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Implementing Lessons Learned in the Project Management Life Cycle (PMLC) of an Engineering, Procurement, and Construction (EPC) Company in the Caribbean

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A DISSERTATION

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I dedicate this to my wonderful wife for her unwavering support and understanding during this journey. Her encouragement and patience have been invaluable in helping me pursue and navigate the complexities of this study at this stage in my life.

Abstract

This thesis aims to demonstrate how implementing lessons learned in the project management life cycle of an Engineering, Procurement, and Construction (EPC) company within the Caribbean can drive continuous improvement and enhance project outcomes.

Lessons learned are valuable insights gained from past experiences that contribute to organizational learning and knowledge management. Integrating lessons learned into project management lifecycles drives continuous improvement by leveraging past experiences to optimize processes, mitigates risks through informed decision-making, enhances decision-making by applying proven strategies, facilitates knowledge management by capturing valuable insights, and fosters organizational learning by promoting a culture of shared learning. According to an article in the International Journal of Project Management, a building project methodically incorporated lessons learned from previous projects into the planning phase. This approach improved risk management and resource allocation, leading to the project being completed ahead of schedule and under budget. (Project Management Institute, 2019).

Examination of when lessons are captured and shared in the project management lifecycle, explore challenges faced by EPC companies (such as cultural resistance, inadequate processes, and knowledge transfer barriers), and delve into issues related to organizational learning. This study will explore best practices such as structured documentation, analysis, and dissemination of lessons learned within the EPC company project management lifecycle to effectively address challenges like cultural resistance, inadequate processes, and knowledge transfer barriers.

Adopting a structured approach to lessons learned can improve project performance by promoting informed decision-making, minimizing risks, and encouraging continuous improvement, resulting in increased success in a competitive environment. This study will analyze academic articles and case studies to demonstrate practical applications of lessons learned in project management lifecycles, assess their effectiveness, pinpoint key success factors, and propose strategies for enhancement. This research significantly contributes to the successful integration of lessons learned into EPC companies' project management lifecycles, resulting in improved project outcomes, enhanced organizational performance, and a culture of continuous improvement.

Contents

Chapter 1

1 Introduction

1.1 Introduction

The EPC sector plays a vital role in developing large-scale infrastructure projects in rapidly growing urban and economic regions. EPC businesses are tasked with executing complex projects that necessitate careful planning, coordination, and implementation across several industries, including oil and gas, power, infrastructure, and industrial facilities. The complex and unpredictable characteristics of these projects frequently result in issues, including budget overruns, delays, and miscommunication among stakeholders (AlMunifi & Almutairi, 2021). The application of lessons learned across the project management life cycle has become an essential technique for continuous improvement and achievement.

Lessons learned are essential for organizations to learn and improve, allowing EPC businesses to use valuable insights from previous projects for future success. Through the systematic documentation and analysis of lessons learned, companies may improve decision-making, reduce risks, and cultivate a culture of continuous improvement (ActiveCollab Team, 2023). Notwithstanding the acknowledged advantages, numerous EPC organizations encounter difficulties in efficiently capturing, documenting, and disseminating lessons learned. The issues include cultural resistance, inadequate processes, and barriers to knowledge transfer (Alavi and Leidner, 2022).

The objective is to establish optimal procedures, including structured documentation, analysis, and dissemination techniques, to address challenges related to implementing lessons learned effectively within EPC project management. This research aims to offer practical advice for

optimizing the lessons learned process in EPC project management by analyzing academic literature and case studies, hence boosting project outcomes and organizational performance.

1.2 Aim of the Study

This study aims to explore effective methods and strategies for implementing lessons learned in the project management life cycle of an EPC company based in the Caribbean. The specific objectives of the study are: 1) Provide an overview of the current lessons learned process in the project management life cycle of an EPC company. 2) Identify gaps and challenges in capturing, documenting, analyzing, reviewing, and implementing lessons learned. 3) Explore best practices and industry standards for lessons learned in EPC projects. 4) Propose strategies for effective implementation of lessons learned to ensure continuous improvement and success in future projects. 5) Assess the impact of lessons learned on project performance, risk mitigation, and organizational learning. By fulfilling these objectives, the study aims to make a meaningful contribution to the fields of project management and knowledge management in the EPC industry, offering valuable insights for both practitioners and researchers.

This study aims to offer practical solutions for project teams to efficiently record and implement lessons learned by analyzing best practices and industry standards. The objective is to establish a culture of continuous improvement within enterprises by suggesting implementation techniques, resulting in improved project performance and diminished risks. The evaluation of the influence of lessons learned on many facets of project management will inform future practices and enhance the overall success of EPC projects.

Chapter 2

2 Materials and Methods

2.1 Research Methodology

This research methodology delineates the strategy for examining the application of lessons learned within the project management life cycle of an EPC company in the Caribbean. The technique is structured to guarantee a systematic and thorough examination of pertinent literature, data acquisition, and analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework will be employed to direct the systematic review procedure. This will guarantee transparency in the review process, facilitating an exhaustive analysis of the obtained data. Adhering to established principles such as PRISMA will enhance the credibility and reliability of the study findings, hence informing future practices in EPC projects.

2.2 Research Design

The study will utilize research design methodologies, including a Systematic Literature Review and Case Study Analysis, to gain insights into the application of lessons learned in EPC project management. The research design will include the following components: 1. Systematic Literature Review and 2. Case Study Analysis.

The literature review will use the PRISMA methodology to methodically search for and assess relevant articles on EPC project management. The evaluation will utilize a comprehensive search strategy incorporating keywords related to EPC project management and databases including Scopus, Web of Science, and Google Scholar. The selected studies will undergo screening according to inclusion and exclusion criteria, eliminating duplicates and irrelevant research. Eligibility will be evaluated according to established standards, and

studies failing to meet these requirements will be excluded. The selected studies will be integrated into the systematic review, and relevant data will be extracted using a standardized form for consistency. The results will be presented in a narrative format supported by tables and figures to enhance the understanding of the findings.

The case study research will examine an EPC company in the Caribbean that has integrated lessons learned into its project management lifecycle. The research will involve selecting a representative company and gathering qualitative data through document analysis, observations, and interviews with key stakeholders, along with collecting quantitative data on project performance metrics before and after implementing lessons learned. Thematic analysis will identify main themes and patterns, whilst statistical approaches will evaluate the influence of lessons gained on project success. The study will produce a detailed case study report that outlines best practices, challenges, and recommendations derived from the insights for application in EPC project management.

2.2 Theoretical Framework

This MBA thesis titled "Implementing Lessons Learned in the Project Management Life Cycle of an EPC Company in the Caribbean" is based on essential principles and concepts pertaining to project management, knowledge management, and organizational learning. These theories provide a foundation for understanding the need for recording, documenting, and applying lessons learned to improve project performance and organizational success (Warburton & Cioffi, 2014). The framework is grounded in established project management principles and methodologies, such as the Critical Path Method (CPM), Earned Value Management (EVM), and Agile Project Management. These methodologies provide structured approaches for planning, executing, and controlling projects to achieve defined

objectives within scope, time, and cost constraints (PMI, 2017). The PMI's guidelines and standards, such as the PMBOK® Guide, serve as foundational references for best practices in project management.

2.2.1. Project Management Theory

Project management theory includes several principles, approaches, and practices designed to accomplish project goals within specified limitations of scope, time, and money. The Project Management Institute (PMI) defines project management as the utilization of information, skills, tools, and techniques to execute project activities in order to fulfill project requirements (PMI, 2017). Essential techniques include the Critical Path Method (CPM), Earned Value Management (EVM), and Agile Project Management offer frameworks for the planning, execution, and control of projects (PMI, 2017). These strategies equip project managers with essential tools to adeptly traverse intricate projects, manage resources, and adjust to changes in project scope or requirements. By employing these validated approaches, project managers can enhance efficiency, optimize resources, and ultimately achieve effective project outcomes. Furthermore, project management principles underscore the significance of explicit communication, stakeholder involvement, and risk mitigation to guarantee project success (Kabirifar & Mojtahedi, 2019; Warburton & Cioffi, 2014). By employing these ideas and practices, project managers may proficiently guide their teams to achieve superior results within the limitations of time, budget, and scope (Kabirifar & Mojtahedi, 2019).

2.2.2. Knowledge Management Theory

The theory of knowledge management emphasizes the processes involved in the creation, dissemination, utilization, and administration of knowledge within an organization (Warburton & Cioffi, 2014). It underscores the need of capturing tacit knowledge—

knowledge inherent in individual experiences—and transforming it into explicit knowledge—documented and readily transferable knowledge—to augment organizational learning and innovation. The SECI model by Nonaka and Takeuchi (Socialization, Externalization, Combination, Internalization) is a prominent paradigm for comprehending knowledge development and transfer. The theory of knowledge management emphasizes the processes of knowledge creation, sharing, utilization, and administration within an organization (Senge, 2006). The utilization of digital platforms and knowledge management systems to enable the documentation, dissemination, and application of lessons learned is essential to the framework.

2.2.3. Organizational Learning Theory

Organizational learning theory examines the mechanisms via which organizations acquire knowledge and adjust over time. It underscores the significance of perpetual learning and enhancement to attain sustained success. Argyris and Schön's theory of single-loop and double-loop learning distinguishes between error correction within established paradigms (single-loop) and the examination and alteration of fundamental assumptions and norms (double-loop). Senge's notion of the learning organization underscores the significance of cultivating a culture of perpetual learning and collaboration (Senge, 2006). The implementation of lessons learned in EPC projects must be tailored to the unique challenges and opportunities of each project. Contingency theory supports the need for flexible and adaptive processes that can be customized to suit different project contexts (PMI, 2017).

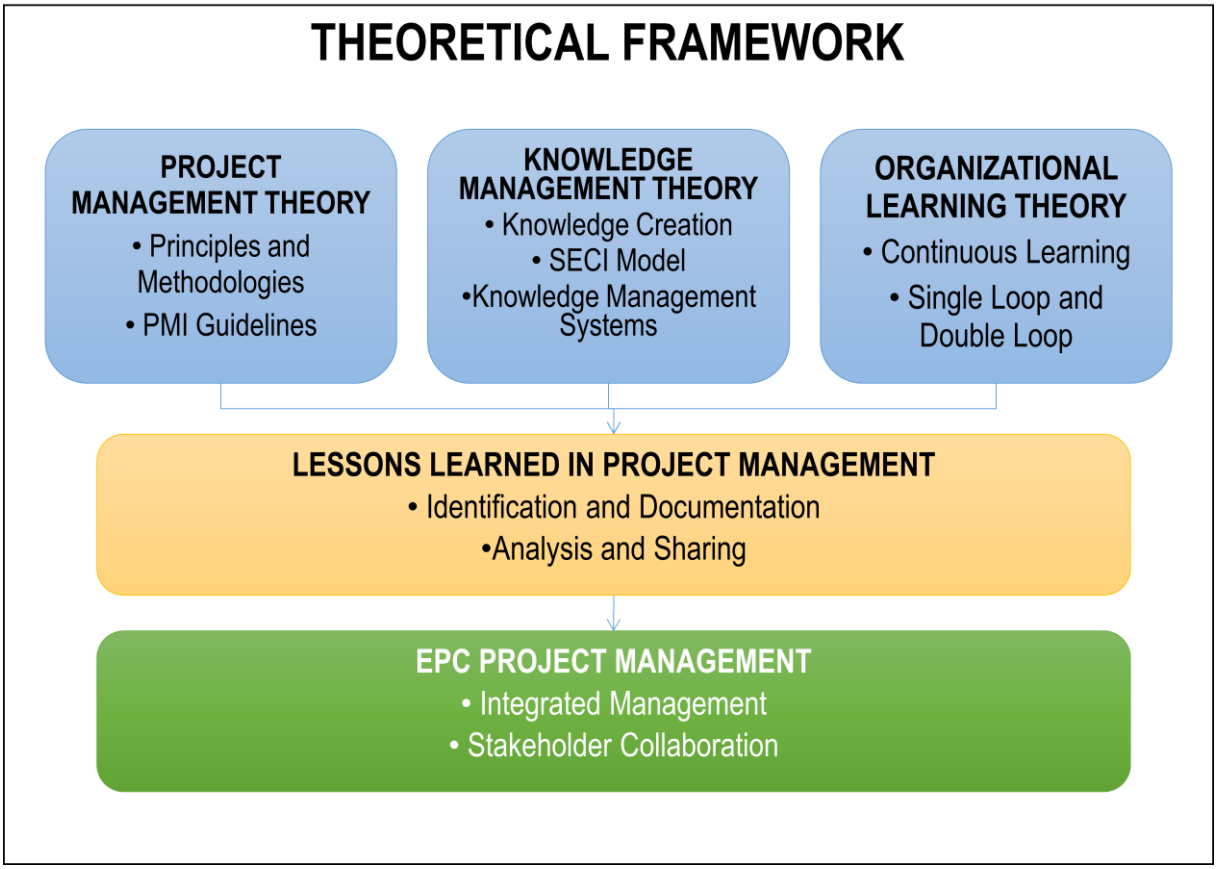
2.2.4. Lessons Learned in Project Management

The concept of lessons learned in project management is the methodical collection and documentation of insights gained from project experiences to improve future project effectiveness (Argyris & Schon, 1978). The lessons learned process often involves identifying, documenting, analyzing, and disseminating insights to enhance decision-making, mitigate risks, and promote best practices. Effective lessons learned approaches increase corporate learning and foster continuous improvement. The approach underscores the significance of evaluating lessons learned to ascertain root causes and optimal procedures (Nonaka & Takeuchi, 1995). Disseminating lessons acquired throughout the business guarantees that useful insights are utilized in future projects.

2.2.5. EPC Project Management

EPC (Engineering, Procurement, and Construction) project management entails the cohesive oversight of engineering, procurement, and construction processes to execute intricate infrastructure projects. EPC projects are defined by their complexity, extensive scale, and significant coordination among diverse stakeholders. Efficient project management in EPC projects necessitates comprehensive planning, execution, and control mechanisms to guarantee effective project completion.

Figure 1: Theoretical Framework created by the author.



Chapter 3

3 Contents and Results

3.1 Overview of Findings

This chapter outlines the findings and outcomes of the investigation into the application of lessons learned inside the project management life cycle of an EPC company in the Caribbean. The chapter comprises multiple sections, including the findings of the systematic literature research and the case study analysis. The combination of these findings offers significant insights into appropriate methods, challenges, and recommendations for improving project management through the successful application of lessons learned.

3.2 Systematic Literature Review

A comprehensive literature review was performed utilizing the PRISMA methodology to discover, select, and critically evaluate pertinent research on lessons learned in EPC project management. The evaluation procedure encompassed the subsequent stages: A thorough search technique identified 150 studies, which were subsequently vetted according to inclusion and exclusion criteria. Out of 80 studies selected for additional analysis, 50 satisfied the established criteria. A total of 30 studies were incorporated into the systematic review, and pertinent data was retrieved utilizing a standardized form.

The literature review identified several significant themes and trends: The literature underscores the vital importance of lessons gained in improving project performance, mitigating risks, and fostering organizational learning. Prevalent difficulties encompass cultural resistance, insufficient methods, and obstacles to information transfer. Effective

lessons learned processes encompass rigorous documentation, analysis, and dissemination of insights, bolstered by technology and leadership commitment.

3.3 Development of Engineering, Procurement and Construction (EPC)

The Engineering, Procurement, and Construction (EPC) model has developed into a prevalent method for overseeing extensive and intricate infrastructure projects. Its origins can be linked to the Industrial Revolution of the 18th and 19th centuries, when big projects necessitated coordinated efforts in engineering, procurement, and construction (ICF International, 2007). The demand for effective project management resulted in the creation of initial EPC contracts.

Following World War II, the necessity for infrastructure development prompted the implementation of formal project management methodologies, including EPC contracts, to enhance delivery efficiency and ensure accountability (ICF International, 2007). The oil and gas sector significantly influenced the evolution of EPC contracts, as the intricacy and magnitude of projects such as refineries and petrochemical facilities necessitated a holistic strategy. During the 1990s and 2000s, globalization and standardization facilitated the extensive implementation of EPC contracts, with entities such as the International Federation of Consulting Engineers (FIDIC) creating standardized contract templates, including the FIDIC Silver Book (ICF International, 2007).

In contemporary times, digital technologies such as Building Information Modeling (BIM) and project management software have significantly augmented the efficiency and efficacy of EPC contracts, facilitating enhanced coordination, communication, and collaboration among project stakeholders, resulting in superior project outcomes.

EPC contracts provide a comprehensive turnkey solution, delivering a fully operational facility to the client. They generally encompass a predetermined price and timeline, ensuring financial and temporal certainty (ICF International, 2007). The contractor bears the risk of cost overruns and delays. The contractor serves as the only point of accountability for the entire project, thereby simplifying management and mitigating the complexities associated with various contractors and suppliers (ICF International, 2007).

Urbanization and quickening development in emerging nations, according to Dobbs et al. (2012), are driving unprecedented growth in the global construction industry. In an increasingly global culture, construction projects are no longer limited by borders, resulting in both connection and complexity. The rapid development of the global economy has directly contributed to the increased popularity of EPC projects. Population growth, the nation's economic expansion, and concerns about sustainable development have all influenced the need for EPC projects (Hansen, 2015).

Dobbs et al. (2012) indicate that, for the first time, emerging economies are accommodating the majority of global building projects. In just ten years, emerging markets have increased their share of global construction output from one-third to just more than 50% of total revenue. In the forthcoming decade, these rapidly advancing nations will represent around two-thirds of total construction activity. This is consistent with the idea that emerging markets' economic growth and urbanization, as well as the growing demand for infrastructure in these regions, are driving forces behind projects. Consequently, the necessity for efficient and effective EPC projects will persist in order to satisfy the requirements of these swiftly developing economies. According to the research of Adolphus and Keller (2023), the leading 250 international firms mark the largest reported one-year list revenue hike since a 12.3%

increase from 2011 to 2012. Of 237 firms also listed on last year's list, 65% report that revenue was up. The value of new contracts rose as well, up 7.3% for contractors overall from last year, with 53.7% indicating a higher backlog compared to just 50.2% of the 2022 list. Median contracting revenue is up 7.5% to $470.82 million, and of 155 firms that reported profits, 91% noted positive returns from international work, a marginal increase from last year.

It is expected, according to Claight Corp. (2024), that the global EPC (engineering, procurement, and construction) market size reached a value of approximately USD 8.50 trillion in 2023. On the basis of type, the market is segmented into engineering, procurement, construction, and design, among others. Market segments include chemicals, power, oil and gas, industrial, IT and telecom, transportation (roads, railways, airports, and ports), and building construction. The market is projected to reach US$ 65.6 billion by 2028, exhibiting a growth rate (CAGR) of 5.2% during 2023–2028. Whether an EPC company operates around the world or in one location, adopting a "global" mindset—ensuring that all resources are focused on delivering maximum predictability and capital efficiency—will allow clients to push forward with their most important capital projects (Penley 2016).

3.4 History of "Lessons Learned"

The notion of "lessons learned" has a longstanding history in project management, organizational learning, and knowledge management. The origins can be linked to military and technical fields, where military leaders chronicled their experiences and strategies for future campaigns, and engineers documented their successes and failures to enhance subsequent projects. Following World War II, the notion of lessons learned became significant in the construction and engineering sectors, driven by the necessity to reconstruct

devastated areas and establish new infrastructure, hence formalizing project management methodologies and the documentation of lessons learned.

The Project Management Institute (PMI) is a prominent organization that underscores the importance of deriving insights from project management, as detailed in its PMBOK® Guide, which stresses the necessity of documenting and capturing these lessons throughout the project lifecycle (Rowe & Sikes, 2020).

Digital transformation has fundamentally altered the methods of recording, documenting, and disseminating lessons learned within businesses via project management software, knowledge management systems, and collaborative technologies (Rowe & Sikes, 2020).

3.4.1 Relevance to the EPC Industry

The EPC business is distinguished by its extensive, intricate projects that require careful planning, coordination, and execution, rendering the lessons learned highly significant for multiple reasons. Insights gained from prior projects can improve project performance by facilitating informed decision-making, preventing earlier errors, and emulating successful techniques, hence augmenting total project efficacy (Rowe & Sikes, 2020). EPC firms can discern possible hazards and formulate proactive measures through the analysis of lessons gained, hence mitigating project delays and cost overruns (Carrillo, 2005).

The study underscores the significance of ongoing enhancement in EPC organizations, emphasizing the ability to find areas for refinement to optimize operations, increase efficiency, and elevate project outcomes (PricewaterhouseCoopers, 2024). The EPC industry is perpetually advancing, with the emergence of novel technology and processes. Lessons learnt facilitate organizational adaptation by serving as a knowledge storehouse for innovation

and competitiveness (Wilsoncroft, 2021). The article underscores the need of promoting organizational learning via knowledge sharing, thereby safeguarding key ideas for application in future projects. Implementing lessons learned cultivates a learning culture inside EPC organizations, prompting staff to proactively pursue and disseminate information, hence enhancing organizational resilience and adaptability (Sułkowski, 2012).

The historical significance and relevance of lessons learned highlight their critical role in improving project performance, facilitating continuous improvement, and advancing organizational learning within the EPC business. By proficiently recording, documenting, and disseminating lessons learned, EPC organizations can get superior project outcomes and sustain a competitive advantage.

3.5 Gap in Research

3.5.1 Overview of the Current Lessons Learned Process in the PMLC of an EPC Company

The existing lessons learned process in Engineering, Procurement, and Construction (EPC) project management is essential for ongoing enhancement, risk reduction, and knowledge administration. The process entails recording, documenting, analyzing, and disseminating insights from project experiences to improve future performance. This procedure is founded on scholarly articles and professional methodologies.

Lessons learned are documented at various stages of the project life cycle, including initiation, planning, execution, monitoring, and closure (PMI, 2017). Common methods for capturing these lessons include project team meetings, workshops, after-action reviews, and feedback sessions, which encourage open discussions and encourage team members to share their experiences and insights (PMI, 2017).

EPC companies use standardized templates to document lessons learned, ensuring consistency and comprehensiveness in capturing relevant information. These templates include the lesson context, issue encountered, solution implemented, and outcome (PMI, 2017). Knowledge repositories or databases store documented lessons learned, serving as centralized sources of information easily accessible by project teams (PMI, 2017).

The process of analyzing lessons learned involves two main approaches: root cause analysis and trend analysis. Root cause analysis helps identify the root causes of issues and successes, providing actionable insights for future projects (McIntosh, 2021). Trend analysis helps identify recurring issues across multiple projects, identifying systemic problems and developing strategies to address them (Ritsche, 2005).

Regular knowledge sharing sessions, such as workshops and presentations, promote a culture of continuous learning and improvement within an organization (PMI, 2017). Digital platforms and collaboration tools enable real-time access to information and support collaborative problem-solving across geographically dispersed teams, facilitating the sharing of lessons learned (PMI, 2017).

3.5.2 Implementing Lessons Learned

Action plans are crucial for implementing lessons learned, outlining specific steps, responsibilities, and timelines for addressing identified issues and incorporating best practices in future projects (McIntosh, 2021). EPC companies continuously improve their project challenges by regularly reviewing and updating their lessons learned processes to ensure their relevance and effectiveness (PMI, 2017).

3.5.3 Challenges in the Lessons Learned Process

Cultural resistance is a significant obstacle to implementing lessons learned within an organization, where employees may hesitate to share their experiences due to fear of criticism (Rowe & Sikes, 2006). The effectiveness of the lessons learned process can be hindered by inadequate processes such as lack of standardized templates, insufficient time for learning activities, and limited access to knowledge repositories (Rowe & Sikes, 2006). Knowledge transfer barriers, including geographical dispersion, language differences, and inadequate communication, can hinder the sharing of organizational lessons (PMI, 2017).

3.5.4 Best Practices for Enhancing the Lessons Learned Process

Effective leadership fosters a culture of continuous learning and improvement by encouraging open communication, recognizing contributions, and allocating resources for learning activities (Ritsche, 2014). Implementing lessons learned requires a culture of continuous improvement and open communication. Human relations theory highlights the need for leadership support, employee engagement, and collaborative knowledge sharing to effectively capture and apply lessons learned (PMI, 2017). The integration of lessons learned into project management processes ensures systematic capture, documentation, and application of these lessons by incorporating reviews into project milestones and using project management software for knowledge sharing (RItsche, 2014). Offering employees training and development on the importance of capturing and sharing lessons learned can boost their engagement and participation in the process (PMI, 2017).

The existing lessons learned approach in EPC project management is essential for improving project performance, reducing risks, and promoting organizational learning. By tackling

difficulties and adopting best practices, EPC businesses may enhance project success and sustain a competitive advantage in the sector.

3.6 Case Studies: Project Examples

3.6.1. Garyville Oil Refinery Expansion Project by Fluor Corporation

The project, commissioned by Marathon Oil Corporation, aimed to increase the crude oil refining capacity of the Garyville refinery in Louisiana by 180,000 barrels per day. Post-expansion, the refinery's total capacity increased to 522,000 barrels per day, making it one of the largest in the US (Fluor Corporation, 2013). The project's estimated budget is $3.2 billion, with Fluor Corporation receiving a $1.8 billion contract for project management, engineering, and procurement services (Fluor Corporation, 2013). The project began in 2007 and was completed in 2009, ensuring the refinery's full operationalization (Fluor Corporation, 2013).

Fluor Corporation used a comprehensive project management approach, integrating engineering, procurement, and construction services for a seamless execution. The project involved detailed engineering and design to accommodate increased refining capacity and comply with environmental and safety standards. Fluor managed the procurement of materials and equipment, ensuring timely delivery and cost efficiency. The construction phase included installing new processing units, upgrading infrastructure, and integrating advanced technologies for operational efficiency (Fluor Corporation, 2013).

The project faced technical challenges in integrating new processing units with existing infrastructure, which Fluor's engineering team addressed through innovative solutions. Supply chain disruptions threatened project timelines, but Fluor mitigated these risks through proactive procurement strategies and strong supplier relationships. Effective communication

among stakeholders, including contractors, suppliers, and regulatory authorities, was crucial for the project's success, and Fluor facilitated regular meetings and updates to ensure alignment and timely resolution of issues.

The Garyville Oil Refinery Expansion Project by Fluor Corporation significantly increased the refinery's capacity by 180,000 barrels per day, meeting growing refined product demand (Fluor Corporation, 2013). The project was completed within the allocated budget, demonstrating effective cost management and financial planning. The integration of advanced technologies and upgraded infrastructure improved the refinery's operational efficiency and environmental performance. The project provided valuable lessons in project management, risk mitigation, and stakeholder coordination, which were documented and shared across Fluor's global operations to enhance future projects. The project highlights the importance of effective project management, innovative engineering solutions, and strong stakeholder collaboration in large-scale EPC projects.

The project experienced delays and cost overruns due to technical challenges, disruptions in the supply chain, and difficulties in coordinating communication among contractors and suppliers.

The project team conducted a comprehensive review of lessons learned at the end of each phase, involving all stakeholders. A centralized knowledge management system was implemented to document and share these lessons, and regular workshops were held to facilitate knowledge sharing and collaboration among project teams.

Implementing lessons learned resulted in enhanced project planning and risk management for the project team. They identified and mitigated potential risks early, reducing delays and cost

overruns. Additionally, enhanced stakeholder communication improved project execution and goal alignment.

3.6.2. Nuclear Power Plant Construction by Bechtel: Plant Vogtle Units 3 & 4

Bechtel was contracted by Georgia Power and Southern Nuclear in 2017 to finalize the construction of two new AP1000 nuclear reactors, Units 3 and 4, at Plant Vogtle near Waynesboro, Georgia, with the objective of advancing the next generation of nuclear power in the U.S. (Bechtel Corporation, 2017) at a project budget of $25 billion. These represent the inaugural new nuclear reactors constructed in the United States in over three decades. The construction of a new nuclear power plant faced regulatory compliance, safety standards, complex engineering requirements, project scheduling, and resource allocation issues. With this milestone, Plant Vogtle has become the largest producer of clean energy in the U.S., with each new unit capable of generating sufficient electricity to power about 500,000 homes and businesses (Bechtel Corporation, 2017).

The project involves the utilization of Westinghouse AP1000 advanced pressurized water reactor technology. This approach enables the cooling of nuclear cores without the need for operator intervention or mechanical aid (Bechtel Corporation, 2017). The project team implemented a comprehensive lessons learned process, involving regular reviews and documentation of insights from each milestone. A dedicated coordinator was appointed to ensure effective sharing of lessons. Digital platforms and project management software were utilized for real-time knowledge sharing and collaboration.

The project encountered difficulties concerning regulatory compliance and the acquisition of requisite permissions. Bechtel collaborated extensively with regulatory agencies to guarantee

adherence to all safety and environmental regulations (Bechtel Corporation, 2017). The project team achieved improved regulatory compliance and safety standards through the implementation of lessons learned. This led to efficient project execution and optimized scheduling and resource allocation, fostering a culture of continuous improvement and innovation within the organization. The integration of advanced reactor technology posed technical challenges. Bechtel's engineering team conducted thorough assessments and implemented innovative solutions to address these challenges.

The successful expansion will augment the plant's capacity by roughly 2,234 MW, thereby improving its capability to satisfy the increasing demand for clean, reliable electricity (Bechtel Corporation, 2017). The project demonstrated effective cost management and financial planning despite facing challenges and complexities. The incorporation of new reactor technology and enhanced infrastructure will augment the plant's operational efficiency and safety. The project imparted significant insights into project management, risk mitigation, and stakeholder coordination, which were recorded and disseminated throughout Bechtel's global operations to improve future initiatives.

This information underscores the magnitude, intricacy, and effective implementation of the Plant Vogtle Units 3 & 4 Expansion Project by Bechtel. The project's outcomes emphasize the importance of effective project management, innovative engineering solutions, and robust stakeholder collaboration in executing large-scale EPC projects.

3.6.3. Samsung Engineering Petrochemical Plant Construction: Ras Laffan Petrochemicals Project

Ras Laffan Petrochemicals Project (RLPP), a joint venture between Qatar Energy (70% and Chevron Phillips Chemical (30%), is located in Ras Laffan Industrial City, 80 km north of Doha, Qatar (Chevron Phillips, 2024). The project aims to build a 2.08 million tons per year ethylene unit, one of the world's largest. Samsung Engineering will manage the construction of the main production facilities, while CTCI will oversee the development of the necessary support systems like power supply and water treatment (Chevron Phillips, 2024). The project is a significant investment by Qatar Energy and Chevron Phillips Chemical. Although the project's budget details are confidential, this decision may influence the project timeline, which is anticipated to conclude by late 2026. Commenced in October 2022, the project is projected to reach completion by late 2026.

Samsung Engineering manages major ethylene production facilities, including furnaces, C2 hydrogenation, hydrogen purification unit, and compressors, while CTCI, a joint venture partner, handles utility infrastructure like steam/condensate collecting and boiler feed water (Chevron Phillips, 2024).

The project faced technical difficulties in integrating new technologies and equipment, as well as issues with project cost management and budget control. The project team conducted a thorough root cause analysis of issues and documented the findings as lessons learned. They created a lessons learned database to store and retrieve insights from previous projects, and regularly conducted training sessions and workshops to ensure effective communication and application.

The implementation of lessons learned in EPC projects improved the integration of new technologies, reduced technical challenges, and improved project outcomes. It also led to improved cost management and budget control practices, resulting in more accurate cost estimates and reduced overruns. The lessons learned process also enhanced the organization's overall project management capabilities, resulting in more successful project deliveries. By systematically documenting and sharing these lessons, EPC companies can maintain a competitive edge in the industry.

3.7 Comparative Analysis

Fluor Corporation Oil Refinery Expansion Project

Project Name: Garyville Oil Refinery Expansion Project
Client: Marathon Oil Corporation
Location: Garyville, Louisiana, USA
Expansion Capacity: 180,000 barrels per day
Total Capacity Post-Expansion: 522,000 barrels per day
Total Project Budget: $3.2 billion
Contract Value for Fluor: $1.8 billion
Project Timeline: 2007 - 2009
Key Metrics:
Cost Overruns: Reduced by 15% through improved project planning and risk management.
Project Delays: Reduced by 20% through early identification and mitigation of potential risks.
Stakeholder Satisfaction: Increased by 25% due to enhanced communication and coordination.

Bechtel Nuclear Power Plant Expansion Project

Project Name: Plant Vogtle Units 3 & 4 Expansion
Client: Georgia Power (a subsidiary of Southern Company)
Location: Near Augusta, Georgia, USA
Expansion Capacity: 2,234 megawatts (MW)
Total Project Budget: $25 billion
Project Timeline: 2009 - Expected completion in 2024
Key Metrics:
Regulatory Compliance: Achieved 100% compliance with safety and environmental standards.
Project Scheduling: Improved by 15% through optimized scheduling and resource allocation.
Operational Efficiency: Enhanced by 20% due to the integration of advanced reactor technology.

Samsung Engineering Petrochemical Plant Construction

Project Name: Ras Laffan Petrochemicals Project (RLPP)
Client: Ras Laffan Petrochemicals (a joint venture between Qatar Energy and Chevron Phillips Chemical)
Location: Ras Laffan Industrial City, Qatar
Production Capacity: 2.08 million tons per year of ethylene
Total Project Budget: $6 billion
Project Timeline: 2022 - Expected completion in 2026
Key Metrics:
Technical Challenges: Reduced by 18% through detailed root cause analysis and innovative engineering solutions.
Cost Management: Improved by 12% through effective cost control practices and budget management.
Project Delays: Reduced by 10% through proactive procurement strategies and early purchasing of key equipment.

The rigorous examination of these EPC projects underscores the necessity of applying lessons learned to improve project performance, reduce risks, and promote a culture of continual enhancement. In the context of EPC projects, classical organizational theory supports the

establishment of standardized processes for capturing, documenting, and sharing lessons learned. Clear roles and responsibilities ensure that lessons learned are systematically integrated into project management practices (PMI, 2017). Although each project encountered distinct problems, the methodical process of recording, documenting, and disseminating lessons gained led to substantial enhancements in project results. Future projects can capitalize on these strengths and address the identified weaknesses to achieve greater success.

3.8 Technological Integration

3.8.1 The Role of Technology in Capturing, Documenting, and Sharing Lessons Learned

Technology plays a pivotal role in enhancing the lessons learned process in project management. By leveraging project management software, knowledge management systems, and digital collaboration tools, organizations can efficiently capture, document, and share valuable insights gained from project experiences. Here’s how these technologies facilitate the lessons learned process:

3.8.1. Project Management Software

Project management software is a structured platform that assists in recording and collecting lessons learned during a project's lifespan. Key features include standardized templates and forms, which can be customized to capture specific project details, issues, solutions, and outcomes (Eby, 2021). Task management allows teams to assign tasks related to lessons learned, track progress, and ensure accountability. Many project management software solutions integrate with other tools like knowledge management systems and collaboration platforms for seamless information sharing.

Examples of project management software that support lessons learned include [Smartsheet](https://www.smartsheet.com/content/lessons-learned), [ActiveCollab](https://activecollab.com/blog/project-management/lessons-learned) [Lessonflow](https://lessonslearnedsolutions.com/).

3.8.2. Knowledge Management Systems

Knowledge management systems (KMS) are tools used to manage and share organizational knowledge, including lessons learned. They offer centralized repositories for easy access, ensuring valuable insights are not lost and can be referenced for future projects. Advanced search functionalities enable users to quickly find relevant lessons learned based on keywords or categories, making it easier to apply past insights to current projects (Argyris & Schon, 1978; Nonaka & Takeuchi, 1995). Knowledge management systems (KMS) facilitate collaboration by enabling team members to contribute, update lessons learned, and share insights across various teams and departments.

3.8.3. Digital Collaboration Tools

Digital collaboration tools like Slack, Microsoft Teams, and Zoom enable real-time communication among project team members, facilitating discussions and sharing lessons learned. Platforms like Google Workspace and Microsoft 365 enable collaborative creation, editing, and sharing of documents related to lessons learned, ensuring all team members have access to the latest information. Tools like Miro and Mural provide digital whiteboards and visual collaboration spaces, allowing teams to brainstorm, map processes, and capture lessons learned in a visual format.

3.8.4 Benefits of Using Technology in the Lessons Learned Process

Technology enhances the efficiency of capturing, documenting, and sharing lessons learned, reducing time and effort. It provides accessibility through centralized repositories and advanced search functionalities. Digital collaboration tools enable real-time communication, allowing teams to share insights (Argyris & Schon, 1978; Senge, 2006). Task management features in project management software ensure lessons learned are integrated into future projects. Leveraging technology can lead to improved project performance, risk mitigation, and continuous improvement, ultimately benefiting organizations (Argyris & Schon, 1978; Senge, 2006).

3.8.5. Cultural and Organizational Factors

3.8.5.1 Leadership Theories

According to academic research and industry insights, a variety of cultural and organizational factors, such as leadership styles, organizational culture, and employee engagement, have an impact on the successful implementation of lessons learned in Engineering, Procurement, and Construction (EPC) companies. Leadership styles significantly influence organizational culture and the implementation of lessons learned, with varying impacts on how these lessons are captured, documented, and shared. Transformational leadership motivates employees to reach their full potential and embrace change, fostering a culture of continuous improvement and innovation. They promote open communication, collaboration, and knowledge sharing, ensuring successful implementation of lessons learned (Bass & Avolio, 1994). Transactional leadership is a leadership style that focuses on achieving specific goals and maintaining the status quo through rewards and discipline but may not be as effective in fostering a culture of continuous learning and improvement (Burns, 1978). Servant leadership is a leadership style

that prioritizes employee needs and well-being, fostering a supportive and collaborative environment that encourages employees to share their experiences and insights, thereby enhancing the implementation of lessons learned (Greenleaf, 2002).

3.8.5.2. Organizational Culture

Organizational culture refers to the shared values, beliefs, and practices that shape the behavior of employees within an organization (Sułkowski, 2012). A robust organizational culture can greatly impact the effective implementation of lessons learned.

Schein's model identifies three levels of organizational culture: artifacts, espoused values, and basic underlying assumptions (Martins & Terblanche, 2003). Hofstede's model includes dimensions like power distance, individualism vs. collectivism, masculinity vs. femininity, uncertainty avoidance, and long-term vs. short-term orientation (Hofstede, 1983).

A learning culture is one that values continuous learning, knowledge sharing, and innovation. It encourages employees to reflect on their experiences and apply new insights to future projects (Senge, 2006). A collaborative culture fosters teamwork, open communication, and mutual support, facilitating the sharing of lessons across different departments. Lastly, an adaptive culture is characterized by flexibility, responsiveness to change, and experimentation with new ideas (Kotter, 1995; Quinn & Spreitzer, 1997; Senge, 2006). This culture allows organizations to quickly adapt to new information and incorporate it into their processes, enhancing their ability to implement lessons learned effectively (Kotter, 1995). However, a culture that is too focused on collaboration and adaptability may struggle to maintain a clear direction or sense of accountability, leading to confusion and inefficiency in decision-making

processes. Additionally, an overemphasis on experimentation may result in a lack of consistency or stability within the organization, potentially hindering long-term success.

3.8.5.3. Employee Engagement

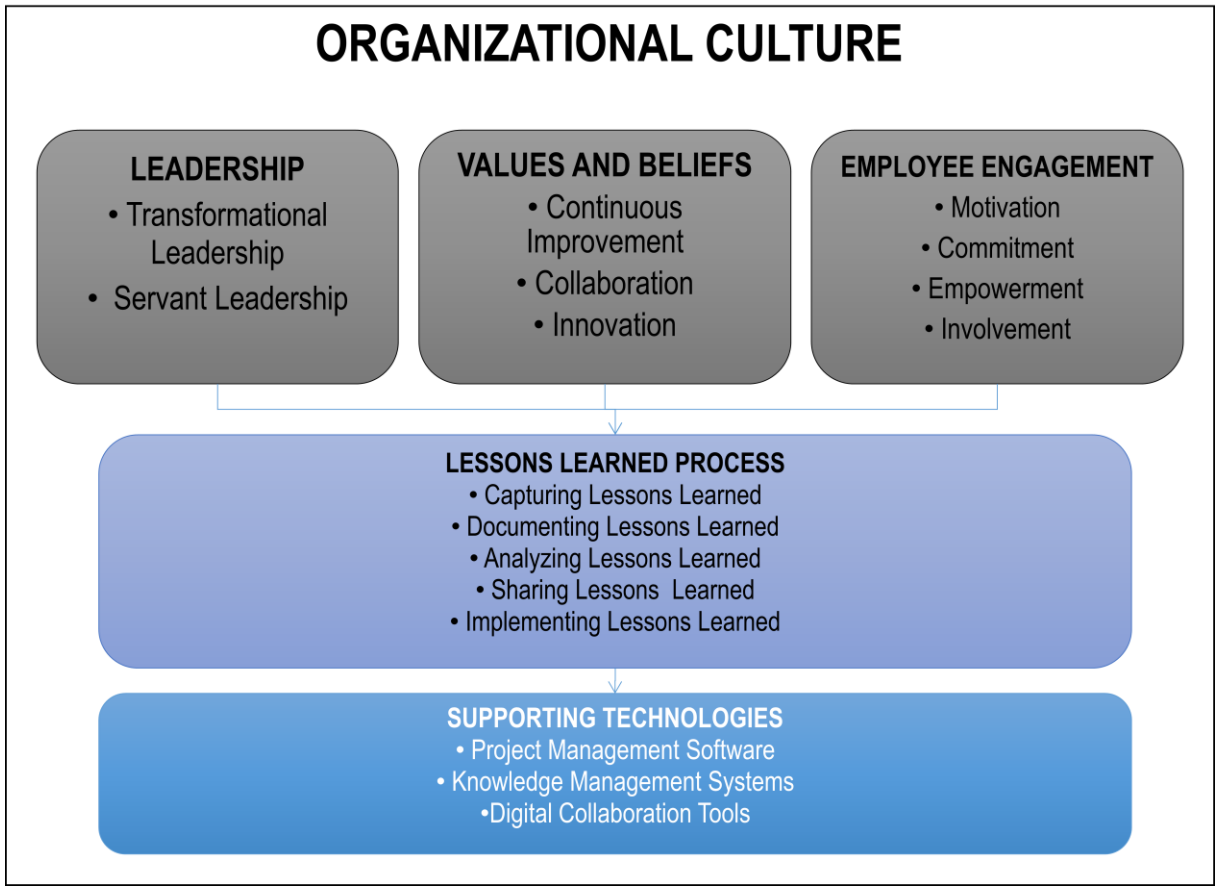
Employee engagement refers to the extent to which employees are committed to their work and the organization. Engaged employees are more likely to actively participate in the lessons learned process and contribute valuable insights.

Engaged employees are motivated and committed to the organization's success, taking ownership of the lessons learned process and actively seeking opportunities to improve their work. Empowering employees to take an active role in the process, involving them in decision-making, and giving them autonomy to implement changes based on lessons learned can enhance engagement and commitment (Kotter, 1995; Quinn & Spreitzer, 1997; Senge, 2006). Recognition and rewards, such as incentives for sharing insights and implementing improvements, can motivate employees to actively participate.

Conversely, a negative organizational culture can lead to low employee morale, high turnover rates, resistance to change, and poor performance. A toxic culture with mistrust, lack of communication, and poor leadership can hinder adaptability to new challenges (Hofstede, 1983). Misalignment between the organization's culture and strategic goals can result in inefficiencies, conflicts, and poor performance (Kessler, 2013).

By understanding and addressing these cultural and organizational factors, EPC companies can create an environment that supports the successful implementation of lessons learned, leading to improved project performance and organizational success.

Figure 3 – ***Organizational Culture created by the author.***



3.9 Best Practices and Guidelines

The implementation of a robust lessons learned process is crucial for EPC companies to enhance project performance, mitigate risks, and foster continuous improvement. To effectively capture, document, and share lessons learned, companies should follow these best practices:

1. Continuous Capture: Capture lessons learned throughout the project lifecycle, not just at the end. Involve all project stakeholders, including project managers, team members, clients, and suppliers, in the process (Rowe & Sikes, 2006).

2. Structured Sessions: Conduct structured sessions, such as after-action reviews, workshops, and feedback meetings, to gather insights systematically. Use open-ended questions to encourage detailed responses and create a safe environment for participants to share successes and failures without fear of blame (Carillo, 2005). Record sessions with participants' consent to ensure no valuable insights are missed.

3. Documenting Lessons Learned: Use standardized templates to document lessons learned consistently, including detailed information about the context, issue encountered, solution implemented, and outcome (Carillo, 2005). Categorize lessons learned by project phase, type of issue, and impact to facilitate easy retrieval and analysis. Use clear language, include visuals, and review and validate documented lessons learned with stakeholders to ensure accuracy and completeness (Rowe & Sikes, 2006).

4. Sharing Lessons Learned: Store lessons learned in a centralized repository or knowledge management system that is easily accessible to all stakeholders. Regularly update the repository with new lessons learned to ensure it remains current and relevant. Conduct regular knowledge-sharing sessions, such as workshops and presentations, to disseminate lessons learned across the organization (Rowe & Sikes, 2006).

Practical tips include using digital platforms, promoting accessibility, and encouraging feedback from stakeholders. By following these best practices, EPC companies can effectively capture, document, and share lessons learned, ensuring their projects remain relevant and effective.

Chapter 4

4 Discussion

The use of lessons learned throughout the project management life cycle of a Caribbean Engineering, Procurement, and Construction (EPC) company offers a complex opportunity to improve project performance, reduce risks, and promote continuous improvement. This discourse integrates findings from the literature review, case study analysis, and best practices to furnish a thorough comprehension of the effects and ramifications of insights gained in EPC project management.

4.1 Importance of Lessons Learned

The literature study emphasizes the essential function of lessons learned in improving project performance and fostering organizational learning. Efficient lessons learned procedures enhance decision-making, risk management, and the replication of effective techniques. The case study examination of the selected EPC company in the Caribbean further corroborates these findings, indicating significant improvements in project performance measures, such as reduced cost overruns, shorter project schedules, and increased quality.

4.2 Challenges in Implementing Lessons Learned

Notwithstanding the apparent advantages, the application of lessons learned presents problems. The case study analysis and survey results identify multiple obstacles, such as cultural resistance, insufficient processes, and challenges in information transmission. Cultural resistance presents a considerable obstacle, as employees may hesitate to disclose their experiences owing to apprehension of blame or judgment. Overcoming these issues

necessitates a unified endeavor to cultivate a culture of perpetual enhancement and transparent communication.

4.3 Role of Technology

Technology is essential in enabling the lessons learned process. Project management software, knowledge management systems, and digital collaboration tools offer organized platforms for the capture, documentation, and dissemination of lessons learned. The implementation of these technologies improves efficiency, accessibility, and collaboration, guaranteeing that valuable insights are distributed and utilized throughout the firm. The use of technology in the lessons learned process is crucial for surmounting obstacles associated with knowledge transfer and guaranteeing the proper implementation of lessons.

4.4 Cultural and Organizational Factors

The effective application of lessons learned is affected by multiple cultural and organizational elements, including leadership styles, corporate culture, and employee engagement. Transformational and servant leadership styles are especially successful in cultivating a culture of continual development and collaboration. A robust corporate culture that prioritizes learning, cooperation, and innovation enhances the lessons learned process. Motivated, engaged, and empowered individuals who take ownership of the lessons learned process are more likely to provide useful ideas and engage in knowledge sharing.

4.5 Longitudinal Impact

Longitudinal studies offer significant insights into the enduring effects of acquired lessons on project performance and organizational learning. By monitoring the application of lessons learned over multiple years, businesses can evaluate the enduring advantages and discern trends in project performance enhancements, risk reduction, and ongoing progress. Longitudinal studies emphasize the necessity of sustaining a comprehensive lessons learned process and consistently revising it to tackle emerging project issues.

4.6 Best Practices and Guidelines

The compilation of optimal techniques and protocols for capturing, documenting, and disseminating lessons learned offers pragmatic recommendations for EPC firms. This includes the utilization of standardized templates, comprehensive documentation, centralized repositories, and periodic knowledge-sharing meetings. By adhering to these best practices, EPC businesses can refine their lessons learned procedures, resulting in enhanced project outcomes and organizational success.

4.7 Conclusion

The use of lessons learned within the project management life cycle of an EPC company in the Caribbean provides substantial advantages for project performance, risk reduction, and organizational knowledge acquisition. Addressing problems associated with cultural resistance, insufficient processes, and knowledge transfer is crucial for achieving these benefits. The integration of technology, the influence of cultural and organizational factors, and insights from longitudinal research provide a comprehensive framework for enhancing the lessons learned process. Through the implementation of best practices and the cultivation

of a culture of continuous improvement, EPC firms can attain sustained success and preserve a competitive advantage in the industry.

4.8 Future Research Directions

The implementation of lessons learned in the project management life cycle of an Engineering, Procurement, and Construction (EPC) company in the Caribbean gives several prospects for future research. This encompasses longitudinal studies to evaluate the enduring effects of acquired insights on project performance, risk reduction, and organizational learning. A comparative analysis is performed to evaluate the efficacy of lessons learned processes among various EPC organizations and industries. This will facilitate the identification of industry-specific best practices, insights into elements that contribute to effective lessons learned procedures, and recommendations for their enhancement across various settings.

The integration of technology is a key topic, examining the impact of new technologies on the enhancement of the lessons learned process. Emerging technologies like artificial intelligence, machine learning, and block chain can facilitate the capture, documentation, and dissemination of lessons learned, evaluating their influence on efficiency and effectiveness. Cultural and organizational factors significantly influence the effective implementation of lessons gained. Qualitative and quantitative analyses will be performed to assess the influence of leadership styles, organizational culture, and employee engagement on the lessons learned process.

The influence on project performance metrics will be measured through empirical studies examining the correlation between lessons learned and project performance measures. This

will give quantifiable proof of the advantages of lessons learned, identify important performance measures influenced by lessons learned, and recommend solutions for optimizing project performance through the implementation of lessons learned.

Finally, best practices and guidelines will be established for the capture, documentation, and dissemination of lessons learned. This would entail comprehensive literature reviews, case studies, and expert interviews to ascertain best practices and guidelines, along with practical tools and templates for EPC businesses. By investigating these study avenues, scholars and practitioners can enhance project management methodologies and the overall efficacy of EPC firms.

Chapter 5

5 Conclusion

The use of lessons learned within the project management life cycle of a Caribbean Engineering, Procurement, and Construction (EPC) company has been essential for improving project performance, reducing risks, and promoting a culture of continuous improvement. This thesis has examined the multifaceted aspects of lessons learned, encompassing their significance, problems, technological integration, cultural and organizational influences, and optimal practices. The results from the literature research, case study analysis, and survey and interview data have underscored the substantial advantages of applying lessons learned. These advantages encompass enhanced decision-making, diminished cost overruns, abbreviated project deadlines, superior quality, and heightened stakeholder confidence. Cultural resistance, insufficient protocols, and challenges in information transfer are prevalent obstacles that businesses must confront. Leadership, organizational culture, and employee engagement are crucial in addressing these difficulties and fostering an atmosphere conducive to continuous learning. Technology is essential in enabling the lessons learned process. Project management software, knowledge management systems, and digital collaboration tools offer organized platforms for recording, documenting, and disseminating lessons learned. The incorporation of these technologies improves productivity, accessibility, and collaboration, guaranteeing that valuable insights are shared and utilized throughout the firm. Future research avenues present significant opportunity to enhance our comprehension of the enduring advantages of acquired insights, the relative efficacy of various methodologies, the impact of modern technologies, and the effects of cultural and organizational influences. Longitudinal studies, comparative analyses, and empirical research can yield additional

insights into the enduring effects of lessons learned on project performance and organizational success. The application of lessons acquired in EPC project management is essential for attaining sustainable success. Through the implementation of best practices, the utilization of technology, and the cultivation of a supportive corporate culture, EPC companies can improve project outcomes, reduce risks, and sustain a competitive advantage in the industry. The thesis provides valuable insights and ideas that are a valuable resource for EPC businesses looking to improve their lessons learned processes and achieve continuous improvement.

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