logistics inherent in the LNG sector. LNG supply chains involve multiple stages, including upstream gas production, liquefaction, maritime transport, storage, and regasification. Each segment is capital-intensive and tightly interdependent, requiring precise coordination to meet delivery timelines and quality specifications. Any disruption—such as a delay at liquefaction terminals, port congestion, or shipping constraints—can cascade through the supply chain and impact the ability to meet contractual obligations. The just-in-time nature of LNG deliveries, particularly for spot and short-term contracts, exacerbates the risk. Additionally, the variability in shipping durations, vessel availability, and regulatory environments across different jurisdictions makes logistics planning a complex and often reactive process, thereby reducing the agility needed for sales optimization (Christensen *et al.*, 2018; Slack *et al.*, 2018).

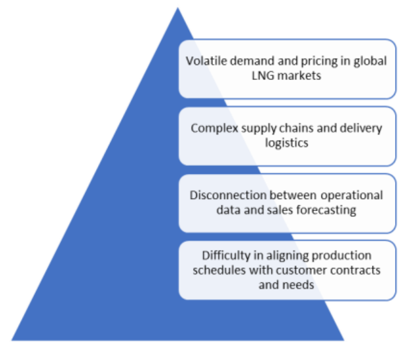

Figure 1: Industry Challenges in LNG Sales Optimization

Another critical challenge lies in the disconnection between operational data systems and sales forecasting tools. Many LNG companies operate legacy Supervisory Control and Data Acquisition (SCADA) systems that capture real-time operational data, including production rates, equipment status, and storage levels. However, these systems are often isolated from commercial platforms such as Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) tools. This siloed data architecture hampers the ability to translate operational insights into actionable sales strategies. Without integrated analytics, sales teams lack visibility into real-time production capacity and cannot respond proactively to customer inquiries or market opportunities (Laursen and Thorlund, 2016; Rathore, 2016). This disconnect limits the potential of predictive analytics and artificial intelligence (AI) in improving forecasting precision, dynamic pricing, and customer segmentation.

Closely related to this is the difficulty in aligning production schedules with customer contracts and needs. LNG production is typically based on long-term planning and technical constraints, including liquefaction capacity, feed gas availability, and maintenance windows. Conversely, customer requirements—especially in deregulated or emerging markets—may be more variable and influenced by short-term price signals or unforeseen demand spikes. This mismatch creates a tension between operational stability and commercial flexibility. For example, failure to adjust production schedules in response to high-value spot market opportunities may result in revenue loss, while overcommitting production volumes without buffer capacity can lead to penalties and reputational damage. Furthermore, long-term contracts often include destination flexibility and price indexation clauses, increasing the complexity of aligning physical flows with commercial obligations (Peng and Poudineh, 2016; Carriere, 2018).

Optimizing LNG sales cycles requires navigating a volatile market landscape, coordinating a highly complex supply chain, bridging the gap between operational and commercial data, and achieving synchronization between production and customer requirements. Addressing these challenges demands a holistic digital transformation strategy, integrating AI-driven analytics, real-time system interoperability, and agile decision-making frameworks. Only through such comprehensive approaches can the LNG industry achieve the responsiveness and efficiency necessary to thrive in an increasingly competitive global energy market.

2.3 Conceptual Framework for Integration

The integration of AI-augmented Customer Relationship Management (CRM) systems with Supervisory Control and Data Acquisition (SCADA) platforms represents a significant advancement in digital transformation within the Liquefied Natural Gas (LNG) industry. Given the complexity of the LNG value chain and the critical importance of aligning customer demands with operational capacity, a conceptual framework that connects commercial and technical domains is essential. This framework must be capable of synchronizing real-time plant operations with customer-facing strategies, thereby enabling optimized sales cycles, predictive decision-making, and agile responses to market fluctuations. At its core, the integration relies on a three-tier architecture comprising the Operational Layer (SCADA), the Analytical Layer (AI), and the Customer Interaction Layer (CRM) as shown in figure 2(Serpanos and Wolf, 2018; Hingant *et al*., 2018).

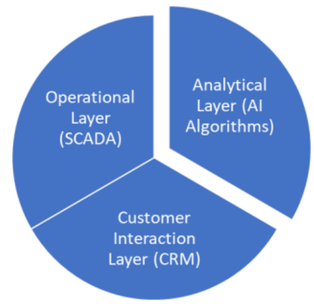

Figure 2: Three-tier architecture which the integration relies

The foundational element of this integration is the data flow between customer insights generated by CRM systems and operational data captured through SCADA systems. Traditionally, CRM systems store customer profiles, sales histories, contract details, and engagement patterns, while SCADA systems collect process variables such as pressure, temperature, throughput, and system alarms. By establishing bidirectional data flow, this architecture enables operational decisions to be informed by customer expectations (e.g., delivery schedules, order modifications) and commercial strategies to be adjusted based on real-time plant performance (e.g., production delays, capacity limitations). Such integration ensures that customer-facing teams can offer precise delivery forecasts, tailored pricing, and responsive service while operations can prioritize processes based on contractual urgency and demand patterns.

At the center of this framework is the Analytical Layer, where Artificial Intelligence serves as the bridge between the CRM and SCADA domains. This layer houses a suite of AI tools, including machine learning algorithms, natural language processing (NLP), and predictive modeling techniques. Machine learning algorithms analyze historical sales, customer preferences, and operational metrics to predict future demand and optimize asset utilization. These models can also identify patterns such as seasonal fluctuations, consumption trends, and equipment degradation, enabling proactive interventions. NLP algorithms are used to process unstructured data from customer communications, contracts, and service logs, extracting relevant insights to enhance decision-making. For example, NLP can identify dissatisfaction signals from email exchanges or uncover recurring operational issues highlighted by customers. Predictive modeling then merges these insights with SCADA data to forecast system bottlenecks, estimate delivery feasibility, and recommend scheduling adjustments that align with business priorities.

The Operational Layer, composed primarily of SCADA systems, continues to perform its essential function of monitoring and controlling LNG processes. However, within the integrated framework, this layer also becomes a source of real-time intelligence for higher-level decision-making. Data from field sensors, control systems, and remote terminal units (RTUs) are streamed to the Analytical Layer, where AI models continuously evaluate the system's state (Cruz *et al*., 2016; Jiang *et al*., 2017). This enables the detection of anomalies, prediction of maintenance needs, and real-time adjustments to production schedules in accordance with sales forecasts and contract timelines. By doing so, the operational side of the business becomes tightly interlinked with commercial responsiveness, reducing downtime and enhancing production agility.

The Customer Interaction Layer represents the traditional domain of CRM systems but with enhanced capabilities driven by AI integration and real-time data access. This layer is responsible for managing client interactions, configuring service offerings, generating dynamic quotes, and tracking sales performance. When connected to both the Analytical and Operational Layers, the CRM platform becomes significantly more powerful. For instance, sales teams can offer customers data-driven recommendations based on current production levels, delivery logistics, and historical usage patterns. Contract managers can be alerted to potential delivery issues well in advance, allowing for timely renegotiation or adjustment. Furthermore, AI-driven personalization tools can tailor marketing messages, loyalty programs, and after-sales support to specific customer profiles and operational realities.

In terms of system architecture, these three layers communicate via a centralized data integration platform or middleware equipped with robust Application Programming Interfaces (APIs), ensuring data security, standardization, and scalability. The platform supports data synchronization, analytics visualization, and process automation across departments. Cybersecurity protocols, data governance frameworks, and compliance with energy sector regulations (such as ISO 27001 and NIST standards) are integral components of the architecture, given the sensitive nature of both operational and customer data.

The conceptual framework for integrating AI-augmented CRM and SCADA systems in the LNG industry provides a multidimensional approach to synchronizing sales and operations. By linking real-time process data with customer behavior insights through AI analytics, this architecture transforms traditional silos into a cohesive ecosystem (Roden *et al*., 2017; Kitchens *et al*., 2018). The result is a dynamic, data-driven environment where customer satisfaction, operational efficiency, and strategic agility are significantly enhanced—positioning LNG enterprises for competitive advantage in a rapidly evolving global energy market.

2.4 Use Cases and Applications

The integration of artificial intelligence (AI)-augmented Customer Relationship Management (CRM) and Supervisory Control and Data Acquisition (SCADA) systems in the liquefied natural gas (LNG) industry offers a transformative potential for optimizing sales cycles. By leveraging the data-rich environments characteristic of LNG operations, AI applications can enhance decision-making across critical commercial and operational domains as shown in figure 3. The following use cases illustrate the practical applications of these technologies in improving demand forecasting, supply chain efficiency, dynamic pricing, and contract management.

One of the most impactful applications is in demand forecasting, where AI models trained on historical CRM data can provide highly granular predictions of future LNG needs. Traditional forecasting methods often rely on static models and general market assumptions, which are insufficient in a volatile energy market. AI-based models, particularly those using machine learning (ML) techniques such as recurrent neural networks (RNNs) or gradient boosting algorithms, can incorporate variables such as customer consumption patterns, contract histories, macroeconomic indicators, and even weather forecasts. By learning from past behaviors and recognizing trends across different customer segments, these models can generate real-time, customer-specific demand forecasts. This enhances sales planning by reducing overproduction, avoiding lost sales opportunities, and supporting more targeted marketing strategies. Additionally, predictive demand modeling facilitates better alignment between available LNG volumes and customer acquisition efforts, especially in spot or hybrid contract scenarios (Dedehayir and Steinert, 2016; Subramanian *et al.*, 2018).

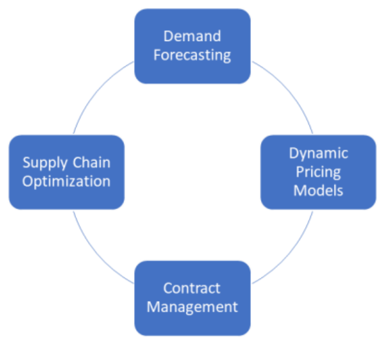

Figure 3: Use Cases and Applications

The optimization of LNG supply chains through SCADA integration is another compelling use case. SCADA systems collect vast amounts of data in real time from sensors and control points throughout LNG production, storage, and distribution networks. Integrating this operational feedback into centralized analytics platforms enables real-time visibility and forecasting of equipment status, inventory levels, and system bottlenecks. When SCADA data is combined with AI algorithms and CRM-based commercial scheduling tools, operators can dynamically adjust delivery schedules to reflect current conditions. For instance, if SCADA detects a slowdown in liquefaction due to maintenance, AI systems can re-optimize vessel routing or suggest rescheduling customer deliveries to minimize disruptions. Similarly, AI models can analyze delivery times, storage availability, and shipping costs to develop logistics strategies that maximize throughput and reduce demurrage charges. This integrated approach improves the responsiveness and reliability of the supply chain, leading to enhanced customer satisfaction and lower operational costs.

Dynamic pricing models powered by AI further contribute to sales cycle optimization by enabling LNG marketers to adapt pricing strategies based on real-time data. Traditional pricing mechanisms often rely on fixed indexation to oil or regional gas prices, limiting flexibility and responsiveness to immediate market changes. AI models, however, can continuously analyze diverse data inputs—including SCADA-based production metrics, market demand trends, competitor pricing, shipping delays, and storage constraints—to recommend optimal pricing structures. Techniques such as reinforcement learning and decision trees can simulate multiple pricing scenarios, forecasting their impacts on sales volume, revenue, and customer behavior. This allows LNG companies to adjust prices in response to changing market conditions or to incentivize customer behavior, such as committing to off-peak deliveries or longer contract durations. Real-time dynamic pricing not only enhances competitiveness in spot markets but also allows firms to extract higher value from surplus capacity or underutilized assets.

In the domain of contract management, AI-driven systems can revolutionize how LNG sales terms are drafted, monitored, and adjusted. LNG contracts are typically complex, involving clauses on volume flexibility, destination rights, pricing mechanisms, and penalty structures. AI applications can automate contract lifecycle management by extracting key terms from documents using natural language processing (NLP), monitoring compliance in real-time, and predicting the financial and operational impacts of contract amendments. Predictive analytics can assess customer risk profiles, usage trends, and market conditions to suggest optimal contract adjustments (Wedel and Kannan, 2016; Kumar and Garg, 2018). For example, if demand forecasts indicate that a customer is likely to exceed contracted volumes, AI systems can proactively recommend upselling or renegotiation strategies. Similarly, in the face of expected shortfalls, the system can flag potential contractual liabilities and recommend mitigation strategies such as reallocation of deliveries. This enables LNG marketers to maintain contractual agility, minimize risks, and enhance commercial value.

Collectively, these applications demonstrate the substantial benefits of integrating AI, CRM, and SCADA technologies in the LNG industry. Demand forecasting enables better supply alignment and resource planning. Supply chain optimization reduces inefficiencies and increases delivery reliability. Dynamic pricing models provide revenue maximization opportunities in volatile markets, while intelligent contract management enhances flexibility and compliance. Importantly, these use cases are not isolated; their full potential is realized when implemented in a cohesive, interoperable ecosystem where data flows seamlessly across operational and commercial domains. As the LNG industry evolves toward digital maturity, the integration of AI-augmented CRM and SCADA systems will be instrumental in enabling smarter, faster, and more customer-centric decision-making throughout the sales lifecycle.

2.5 Benefits and Strategic Implications

The integration of AI-augmented Customer Relationship Management (CRM) systems with Supervisory Control and Data Acquisition (SCADA) platforms in the Liquefied Natural Gas (LNG) industry presents transformative benefits and strategic implications. By bridging the gap between operational control systems and customer engagement platforms, LNG enterprises can unlock a new level of responsiveness, efficiency, and competitiveness (Lu *et al*., 2016; Ngai *et al*., 2018). These benefits extend across core commercial and technical functions, with direct impacts on sales cycle performance, contract reliability, customer satisfaction, and organizational risk posture.

One of the most significant advantages is the shortening of sales cycles and the optimization of the quote-to-cash process. In the traditional LNG business model, sales cycles are often lengthy and complex due to the technical, financial, and logistical intricacies involved in contract negotiation and fulfillment. By integrating AI-driven CRM systems with real-time SCADA data, sales teams can access accurate, up-to-date information about production capacity, inventory levels, and delivery logistics. This allows for faster generation of price quotes and contract terms that reflect actual operational constraints, reducing the need for renegotiation or adjustments. AI algorithms can further automate parts of the quote-to-cash workflow by generating customized proposals, tracking approval processes, and predicting payment behaviors based on historical data. Collectively, these capabilities accelerate deal closure, improve cash flow predictability, and enhance commercial agility.

Another key benefit lies in the enhanced alignment between operations and sales. In many LNG organizations, a lack of synchronization between these functions leads to suboptimal decision-making, production inefficiencies, and customer dissatisfaction. Integrated systems ensure that the sales team is aware of operational constraints—such as maintenance schedules, capacity limits, or supply chain disruptions—when planning deliveries or negotiating contracts. Simultaneously, operations teams receive demand forecasts and customer commitments, allowing them to prioritize production accordingly. This bi-directional flow of data, mediated by AI, eliminates guesswork and improves coordination, enabling the entire organization to function as a cohesive, demand-responsive unit.

Integration also results in improved customer satisfaction and greater contract reliability. When CRM systems are augmented with AI and linked to SCADA platforms, customer-facing teams are better equipped to provide accurate delivery timelines, real-time status updates, and rapid responses to inquiries or issues. Predictive analytics can identify potential bottlenecks before they impact the customer, allowing for preemptive communication and mitigation strategies. This level of transparency and reliability builds trust, strengthens long-term relationships, and reduces the likelihood of contract disputes or penalties due to non-compliance. Moreover, AI-enhanced CRM tools can personalize customer interactions, offer tailored energy solutions, and provide post-sale support that reflects individual client needs, further enhancing loyalty and engagement.

In terms of risk mitigation and proactive decision-making, the benefits are equally profound. The LNG industry faces a wide array of operational and market risks, including equipment failure, volatile pricing, geopolitical disruptions, and logistical delays. By leveraging integrated systems, organizations can detect and respond to these risks in real time. Predictive maintenance models built into SCADA systems alert operators to impending equipment issues, reducing downtime and extending asset life (Kiangala and Wang, 2018; Flichy and Baudoin, 2018). Machine learning models can also forecast demand shifts or pricing fluctuations, allowing commercial teams to adjust terms or inventory levels accordingly. Furthermore, AI-driven scenario modeling enables stakeholders to simulate the impact of various risk factors on both operations and revenue, informing more resilient and evidence-based strategies.

Strategically, the adoption of integrated, AI-powered CRM and SCADA systems positions LNG enterprises at the forefront of digital transformation in the energy sector. It allows companies to move from reactive to proactive modes of operation, fostering a culture of data-driven decision-making and continuous improvement. As the global energy landscape evolves—driven by decarbonization, decentralization, and digitalization—firms that can rapidly adapt to market signals while maintaining operational excellence will enjoy a competitive advantage. Thus, beyond operational benefits, this integration lays the groundwork for long-term strategic resilience, innovation, and customer-centric growth in a complex and dynamic market environment.

2.6 Challenges and Limitations

The integration of AI-augmented Customer Relationship Management (CRM) and Supervisory Control and Data Acquisition (SCADA) systems in the liquefied natural gas (LNG) industry presents transformative opportunities for optimizing sales cycles, yet it is accompanied by significant challenges and limitations. These barriers span technical, organizational, and market-related dimensions, which must be carefully addressed to realize the full potential of digital transformation in this highly specialized and volatile sector (Boer *et al*., 2017; Milios, 2018).

A primary technical challenge is data security and infrastructure compatibility. SCADA systems, historically designed for operational reliability rather than cyber resilience, often run on isolated networks and outdated operating systems. The introduction of AI and CRM platforms requires extensive data integration and, in many cases, real-time connectivity to cloud or edge computing environments. This expanded digital footprint increases the system's attack surface and makes it vulnerable to cyber threats such as ransomware, industrial espionage, and denial-of-service attacks. Given that LNG infrastructure is classified as critical energy infrastructure, any security breach can have severe operational, financial, and geopolitical consequences. In addition, infrastructure incompatibility can hinder smooth integration, as legacy SCADA systems may use proprietary protocols and rigid data formats that are incompatible with the open, API-driven architectures common in modern CRM and AI applications. Overcoming these limitations requires significant investment in cybersecurity frameworks, secure middleware, and standardized data models, which may not be feasible for all organizations, especially those operating under tight capital constraints.

Organizational resistance and upskilling needs further complicate the implementation of integrated AI-CRM-SCADA systems. The LNG industry is traditionally conservative and engineering-driven, with a workforce that may be unfamiliar with advanced analytics, AI algorithms, or customer-centric digital tools. Resistance to change can arise from concerns over job displacement, lack of trust in algorithmic decision-making, and fear of reduced human control over critical systems. Moreover, the transition demands a new set of skills, including data science, digital operations, and system integration. Many LNG firms face a talent gap in these areas, with limited internal capacity to design, implement, and maintain AI-enhanced platforms. Upskilling the workforce through targeted training programs, knowledge transfer from digital experts, and cultural transformation initiatives is essential but can be time-consuming and resource-intensive. Without organizational buy-in and adequate human capital development, the technological solutions may underperform or fail altogether.

A third limitation stems from the inherent volatility of commodity markets, which poses challenges to the reliability and generalizability of AI models. LNG prices and demand fluctuate due to geopolitical tensions, weather events, regulatory changes, and macroeconomic shifts. AI models trained on historical data may fail to capture sudden regime changes or rare events, leading to inaccurate predictions or misguided recommendations. While adaptive and real-time learning algorithms can partially address this issue, they also introduce complexity and require large volumes of high-quality, timely data. Additionally, black-box AI models, such as deep neural networks, can lack transparency and explainability—qualities critical in high-stakes decision-making environments like energy trading (Coglianese and Lehr,, 2016; Dix, 2018). As a result, decision-makers may be reluctant to fully rely on AI-driven insights without robust validation mechanisms and the ability to interpret model outputs in the context of broader market dynamics.

Finally, interoperability between legacy SCADA systems and modern CRM platforms presents a major integration challenge. SCADA systems often lack standardized communication protocols and may be tightly coupled with specific hardware or vendor ecosystems, making integration with contemporary software solutions non-trivial. Conversely, CRM systems are designed for flexibility, scalability, and user engagement but may not natively support real-time data ingestion from industrial control systems. Bridging this gap requires the development of custom interfaces, middleware solutions, and data transformation pipelines—efforts that introduce additional cost, complexity, and risk. Furthermore, synchronization between time-sensitive SCADA data and event-driven CRM workflows is essential to maintain consistency and actionable insights, which is difficult to achieve without sophisticated orchestration tools.

While the integration of AI, CRM, and SCADA systems holds substantial promise for optimizing sales and operational performance in the LNG industry, it is constrained by security vulnerabilities, infrastructure mismatches, cultural and skills-based barriers, and the unpredictability of commodity markets. Addressing these limitations requires a strategic, phased approach that balances technological innovation with organizational readiness, regulatory compliance, and market awareness (Gebhardt and Stanovnik, 2016; Baumgartner and Rauter, 2017).

CONCLUSION AND FUTURE RESEARCH DIRECTIONS

The integration of AI-augmented Customer Relationship Management (CRM) systems with Supervisory Control and Data Acquisition (SCADA) platforms offers a compelling value proposition for the Liquefied Natural Gas (LNG) industry. This integrated approach bridges the traditional divide between customer-facing and operational domains, enabling synchronized decision-making, predictive analytics, and real-time responsiveness. By creating a seamless flow of data between plant operations and commercial functions, LNG enterprises can shorten sales cycles, enhance quote-to-cash processes, improve customer satisfaction, and strengthen risk management. Moreover, the use of Artificial Intelligence to analyze, interpret, and act on both structured and unstructured data ensures that businesses remain agile and competitive in a rapidly evolving global energy market.

This convergence is a critical milestone in the broader digital transformation sweeping through the energy sector. The LNG industry, characterized by long value chains, capital-intensive infrastructure, and volatile market dynamics, stands to benefit immensely from the adoption of smart, integrated technologies. Digital transformation enables a shift from reactive to proactive operations, empowers decision-makers with real-time insights, and enhances transparency and traceability across business processes. As global priorities shift toward cleaner, smarter, and more resilient energy systems, the integration of AI-enhanced CRM and SCADA systems becomes not only a technical upgrade but a strategic imperative.

Despite its transformative potential, the integration framework discussed in this also opens up avenues for future research. One promising area is the development of real-time digital twins—virtual replicas of physical LNG assets that dynamically mirror their performance, enabling real-time simulations, scenario testing, and predictive diagnostics. Integrating digital twins with CRM and AI layers could further enhance the precision of customer promises and the efficiency of operational planning.

Another key frontier is the application of blockchain technologies to secure, validate, and automate transactions across the LNG value chain. Smart contracts powered by blockchain could be linked to AI-driven CRM systems to automatically execute terms based on operational data captured via SCADA, thus improving contract reliability, transparency, and enforcement.

Furthermore, AI-led contract negotiation systems represent an emerging opportunity for enhancing commercial agility. Natural language processing (NLP) algorithms could be trained to review, draft, and adapt contract clauses in real time based on shifts in supply, demand, or regulatory conditions. This capability would be especially valuable in short-term and spot LNG markets where timing and precision are critical.

Integrating AI-augmented CRM and SCADA systems is a strategic enabler for operational efficiency, customer-centricity, and competitive advantage in the LNG industry. As digital transformation accelerates, the fusion of advanced analytics, intelligent automation, and real-time control systems will continue to redefine the future of energy operations. Future research must now focus on deepening this integration, exploring cross-technology synergies, and developing adaptive, secure, and intelligent systems that meet the evolving needs of LNG stakeholders and the broader energy transition agenda.

REFERENCES

[1] Aflaki, S. and Netessine, S., 2017. Strategic investment in renewable energy sources: The effect of supply intermittency. *Manufacturing & Service Operations Management*, *19*(3), pp.489-507.

[2] Agalgaonkar, Y.P., Marinovici, M.C., Vadari, S.V., Schneider, K.P. and Melton, R.B., 2016. *Adms state of the industry and gap analysis* (No. PNNL-26361). Pacific Northwest National Lab.(PNNL), Richland, WA (United States).

[3] Ajonbadi, H.A., Otokiti, B.O. and Adebayo, P., 2016. The efficacy of planning on organisational performance in the Nigeria SMEs. *European Journal of Business and Management*, *24*(3), pp.25-47.

[4] AjonbadiAdeniyi, H., AboabaMojeed-Sanni, B. and Otokiti, B.O., 2015. Sustaining competitive advantage in medium-sized enterprises (MEs) through employee social interaction and helping behaviours. *Journal of Small Business and Entrepreneurship*, *3*(2), pp.1-16.

[5] Akinbola, O.A. and Otokiti, B.O., 2012. Effects of lease options as a source of finance on profitability performance of small and medium enterprises (SMEs) in Lagos State, Nigeria. *International Journal of Economic Development Research and Investment*, *3*(3), pp.70-76.

[6] Akinbola, O.A., Otokiti, B.O., Akinbola, O.S. and Sanni, S.A., 2020. Nexus of born global entrepreneurship firms and economic development in Nigeria. *Ekonomicko-manazerske spektrum*, *14*(1), pp.52-64.

[7] Álvarez, E. and Bravo, M., 2018. The Oil Industry Challenges and Strategic Responses.

[8] Amos, A.O., Adeniyi, A.O. and Oluwatosin, O.B., 2014. Market based capabilities and results: inference for telecommunication service businesses in Nigeria. *European Scientific Journal*, *10*(7).

[9] Baumgartner, R.J. and Rauter, R., 2017. Strategic perspectives of corporate sustainability management to develop a sustainable organization. *Journal of Cleaner Production*, *140*, pp.81-92.

[10] Boer, H., Berger, A., Chapman, R. and Gertsen, F., 2017. *CI changes from suggestion box to organisational learning: Continuous improvement in Europe and Australia*. Routledge.

[11] Braude, E.J. and Bernstein, M.E., 2016. *Software engineering: modern approaches*. Waveland Press.

[12] Carriere, C., 2018. The effects of Japan's push for greater LNG market flexibility on LNG pricing and destination restrictions. *The Journal of World Energy Law & Business*, *11*(2), pp.136-144.

[13] Christensen, T., Lasserre, F., Dawson, J., Guy, E. and Pelletier, J.F., 2018. Shipping.

[14] Coglianese, C. and Lehr, D., 2016. Regulating by robot: Administrative decision making in the machine-learning era. *Geo. LJ*, *105*, p.1147.

[15] Cruz, T., Rosa, L., Proença, J., Maglaras, L., Aubigny, M., Lev, L., Jiang, J. and Simões, P., 2016. A cybersecurity detection framework for supervisory control and data acquisition systems. *IEEE Transactions on Industrial Informatics*, *12*(6), pp.2236-2246.

[16] Dedehayir, O. and Steinert, M., 2016. The hype cycle model: A review and future directions. *Technological Forecasting and Social Change*, *108*, pp.28-41.

[17] Dix, A., 2018. Sufficient Reason. *Keynote at HCD for Intelligent Environments, BHCI, Belfast, 3rd July*.

[18] FAGBORE, O.O., OGEAWUCHI, J.C., ILORI, O., ISIBOR, N.J., ODETUNDE, A. and ADEKUNLE, B.I., 2020. Developing a Conceptual Framework for Financial Data Validation in Private Equity Fund Operations.

[19] Flichy, P. and Baudoin, C., 2018, September. The industrial IoT in oil & gas: Use cases. In *SPE Annual Technical Conference and Exhibition?* (p. D031S032R002). SPE.

[20] Gebhardt, C. and Stanovnik, P., 2016. European innovation policy concepts and the governance of innovation: Slovenia and the struggle for organizational readiness at the national level. *Industry and Higher Education*, *30*(1), pp.53-66.

[21] Givehchi, O., Landsdorf, K., Simoens, P. and Colombo, A.W., 2017. Interoperability for industrial cyber-physical systems: An approach for legacy systems. *IEEE Transactions on Industrial Informatics*, *13*(6), pp.3370-3378.

[22] Hingant, J., Zambrano, M., Pérez, F.J., Pérez, I. and Esteve, M., 2018. Hybint: a hybrid intelligence system for critical infrastructures protection. *Security and Communication Networks*, *2018*(1), p.5625860.

[23] Huang, M.H. and Rust, R.T., 2017. Technology-driven service strategy. *Journal of the Academy of Marketing Science*, *45*(6), pp.906-924.

[24] Hunzinger, R., 2017. SCADA fundamentals and applications in the IoT. *Internet of things and data analytics handbook*, pp.283-293.

[25] Jiang, H., Wang, K., Wang, Y., Gao, M. and Zhang, Y., 2017. Energy big data: A survey. *IEEE Access*, *4*, pp.3844-3861.

[26] Kiangala, K.S. and Wang, Z., 2018. Initiating predictive maintenance for a conveyor motor in a bottling plant using industry 4.0 concepts. *The International Journal of Advanced Manufacturing Technology*, *97*(9), pp.3251-3271.

[27] Kitchens, B., Dobolyi, D., Li, J. and Abbasi, A., 2018. Advanced customer analytics: Strategic value through integration of relationship-oriented big data. *Journal of Management Information Systems*, *35*(2), pp.540-574.

[28] Kobos, P.H., Malczynski, L.A., La Tonya, N.W., Borns, D.J. and Klise, G.T., 2018. Timing is everything: A technology transition framework for regulatory and market readiness levels. *Technological Forecasting and Social Change*, *137*, pp.211-225.

[29] Kotarba, M., 2016. New factors inducing changes in the retail banking customer relationship management (CRM) and their exploration by the FinTech industry. *Foundations of management*, *8*(1), p.69.

[30] Kumar, V. and Garg, M.L., 2018. Predictive analytics: a review of trends and techniques. *International Journal of Computer Applications*, *182*(1), pp.31-37.

[31] Lampropoulos, G., Siakas, K. and Anastasiadis, T., 2018. Internet of things (IoT) in industry: Contemporary application domains, innovative technologies and intelligent manufacturing. *people*, *6*(7), pp.109-118.

[32] Laursen, G.H. and Thorlund, J., 2016. *Business analytics for managers: Taking business intelligence beyond reporting*. John Wiley & Sons.

[33] Lawal, A.A., Ajonbadi, H.A. and Otokiti, B.O., 2014. Leadership and organisational performance in the Nigeria small and medium enterprises (SMEs). *American Journal of*

Business, Economics and Management, *2*(5), p.121.

[34] Lojka, T., Bundzel, M. and Zolotová, I., 2016. Service-oriented architecture and cloud manufacturing. *Acta polytechnica hungarica*, *13*(6), pp.25-44.

[35] Lu, I.Y., Kuo, T., Lin, T.S., Tzeng, G.H. and Huang, S.L., 2016. Multicriteria decision analysis to develop effective sustainable development strategies for enhancing competitive advantages: Case of the TFT-LCD industry in Taiwan. *Sustainability*, *8*(7), p.646.

[36] Mayer-Schönberger, V. and Ramge, T., 2018. *Reinventing capitalism in the age of big data*. Basic Books.

[37] Menzies, T., Nichols, W., Shull, F. and Layman, L., 2017. Are delayed issues harder to resolve? Revisiting cost-to-fix of defects throughout the lifecycle. *Empirical Software Engineering*, *22*(4), pp.1903-1935.

[38] Milios, L., 2018. Advancing to a Circular Economy: three essential ingredients for a comprehensive policy mix. *Sustainability science*, *13*(3), pp.861-878.

[39] Nabi, A.G., 2017. Comparative study on identity management methods using blockchain. *University of Zurich*, *118*.

[40] Ngai, E.W.T., Law, C.C., Lo, C.W., Poon, J.K.L. and Peng, S., 2018. Business sustainability and corporate social responsibility: case studies of three gas operators in China. *International Journal of Production Research*, *56*(1-2), pp.660-676.

[41] Nwani, S., Abiola-Adams, O., Otokiti, B.O. & Ogeawuchi, J.C., 2020. Building operational readiness assessment models for micro, small, and medium enterprises seeking government-backed financing. Journal of Frontiers in Multidisciplinary Research, 1(1), pp.38–43. Available at: https://doi.org/10.54660/.IJFMR.2020.1.1.38-43

[42] Olajide, J.O., Otokiti, B.O., Nwani, S., Ogunmokun, A.S., Adekunle, B.I., & Fiemotongha, J.E. (2020). Designing a financial planning framework for managing SLOB and write-off risk in fast-moving consumer goods (FMCG). IRE Journals, 4(4). https://irejournals.com/paper-details/1709016

[43] Otokiti, B.O. and Akinbola, O.A., 2013. Effects of lease options on the organizational growth of small and medium enterprise (SME's) in Lagos State, Nigeria. *Asian Journal of Business and Management Sciences*, *3*(4), pp.1-12.

[44] Otokiti, B.O. and Akorede, A.F., 2018. Advancing sustainability through change and innovation: A co-evolutionary perspective. *Innovation: Taking creativity to the market. Book of Readings in Honour of Professor SO Otokiti*, *1*(1), pp.161-167.

[45] Otokiti, B.O., 2012. *Mode of entry of multinational corporation and their performance in the Nigeria market* (Doctoral dissertation, Covenant University).

[46] Otokiti, B.O., 2017. A study of management practices and organisational performance of selected MNCs in emerging market-A Case of Nigeria. *International Journal of Business and Management Invention*, *6*(6), pp.1-7.

[47] Otokiti, B.O., 2017. Social media and business growth of women entrepreneurs in Ilorin metropolis. *International Journal of Entrepreneurship, Business and Management*, *1*(2), pp.50-65.

[48] Peng, D. and Poudineh, R., 2016. A holistic framework for the study of interdependence between electricity and gas sectors. *Energy Strategy Reviews*, *13*, pp.32-52.

[49] Prosper, J., 2018. AI-Driven Innovations in Sales and Marketing.

[50] Ramamurthy, A. and Jain, P., 2017. The internet of things in the power sector opportunities in Asia and the Pacific.

[51] Rathore, B., 2016. AI and the future of ethical fashion marketing: A comprehensive analysis of sustainable methods and consumer engagement. *Eduzone: International Peer Reviewed/Refereed Multidisciplinary Journal*, *5*(2), pp.14-24.

[52] Roden, S., Nucciarelli, A., Li, F. and Graham, G., 2017. Big data and the transformation of operations models: a framework and a new

research agenda. *Production Planning & Control*, *28*(11-12), pp.929-944.

[53] Sayed, K. and Gabbar, H.A., 2017. SCADA and smart energy grid control automation. In *Smart energy grid engineering* (pp. 481-514). Academic Press.

[54] Schooler, E.M., Milenkovic, M., Ellis, K.A., McCarthy, J., Sedayao, J. and McCarson, B., 2018, July. Rational interoperability: a pragmatic path toward a data-centric IoT. In *2018 IEEE 38th International Conference on Distributed Computing Systems (ICDCS)* (pp. 1139-1149). IEEE.

[55] Serpanos, D. and Wolf, M., 2018. Internet-of-Things (IoT) Systems. *Architectures, Algorithms, Methodologies*.

[56] SHARMA, A., ADEKUNLE, B.I., OGEAWUCHI, J.C., ABAYOMI, A.A. and ONIFADE, O., 2019. IoT-enabled Predictive Maintenance for Mechanical Systems: Innovations in Real-time Monitoring and Operational Excellence.

[57] Slack, B., Comtois, C., Wiegmans, B. and Witte, P., 2018. Ships time in port. *International Journal of Shipping and Transport Logistics*, *10*(1), pp.45-62.

[58] Subramanian, A.S.R., Gundersen, T. and Adams, T.A., 2018. Modeling and simulation of energy systems: A review. *Processes*, *6*(12), p.238.

[59] Verzijlbergh, R.A., De Vries, L.J., Dijkema, G.P.J. and Herder, P.M., 2017. Institutional challenges caused by the integration of renewable energy sources in the European electricity sector. *Renewable and Sustainable Energy Reviews*, *75*, pp.660-667.

[60] Wedel, M. and Kannan, P.K., 2016. Marketing analytics for data-rich environments. *Journal of marketing*, *80*(6), pp.97-121.