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Offshore Wind Industry Leaders' Operations and Maintenance Management Strategies

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Walden University
2023

Abstract

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MBA, University of Southern California, 1983

BS, Georgia State University, 1981

Doctoral Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The difficulties offshore wind leaders have in managing operations and maintenance (O&M) costs threaten the ability to operate offshore wind farms profitably, diversify the energy supply, and reduce dependence on imported fuels. Grounded in the frameworks of Lean Six Sigma and McKinsey 7-S, the purpose of this qualitative multi-case study was to explore offshore wind farm leaders’ strategies to manage O&M costs in Europe. The participants were six offshore wind leaders who implemented strategies to successfully manage O&M costs for offshore wind farms located in Europe. Data were collected using semistructured interviews, participant observation, and reviewing public and participant-supplied documents. Four themes emerged from the thematic analysis: operations and environmental monitoring to enhance financial planning efficiencies, infrastructure risks that affect performance and influence management strategies, contractual risk management strategies, and stakeholder engagement. Key recommendations are for offshore wind leaders to invest in monitoring tools, implement effective stakeholder engagement strategies, increase staff training programs, and engage in partnership arrangements to encourage industry-wide innovation and cost-reduction strategies. The implications for positive social change include the potential for successful change initiatives that positively impact employment, promote economic health, and contribute to a cleaner environment.

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Dedication

With profound gratitude and appreciation, I dedicate this study to the people who have been my unwavering support system throughout my academic journey. To my partner Michael, whose constant presence as my rock, confidant, and life partner has driven my success. Thank you for being so patient and understanding and for always cheering me on, even during the most challenging moments of my academic pursuits. I am grateful for your encouragement, guidance, and unwavering belief in me, which have always motivated me to strive for excellence and never give up on my dreams. To my wonderful children, Adam and Emilee, whose love, laughter, and joy have brought sunshine into my life. To my mother, who has been a pillar of strength and wisdom, I cannot thank you enough. Your tireless efforts to instill the value of education in me have led me to this point. This study is a testament to the love, support, and encouragement each of you has shown me; without it, it would not have been possible. I dedicate this study to all of you with immense gratitude and love.

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Section 1: Foundation of the Study

Background of the Problem

The challenges of climate change, along with increased global demand for electricity, increased energy security, and the rising cost of energy, all influence global governmental energy policies (International Energy Agency, 2022). Wind energy is one of the most cost-efficient renewable technologies available to policymakers and is a significant portion of decarbonization renewable energy portfolios (Hevia-Koch & Jacobsen, 2019). The European Union set a target to source 20% of its energy from renewable energy sources by 2020 and 32.5% by 2030 (Ciucci, 2023; Vieira et al., 2019). By the end of 2018, total global wind capacity reached 592 gigawatts (GW), of which 23 GW was offshore wind, with 18 GW installed throughout Europe (Ohlenforst et al., 2019; Vieira et al., 2019).

Offshore wind farms hold many advantages over onshore wind farms. Offshore wind resources are more substantial and more predictable. Additionally, most offshore wind farms are located many miles from coastal communities, minimizing the negative impacts of noise and visual appearance (Solman et al., 2021; Sovacool & Enevoldsen, 2015). However, due to higher installation costs and operations and maintenance (O&M) costs, an offshore wind farm’s lifetime cost is 50% more than the lifetime cost of an onshore wind farm (Raknes et al., 2017). Under pressure to maximize production and minimize costs, offshore wind leaders must find ways to become competitive if offshore wind installations increase to 150 GW by 2030 and 460 GW by 2050 (Vieira et al., 2019).

Problem Statement

Failure to manage O&M activities leads to increased costs for offshore wind farms (Yan & Dunnett, 2021). The 2025 estimated lifetime levelized cost of energy (LCOE) for an offshore wind farm is 67% higher than for an onshore wind farm and 50% higher for fossil fuels (U.S. Energy Information Administration, 2020). One-third of an offshore wind farm's total lifetime costs are attributable to O&M activities (Stehly & Duffy, 2022; Xia & Zou, 2023). The general business problem is that mismanaged O&M activities for offshore wind farms result in increased costs. The specific business problem is some offshore wind farm leaders lack strategies to manage O&M costs.

Purpose Statement

The purpose of this qualitative multiple case study was to explore the strategies offshore wind farm leaders use to manage O&M costs. The targeted population consisted of six offshore wind leaders who have implemented strategies that successfully manage O&M costs for offshore wind farms located in Europe. The implications for positive social change include the potential to provide local communities with the environmental and economic benefits of offshore wind energy, leading to both direct and indirect economic growth for benefiting citizens and families.

Nature of the Study

The three research methods are qualitative, quantitative, and mixed (Yin, 2018). I selected the qualitative method to use open-ended questions. Qualitative researchers use open-ended questions to understand a phenomenon and find in-depth meanings in nonnumerical data (Caggiano & Weber, 2023). The qualitative method was appropriate for this study to formulate inferences through observation and interviews to understand what had occurred. Quantitative researchers use closed-ended questions and highly structured, objective, numeric, and measurable techniques to test hypotheses about variables' relationships (Brunsdon, 2018; Story & Tait, 2019). The mixed method integrates qualitative and quantitative methods (Timans et al., 2019). Since I did not test hypotheses about the variables' relationships, neither the quantitative nor the mixed method was appropriate for this study.

I considered four qualitative research designs for my qualitative study of managing offshore wind O&M costs: (a) case study, (b) phenomenological, (c) ethnographic, and (d) narrative. I chose the case study design for this study. Researchers use the case study design to identify and explain the "what," "how," and "why" of a social phenomenon or issue bounded by space or time (Yin, 2018). I chose the multiple-case design, as using a multiple case design allows me to analyze several data types and collection sources within and among cases (Yin, 2018). Researchers use the phenomenological design to gain insight into a phenomenon through people's recollections and interpretation of the meanings of participants' lived experiences with phenomena (Moustakas, 1994). Ethnographic researchers explore groups' or communities' social or cultural behaviors, attitudes, and beliefs (Lau et al., 2022). Narrative scholars tell the personal stories of participants' individual experiences (Smith & Monforte, 2020). Since I sought to identify, contrast, and compare different organizational situations, neither the phenomenological, ethnographic, nor narrative designs were appropriate for this study.

Research Question

What strategies do offshore wind farm leaders use to manage O&M costs?

Interview Questions

1. What strategies have you used to manage your offshore wind O&M costs?
2. How have you addressed the key barriers that prevent the implementation of your organization's strategies to manage your offshore wind O&M costs?
3. How did you assess the effectiveness of your organization's strategies to manage offshore wind O&M costs?
4. What strategies did you find to be most effective for the management of your offshore wind O&M costs?
5. What strategies were least effective in the management of your offshore wind O&M costs?
6. What modifications, if any, did you apply to the strategies you used for the successful management of your offshore wind O&M costs?
7. What else would you like to share with me about your organization's strategies to successfully manage offshore wind O&M costs?

Conceptual Framework

I chose the McKinsey 7-S framework supplemented with Lean Six Sigma (LSS) as the conceptual frameworks for my study. In 1980, McKinsey & Company employees Waterman, Peters, and Phillips introduced the McKinsey 7-S framework (Waterman et al., 1980). The McKinsey 7-S framework is a model of organizational change to ensure profitability and sustainability. Waterman et al. (1980) posited that organizational problems were related to organizational structure and other influencing factors. Waterman et al. identified seven factors: three hard factors and four soft factors. The three hard factors, strategy, structure, and systems, represent tangible, easily evidenced influences. The four soft factors of style, skills, staff, and shared values are difficult to quantify, change, influence, or put into practice (Burger & Blažková, 2020). The framework's premise is that it is a nonhierarchical, mutually supportive model. There is no starting point or an ending point; the framework is entirely interdependent (Waterman et al., 1980).

I chose to augment the McKinsey 7-S framework with LLS to achieve synergies between the two frameworks for understanding my study's findings. McKinsey 7-S is an organizational change model, and LSS is an implementation structure for implementing value-added organizational change. LSS is a continuous improvement business strategy that emerged in 2002 as a hybrid of Lean Manufacturing (Lean) and Six Sigma, integrating the best of both concepts (Çiğal & Saygili, 2022). The LSS framework provides a set of processes and tools to help organizations reduce costs and waste to simultaneously increase process efficiencies and reduce process variations (Stojanović & Milovanović, 2020). Six Sigma, which was first developed and applied in 1987 by Motorola, implementers of LSS can use the Define-Measure-Analyze-Improve-Control (DMAIC) approach for process improvement (Stojanović & Milovanović, 2020). Implementers use the DMAIC approach to improve existing products, processes, or services (Çiğal & Saygili, 2022). From Lean, popularized by Womack, Jones, and Roos in 1990, implementers can use the Lean practices of Kanban, total productive maintenance, kaizen events, and Lean metrics (Oey & Lim, 2021; Womack et al., 1990). With McKinsey 7-S and LSS as the composite conceptual frameworks for my study, I expected to understand the strategies for managing and mitigating offshore wind farm O&M costs from both a practical and theoretical perspective.

Operational Definitions

Capacity factor: The capacity factor is the ratio of the net electricity generated, over a specific period, to the energy that could have been generated at the full-power continuous operation during the same period (United States Nuclear Regulatory Commission, 2019).

Generation: Electric generation refers to the amount of electricity a generating source, for example, a power plant, generates over a specific period. Per the Office of Nuclear Energy (2020), the standard units of measure for electrical generation for the wind industry are kilowatt-hours (KW), megawatt-hours (MW), and gigawatt-hours (GW).

Installed nameplate capacity: Generator capacity is the maximum output a generator can produce under specific conditions defined by the manufacturer (U.S. Energy Information Administration, n.d.). The installed nameplate capacity of a power system represents the defined maximum capacity at which a power plant can run; it is the intended full load of sustained output. Installed nameplate wind capacity is also known as peak installed capacity, rated capacity, or installed wind capacity (Office of Nuclear Energy, 2020).

Levelized avoided cost of electricity (LACE): The levelized avoided cost of electricity is the system's potential value of a generation power plant's output to the grid using prevailing electricity prices and capacity value that satisfies energy and capacity requirements. The LACE calculation represents the aggregated cost to generate the electricity needed to displace a new generation project or the aggregated potential revenue available to procure a new generation plant (Beiter et al., 2017). The LACE metric is the generation power plant's aggregated cost over the plant's financial lifetime, divided by the average annual output, commonly expressed as dollars or euros per MW (U.S. Energy Information Administration, 2019b). The LACE calculation is more complicated than the LCOE calculation since it requires an absence of assumption about the behavior of the electrical system of the asset under the calculation (Beiter et al., 2017).

Levelized cost of electricity (LCOE): The levelized cost of electricity, also known as the levelized cost of energy, is a measure of power used to describe the average revenue per unit of generation needed to recover the costs to build and operate a generating power plant over an assumed financial and asset lifecycle (National Renewable Energy Laboratory, n.d.; U.S. Energy Information Administration, 2019b). The LCOE allows for comparing technologies with different life spans, project sizes, costs, risks, and returns. In simple terms, the LCOE is the total lifetime costs of a generation power plant divided by the total lifetime energy production of that plant, depicted by the equation below:

$$LCOE = \frac{Total\ Lifetime\ Cost}{Total\ Lifetime\ Output}$$

$$Total\ Life\ Time\ Cost = \sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}$$

$$Total\ Lifetime\ Output = \sum_{t=1}^{n} \frac{\mathrm{E}_t}{(1+r)^t}$$

$$LCOE = \frac{\sum_{t=1}^{n} \frac{I_t + M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

The parameters needed to calculate the LCOE of a specific generation source and technology include lifetime expenses for all the following variables (I_t) Investment expenditures for the year, including financing (t); (M_t) O&M expenditures for the year (t); (F_t) fuel expenditures for the year (t); (E_t) electrical output for the year (t); (r) the discount rate; (n) the expected lifetime of the generation source, including the development and construction period (U.S. Department of Energy Office of Indian Energy, n.d.). Investors and operators use the LCOE to compare the competitiveness between different generating technologies, noting each comparison's assumptions. They compare the LCOE with LACE to estimate the economic viability, break-even point, or net value of a specific generation source and technology (U.S. Energy Information Administration, 2019a).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions are the presumed truths inherent in all research methods; they define the validation and verification of a study and significantly impact the outcome (Simon & Goes, 2018). The most fundamental assumption of this study was that the participants were the most knowledgeable offshore wind industry leaders and provided accurate information. Offshore wind farm technology is rapidly changing, such that the participant’s knowledge of the industry may not be current. I assumed the participants would be forthright, truthful, and willing to answer my questions. Since participation was voluntary and confidentiality assured, I believe I met this assumption. Also, there was the possibility the participants possessed trade secrets they did not wish to reveal about their practices; there was an assumption that the participants would disclose to me when this was the case. Without the presumed cooperation of the participants, neither my research nor my findings would have validity.

Limitations

Limitations are those weaknesses and constraints that define the study’s boundaries and scope and are beyond the researcher’s control (Connelly, 2013). A limitation of this study was that publicly available offshore wind farm O&M financial data were not readily available. Due to high competition within the industry, original turbine manufacturers are reluctant to release O&M cost information (International Renewable Energy Agency & Climate Policy Initiative, 2023). However, as offshore wind farms’ turbine warranty agreements begin to expire, data will become more readily available (Dalgic et al., 2015).

The lack of generalizability is inherent in case study design (Yin, 2018). Generalizability is a limitation of this study. Offshore wind technology has existed in Europe since 1991; there are 95 offshore wind farms with a combined 21 GW of offshore wind capacity operating or approved through 2020 (Vieira et al., 2019). The first and only offshore wind farm in the United States, Block Island Windfarm, began operation in 2016 (Hines et al., 2023). I selected Europe as the geographical location for my study, as offshore wind in the United States is in its infancy, and access to United States offshore wind farm leaders was limited. The geographical distribution of offshore wind farms throughout Europe also inhibits generalizability. National differences in support schemes, feed-in-tariffs, or regulations may influence leaders' strategic decisions.

Delimitations

Delimitations are those weaknesses and constraints that define the study's boundaries and scope over which the researcher controls (Simon & Goes, 2018). The United Kingdom, Germany, Denmark, Belgium, and the Netherlands are global leaders in the offshore wind industry (Wilson, 2020). As of 2016, only one offshore wind farm existed in the United States, Block Island (Hines et al., 2023). I geographically delimited my wind farm population to Europe.

My chosen population operated wind farms in Europe; communication limitations existed due to cultural or linguistic differences, particularly for Danish, French, and German speakers. I am not bi-lingual and speak English only. I relied on the participant to be proficient in English. A delimitation of my study was that I conducted my research in English only.

Significance of the Study

Contribution to Business Practice

The findings of my study may provide leaders with strategies to manage offshore wind O&M costs successfully. My research findings could provide offshore wind leaders with alternative long-term planning strategies and processes to mitigate O&M costs for offshore wind farms. My findings may enable leaders to plan and prioritize organizational change activities to minimize offshore wind O&M costs. Leaders could use the findings of this study to improve safety protocols, reduce O&M costs, and maximize production availability to increase offshore wind farm profitability.

Implications for Social Change

The implications for positive social change include providing coastal communities with potential increased economic growth and self-sufficiency. Most offshore wind energy jobs are local and cannot move abroad (Glasson et al., 2022). For coastal communities seeking to create a greener future and maintain environmental goals, the benefits of offshore wind energy include lower unemployment, cleaner water, cleaner air, efficient energy usage, and increased communal pride (Glasson et al., 2022; Scottish Government, 2018). Environmentally aware coastal communities attract organizations with a high sense of corporate social responsibility. In turn, this can lead to increased investments in coastal communities’ infrastructure, increased employment, raised tax revenues, expanded funding for educational support, discounted local electricity, and promoted tourism (Glasson et al., 2022; Scottish Government, 2018).

A Review of the Professional and Academic Literature

I reviewed the current literature regarding strategies offshore wind leaders use to manage O&M costs. I organized the literature review into four sections: McKinsey 7-S and LSS, the European renewable energy climate, the offshore wind industry, and offshore wind leaders’ O&M strategies. I searched for keywords and phrases in multiple search engines to explore these topics. For an all-encompassing search for peer-reviewed studies, I used the following keywords, *corrective maintenance, electricity, green energy, green jobs, Lean, Lean Six Sigma, maintenance cost, McKinsey 7-S, offshore wind, offshore wind farm costs, onshore wind, operation and maintenance, predictive maintenance, preventive maintenance, renewable energy, renewable power plants, Six Sigma,* and *sustainable energy.* I used the search engines Google Scholar, ProQuest Central Database, Sage Journals, SCE Library, ScienceDirect, Elsevier, IEEE Xplore, EBSCO, and Emerald Management Journals. I included seminal works, peer-reviewed journal articles, government publications, and conference papers to support my literature review. I based my literature review on 130 reference sources, of which 101 were journal articles, 16 were organizational or governmental reports, and 13 were seminal sources or conference papers. Of the 101 journal articles, 94 were peer-reviewed (93.06%).

McKinsey 7-S and Lean Six Sigma

McKinsey 7-S Framework.

The McKinsey 7-S framework was developed in the 1980s by Waterman, Peters, and Phillips, who were employees of McKinsey & Company (Dewey, 2020; Masfi & Sukartini, 2022). The McKinsey 7-S framework is a management model leaders use as a diagnostic and prescriptive framework for strategic organizational alignment. Implementers use the framework to assess and monitor changes occurring within an organization (Errida & Lotfi, 2021). The framework’s premise is that the organization is not a structure, but that structure is part of the organization (Waterman et al., 1980). Waterman et al. posited that for an organizational strategy to succeed, other aspects of the organization, such as organizational resources (physical, intangible, and human), structure, systems, and philosophies, must align.

Waterman, Peters, and Phillips developed the McKinsey 7-S framework to be easily recognizable and remembered. Seven factors make up the framework: strategy, structure, systems, style, staff, skills, and shared values (Waterman et al., 1980). Every factor must align with each other for the framework to be effective. This framework's applications include facilitating organizational change, implementing new organizational strategies, facilitating mergers and acquisitions, or identifying areas for potential future change (Michulek, 2022). Waterman et al. (1980) segregated the seven factors into hard and soft elements. The hard factors: strategy, structure, and system, are readily identifiable and most manageable in an organization. The soft factors: style, staff, skills, and shared values are the humanistic components often related to an organization's sustainable competitive advantage (Kocaoglu & Demir, 2019).

Strategy Factor. Organizational strategies are actions that managers undertake to gain and sustain a competitive advantage in the marketplace. An organization can respond to changes in its external environment through strategic initiatives and provide unique value to its customers (Waterman et al., 1980). An organization designs strategic initiatives to retain or improve its competitive position within its chosen markets. By harnessing the buying power of its suppliers and customers, or by preventing new entrants into the field, or reducing the threat of product or service substitution, an organization can retain its strong competitive position (Porter, 2008)

A clear mission and vision statement coupled with defined goals and objectives helps define the strategic plan in allocating resources. For example, in protecting their market share and competitive edge, the largest offshore wind farm vendors, Vestas and Siemens, preserve their research and innovations (Sovacool & Enevoldsen, 2015). Until third-party suppliers overcome offshore wind development and maintenance logistical constraints, owners are limited in their vendor selection and must strategize accordingly (Paulraj et al., 2019).

Structure Factor. Within the McKinsey 7-S framework, an organization’s structure defines the roles, responsibilities, and accountability relationships (Singh, 2013). The level of specialization required by the organization’s size, strategy, and diversity can influence an organization’s structure. However, of the seven McKinsey 7-S factors, it is the easiest to change (Ravanfar, 2015). Organizational structure decisions include whether to have a centralized or decentralized arrangement, have a formal or an informal hierarchy, or specialize or generalize (Shiri et al., 2014). Their ownership arrangements typically influence offshore wind farm organizational structures, varying from full governmental ownership to private partnership agreements, as in Europe and the United States (Meckling, 2021).

Systems Factor. The McKinsey 7-S framework’s system factor refers to the organization’s processes and procedures that support the organization’s strategy and structure. Systems enable the organization to achieve its goals and objectives daily (Higgins, 2005; Singh, 2013). The organization’s processes and procedures describe how it will perform its financial obligations, such as capital budgeting; operate its human capital processes, such as performance measurement and reward recognition; and monitor its manufacturing and quality-control systems and processes (Higgins, 2005; Waterman, 1982). Offshore wind farm operators rely heavily on technical, safety, and managerial processes and procedures to run their day-to-day operations. Many researchers have described systematic approaches to the efficient operation of an offshore wind farm, from the full systematic approach described by Stock-Williams and Swamy (2019) to the examination of individual systems, such as vessel management or technician allocation (de Jonge & Scarf, 2020).

Style Factor. Style represents both organizational culture and the style of management. The beliefs and norms developed over time make up an organization’s culture. An element of organizational culture is management’s leadership style (Gechkova & Kaleeva, 2020; Waterman et al., 1980). Organizational beliefs arise from managerial actions. Leaders must support corporative programs financially, experiencedly, and technologically. Without leadership’s support, organizational culture could turn toxic (Okray & Şimşek, 2020). A healthy organizational communication system promoted and supported by leadership ensures stakeholders accept organizational changes (Kotter, 2012).

A good leader creates an ethical culture and operates within the organization’s values, mission, and strategy. For example, there are many leadership styles, such as autocratic, democratic, strategic, transformational, transactional, servant, and situational (Bass, 1985). Some styles consider the well-being of the followers, while others disregard their welfare. Each leadership style has its merits and shortcomings. Transformational leadership is at the forefront of innovative thinking. Transformational leaders are more proactive than reactive, innovative, and creative, and inspire their followers to put forth extra effort leading to more exceptional accomplishments than other leadership types (Arunga & Kilika, 2023). The transformational leadership style is well suited for a McKinsey 7-S implementation as the framework requires the leader to balance strategy, skills, and systems, all traits of a transformational leader. If the followers lack the skills needed to perform tasks, the transformational leader creates learning opportunities to perform at the optimal level possible, motivating their followers to go beyond self-interest (Singh, 2013).

Staff Factor. In the McKinsey 7-S framework, the staff factor refers to the organization’s employees. The staff factor concerns the human resource management activities related to those employees. The human resource team recruits, retains, motivates, trains, rewards, and hopes to maintain high employee morale to optimize human resource capital levels (Galli, 2018b). Human capital is a source of competitive advantage for organizations (Hamadamin & Atan, 2019). A component of human capital management is to help the organization build dynamic teams. High-performing teams deliver quality products that meet the stakeholder’s objectives timely. In innovative industries such as offshore wind, projects are delivered on time, maintenances are well executed, and uninterrupted power is delivered to the customer economically.

Human resource management is uniquely positioned to impact the organization’s culture and dynamics by creating effective teams (Estrada et al., 2013; Harsch & Festing, 2020). Effective teams promote innovation, safety, scientific advancement, productivity, quality, and competitiveness (O’Neill & Salas, 2018; Zainal et al., 2020). Effective teams must be trained and developed to meet the quality standards expected by the stakeholders. In pioneering industries such as offshore wind, training and development protocols are not well-established. Therefore, most organizations instruct employees through on-the-job training (Swift et al., 2019). Consequently, groundbreaking organizations choose to develop training in-house or strategically partner with competitors to gain synergies (Scully-Russ, 2015). Due to the limited employee pool, offshore wind organizations must compete with original equipment manufacturers to recruit and retain critical personnel (Sovacool & Enevoldsen, 2015).

Skills Factor. Skills are the competencies of the individuals, the staff, and the organization needed to accomplish organizational goals holistically (Waterman et al., 1980). Waterman (1982) described the skills factor as the skill of the collective versus a collection of individual skills. The organization’s skills define its competitiveness within the market and the ability to lead change. The company’s strategic intent delineates the skill requirements of its employees and management. Organizational skill development must be flexible. Technological skills are highly sought after within the offshore wind farm industry, although there are synergies between offshore oil and gas and offshore wind industries that can fill that gap (Esteban et al., 2011).

Shared Values Factor. The shared values, or superordinate goals, are the core principles upon which the organization shapes its mission, core values, and ethical framework. They are the fundamental ideas around which management builds an organization (Waterman et al., 1980). The shared values define the organization’s business direction and the energy management wants to infuse into the group. The drive to achieve or maintain the shared values unites the organization, thereby providing organizational stability (Waterman et al., 1980). Without shared values, the systems, structure, and strategy factors would not align. Offshore wind leaders unite in the belief that renewable energy technologies such as offshore wind can mitigate some of the climate change impacts from the planet's carbonization. At the 21st Conference of the Parties (COP21) in Paris, 19 countries agreed to uphold and pursue efforts to limit temperature increases to 1.5℃ (Ancygier et al., 2021). This belief drives government policy, financial investment, and organizational strategies with social, environmental, and technical implications (Price et al., 2018).

McKinsey 7-S Implementation. As previously noted, the McKinsey 7-S framework is a model of organizational change to ensure profitability and sustainability. Every factor in the McKinsey 7-S framework must be analyzed and aligned toward a common goal. In their original writings, Waterman et al. (1980) did not describe the best model implementation strategies. However, alignment of the McKinsey 7-S factors does not occur in a vacuum. For many functionally structured organizations, the execution of cross-functional strategies can challenge the leaders implementing the change (Burger & Blažková, 2020; Higgins, 2005). Ravanfar (2015) built upon the original framework and provided a five-step implementation process. His approach is similar to the LSS DMAIC approach I will discuss in the following sections.

Ravanfar's (2015) first step was to identify the inadequately aligned areas to look at the gaps, weaknesses, and inconsistencies within the factors strategically. For example, if an organization’s strategy is to expand into new markets, as with the offshore wind industry in the United States, it would benefit the organization to align the staff and skill factors to support the new strategy. In the second step, Ravanfar recommended management choose an organizational design to achieve the best outcome. Thirdly, management must decide where and what changes to make; this is the action plan and should describe how each realignment will occur and how it will control change management. Once decided, management should implement the plan, carefully monitoring change management risk. The fourth step is essential, for if the organization’s communication strategy is not aligned, the changes will not produce positive outcomes. Finally, top management must continuously review the seven factors for signs of misalignment.

Critics of the McKinsey 7-S framework claim that the framework does not consider the external environment, nor does it evaluate the impact that external forces have on the organizations (Errida & Lotfi, 2021). Consequently, the seven factors are often out of alignment as external factors continually impact how an organization reacts to these forces (Chege & Wang, 2020). Similarly, Higgins (2005) observed the McKinsey 7-S framework did not address the financial, informational, technological, or time-based distribution of resources. Nor did the framework address the voice of the customer. There is an assumption made by the authors of the McKinsey 7-S framework that the authors consider resources as part of the model, but not explicitly.

Consequently, gaps will occur when management does not consider resources and external factors as part of the organization’s alignment strategy. Higgins (2005) further observed that the McKinsey 7-S framework did not address strategic performance. Strategic performance measures inform management as to the success of the initiative. Furthermore, Shiri et al. (2015) remarked that for an organization to be responsive to changes or misalignment of the factors, the organization must be agile. To be agile, the organization must provide support from management and hold itself accountable. Through self-assessment, the organization can obtain accountability.

Given these criticisms, for offshore wind leaders to successfully implement a McKinsey 7-S alignment, they must consider proven tools from other scholarly areas. LSS provides management with a tool kit that they can use to better understand the forces from within and from without the organization. Management can then align the seven factors while hearing the voice of the customer, reducing waste, and maintaining a quality product or service.

Lean Six Sigma

LSS emerged as a framework in the early 2000s (Daly et al., 2022). LSS is a philosophy and a methodology that combines the best principles and tools to maximize value, understand customers' needs, and eliminate waste (Çiğal & Saygili, 2022; Deithorn & Kovach, 2018). Since LSS is a combination of both the Lean and Six Sigma philosophies, to gather a comprehensive understanding, a discussion of the advantages and disadvantages of Lean and Six Sigma follows; culminating with a discussion on the integration of the Lean and Six Sigma methodologies and tools that led to LSS and its application in the offshore wind industry.

Lean Manufacturing (Lean). Popularized in the 1990s by Womack et al. (1990), most Lean Manufacturing scholars credit John Krafcik with coining the term *Lean Manufacturing* (Lean) in 1988 (Singh et al., 2021). The Lean principles emerged from philosophical synergies between Henry Ford's concept of flow and Frederick Taylor's work management philosophy at the turn of the 20th century to become the Toyota Production System in the 1940s (Seddon et al., 2011). During that period, to compete with United States automobile manufacturers, Toyota needed to reinvent itself to stay afloat. Out of necessity, due to the capital and supply shortages stemming from World War II, Taiichi Ohno, an industrial engineer and manager, sought to eliminate all waste in the manufacturing process at Toyota (Pepper & Spedding, 2010). Ohno realized that Toyota could not compete with the large assembly lines and concluded that the answer lay in creating a continuous flow in small-lot production (Womack & Jones, 2003). Since waste is inherent in all processes, the principles and tools known as the Toyota Production System later became Lean Manufacturing (Womack et al., 1990).

Stimulated by Womack et al.'s (1990) publication, Lean enthusiasts questioned how to implement Lean principles. In response, Womack and Jones (2003) identified five Lean organization elements in their follow-on book. Every successful Lean organization, Womack and Jones argued, delivers value to the customer by eliminating all unnecessary waste, identifies value streams for its products, ensures the flow of that value, paces production on a pull (or Kanban) signal, and follows a continuous pursuit of perfection (Melton, 2005; Womack & Jones, 2003).

The first principle of Lean introduced the concept of customer value (Melton, 2005). Customer value is whatever the customer is willing to pay for the product or service. The customer defines value, but the product or service provider creates it. Under Lean, the product or service provider must understand the customer’s value proposition (Womack & Jones, 2003). Unfortunately, customers do not always know what they want before delivery. Historically, most product or service providers created products, services, or both, pushing them out to the market regardless of customer value. Part of the essence of value is the elimination of waste. Womack and Jones argued that providing the wrong product or type of service to the customer is a form of waste.

Central to the creation of value in Lean is the elimination of waste (Muda) created from overburden (Mura) and unevenness of workloads (Muri) (Oey & Lim, 2021). Waste, or Muda, is anything that is not essential, including unnecessary equipment, materials, or parts, or excess space and time, that does not create value for which a customer is willing to pay (Çiğal & Saygili, 2022; Oey & Lim, 2021; Singh et al., 2023). Originally, Ohno listed seven sources of waste. These sources of waste are as follows: excessive transportation of goods, unnecessary storage of inventory, unnecessary motion (of people), unnecessary waiting for the completion of processes, over-production of products and services, over-processing, and product defects (Melton, 2005). In subsequent years, Lean practitioners put forth another source of waste, the underutilization of capabilities or skills. These eight forms of waste are the generally accepted forms of Muda that Lean practitioners use to pursue perfection (Sunder, 2016;

Womack & Jones, 2003). Table 1 includes examples of waste for the offshore wind industry related to the generally accepted eight sources of waste.

Table 1

The Eight Types of Waste, Examples in the Offshore Wind Industry

Waste	Description	Example
Overproduction	Overproduction of goods or services	The production of electricity in the wind industry is not predictable. Overproduction of electricity can cause damage to generators if not managed carefully. When storage capacity is low, operators must curtail wind farm output and potential revenue is lost ((McKenna et al., 2022).
Waiting	Unnecessary waiting for the completion of processes	Inclement metocean conditions create downtime for offshore wind leaders. Construction processes like cable installation must stop when conditions are dangerous. Lean offshore wind leaders can mitigate increased costs through careful site placement and proper scheduling (Gonzalez-Rodriguez, 2017).
Transport	Excessive transportation of goods	Minimizing parts’ transportation is most significant during an offshore wind farm's

Waste	Description	Example
		design and construction stage. The strategic placement of the port servicing facilities and the sub-area design should be optimized to decrease costs (Irawan, Song, et al., 2017).
Inventory	Unnecessary storage of inventory	Two manufacturers dominate the market. Additionally, component replacement parts for a turbine have extended lead times and are logistically awkward to transport. Shortages of components would mean lost production and revenue. Offshore wind leaders must strategize for optimal inventory levels to ensure steady flow without waste (Gonzalez-Rodriguez, 2017).
Over-processing	Over-processing in the flow, no value is added with the additional processing	Maintenance of a wind turbine is either corrective or preventive. With corrective maintenance, there is a risk that maintenance is not often enough. Conversely, offshore wind preventive maintenance schedules may be too

Waste	Description	Example
		frequent. Neither strategy is Lean. Offshore wind leaders are moving toward a predictive maintenance strategy, a blended approach using technology (Shafiee & Sørensen, 2019).
Motion	Unnecessary motion (of people)	O&M technicians arrive at their worksites either by helicopter or by ship. Those transported by ship are transported daily or live aboard the vessel for 2 weeks. The transportation of crews to and from the port and between turbines is vulnerable to motion waste (Mette et al., 2018).
Defects	Product defects or performing the incorrect service	Repairing a defective part for an offshore wind turbine requires skilled technicians, parts availability, and the tools to complete the repair, such as jack-up barges or crane vessels (Seyr & Muskulus, 2019). Insurance companies most frequently cite design and mechanical defects as the most common type reported (Mentes & Turan, 2019).

Waste	Description	Example
Skills	Underutilization of capabilities or skills	To minimize unused human talent and ingenuity, offshore wind leaders can support employees with a continuous learning mindset. The skills needed to construct or operate an offshore wind farm blend offshore oil and gas and onshore wind capabilities. Industry leaders cite a lack of training, poor knowledge transfer planning, and a lack of incentives for the current skills shortage in the United States (Swift et al., 2019).

Once customer value is understood, to be Lean, the organization needs to identify all the specific actions required to provide a product or service that creates that value for the customer (Womack & Jones, 2003). Womack and Jones advocated that organizations use value stream maps for visibility into their product or service’s life cycle to obtain that understanding. Lean organizations must map all steps, materials, features, and product movement. When mapped in totality and accurately, the value stream map will identify waste areas, such as avoidable or unavoidable, non-value-added steps. This second principle of Lean can be applied holistically, individually, or both to each of the critical project cycles of an offshore wind farm; for example, practitioners can map the installation, O&M, generation, and decommissioning stages as an entire asset lifecycle or separate stages.

Not only must practitioners understand all the steps within each product life cycle to be Lean, but the time it takes for the product to move through the process must be seamless. There should be no unavoidable interruptions, downtime, or stoppages that interrupt the flow of the product. Flow, the third principle of Lean, requires the organization to be flexible and agile enough that the production of the product or service moves at the perfect rate at which the customer demands it (Bendell, 2006). For example, waste in transportation or the unnecessary movement of people, tools, inventory, or products can slow down the product's flow to the customer. Every machine and worker must always be in peak condition for the system to run precisely (Womack & Jones, 2003).

Customer demand, or pull, is the fourth principle of Lean. Ideally, in a perfect pull system, no one upstream in the Lean process should produce a good or service until the customer asks for it (Womack & Jones, 2003). Once triggered by the customer, the Lean system should flow continuously. Lean tools such as Kanban, 5 Ss, Visual Control, Poke Yoke, and SMED can help the Lean practitioner manage and eliminate waste within the process (Melton, 2005). To achieve constant flow, the organization must manage process throughput to identify bottlenecks and roadblocks (Subramaniyan et al., 2020). Kanban systems allow downstream teams to notify their upstream counterparts that they need inputs so as not to create a bottleneck or stoppage.

Lean practitioners can apply mistake-proof processes (poke-yoke) to ensure that defective parts or services do not reach the next step. Visual controls and the 5 Ss (sort, set in order, shine, standardize, sustain) techniques allow teams to organize workspaces for maximum efficiency (Melton, 2005). When a stoppage occurs, teams should be crossed-skilled in their tasks. This way, they can quickly help each other resolve the bottleneck (Melton, 2005). As the reiterative process continues and the organization learns from its errors, this shortens throughput time, and affordable, quality parts or services reach the customer faster (Womack & Jones, 2003).

Waste exists in all systems, and no matter how often processes are made leaner, there is always an opportunity for additional improvement (Womack & Jones, 2003). The natural consequence of Lean thinking is perfection, albeit unattainable (Melton, 2005). Pursuing perfection, the complete elimination of waste, is the fifth Lean principle, an evolving outcome of the first four principles. Lean practitioners pursue perfection by continuously lowering costs, reducing defects, reducing inventories, and providing endless varieties of products (Bendell, 2006). Therefore, organizations must have a continuous improvement mindset to eliminate all sources of waste and deliver value-added products and services to customers. Since improvements are incremental, some critics of Lean argued to seek perfection can be cost-prohibitive (Chamberlin & Fleming, 2016). To manage variation in the business process, practitioners turn to the Six Sigma methods and tools to add better structure around variation and quality management.

Six Sigma. Motorola first implemented Six Sigma in the 1980s in response to increased customer demand for better quality and to control escalating incidents of defective parts (Anthony & Antony, 2022). Noting Motorola's success, many other large organizations adopted Six Sigma, including General Electric (GE), which modified the framework to a five-phase approach (Singh & Rathi, 2019). In 2009, 82 United States' largest companies embraced the Six Sigma methodology (Apak et al., 2012).

Six Sigma is a deliberate project methodology and tool structure that reduces variations in the business process (Antony, Sony, et al., 2019). The purpose of Six Sigma is to improve quality, reduce costs, and make processes easier to manage through data gathering and statistical analysis (Galli, 2018a). The Six Sigma process obtains this objective by limiting the number of defects per million opportunities (DPMO) to 3.4 DPMOs (A & Joghee, 2020). Using statistical methods, an organization can achieve acceptable DPMOs by keeping the standard deviations between the process average and acceptable process limits at six (Ravichandran, 2017). The more the standard deviations between the process average and acceptable process limits, the less likely the process performs outside the acceptable process limits and therefore causes a defect (Antony, Sony, et al., 2019).

Six Sigma projects are often led by full-time improvement engineers called Black Belts (Kregel et al., 2021). These Black Belts implement the five phases of Six Sigma and represent a significant portion of the Six Sigma investment, a concern for organizations when implementing Six Sigma corporate-wide (Romdhane et al., 2017). For example, when GE implemented Six Sigma in 1998, the company invested US$400 million to train everyone in Six Sigma techniques and philosophies, expecting to reap US$1.2 billion in benefits (Henderson & Evans, 2000).

For GE, customer focus was central to its management philosophy. When GE deployed Six Sigma, it expanded Motorola's Six Sigma four-phase approach of Measure-Analyze-Improve-Control and added a fifth phase, the Define phase. The Define phase represents the voice of the customer (Bendell, 2006). Consequently, GE's five phases of Six Sigma or the DMAIC approach to implementing Six Sigma is considered by implementers as the foundation of the framework (Romdhane et al., 2017). Each phase of the DMAIC approach for process improvement has well-defined steps and tools (Farrukh et al., 2021). Table 2 describes the DMAIC steps, each step's activities, and the tools used to implement each step.

Table 2

The Five Phases of the DMAIC Approach

Phase	Description	Activity	Tools
Define	Understand the problem and the financial impact	Define the problem. Identify stakeholders. Team formation. Assess the benefits. Understand the process, simple mapping, and process inputs, outputs, and controls.	Voice of the customer (VOC) SIPOC Project team charter Process map In-frame/out-of-frame tool

Phase	Description	Activity	Tools
Measure	Develop appropriate collection methods	Determine how the process works and current performance. Collect baseline data. Identify strengths and weaknesses. Measure the Y	Cause-and-effect (Ishikawa) diagram Data collection planning Run Charts Critical to Quality (CTQ) Cost of poor quality (COPQ) Benchmarking Y = f (x)
Analyze	Find the root cause of the problem	Identify the root cause of the defect. Understand the nature of the data (distributions and patterns). Compare to data collected in the Measure phase	Root cause analysis The 5 Ss Cause-and-effect (Ishikawa) diagram Pareto analysis Five Whys Weibull analysis
Improve	Generate and implement solutions	Brainstorm ideas for improvements and efficiencies.	Brainstorming Hypothesis testing Piloting solution

Phase	Description	Activity	Tools
		Test ideas and implement them. Assess risks. Validate improvements. Re-evaluate impact	
Control	Ensure the sustainability of the results	Develop new standards and procedures. Maintain the implemented ideas during the improve phase. Train employees on change Monitor the project for any problems.	Control charts Training Change Management Standard operating procedures

Note. Adapted from Antony, Rodgers, et al., (2019), Farrukh et al. (2021), Galli (2018a), Rabii et al. (2018).

The strength of Six Sigma techniques lies in applying its tools and the five-phase DMAIC methodology. However, despite many successes, as a project-driven management approach, approximately 60% of all corporate Six Sigma projects have failed to yield the benefits expected (Galli, 2018a; Sony et al., 2019). Many organizations claimed that implementations were too expensive and did not produce the anticipated results (Sony et al., 2019). Scholars argued that because of the expense, if Six Sigma is to succeed, only large companies have the resources to implement it effectively (Romdhane et al., 2017). However, funding is not the only roadblock to implementing Six Sigma successfully. Some Six Sigma projects fail due to a lack of leadership from top executives, insufficient training, poor coaching, inaccurate identification of process parameters, or immature organizational culture or alignment (Romdhane et al., 2017).

There can be negative customer repercussions when practitioners poorly implement Six Sigma (Sony et al., 2019). For example, some scholars argued that the push propensities of the Six Sigma methodology focus on existing customers and do not stress the development of new ones, unlike the fourth principle of Lean, pull (Galli, 2018a). Other criticisms of Six Sigma include the lack of adaptability to adjust to changing environments, which can hinder organizational innovation (Sony et al., 2019). These critics argued that Six Sigma is best applied in situations that focus on reducing variation within current processes, which are inherently stable (Clancy et al., 2021). A weakness of the Six Sigma approach is that Six Sigma highlights the past, focusing on finite processes, with no feedback loops, unlike in Lean (Galli, 2018a). Consequently, when environments are fast-paced with a high output level or frequently changing, as in innovative environments, scholars have advocated for a merged Lean and Six Sigma approach (Bendell, 2006).

Lean Six Sigma. Six Sigma does not guarantee a competitive advantage, nor does Lean provide the statistical rigor to control a process (Caiado et al., 2018). The flexibility of Lean strengthens Six Sigma, and Six Sigma’s statistical rigor enhances Lean. Combining the five principles of Lean and Six Sigma’s DMAIC structure, the LSS philosophy and framework provide practitioners with the tools to improve process speed, visualize problems, increase revenues, reduce costs, and improve collaboration. Organizationally, the implementation of LSS is the data-driven elimination of waste in the pursuit of organizational efficiencies, improved quality management, reduction of costs, and perfection (Caiado et al., 2018; Gupta et al., 2019; Sunder, 2016).

Lean and Six Sigma practitioners initially applied their respective frameworks to manufacturing industries (Seddon et al., 2011). However, as practitioners merged Lean and Six Sigma, they increasingly used the LSS philosophy and tools in the transactional and service industries (Pacheco et al., 2015). Implementing LSS as a business strategy in the transactional and service sectors is challenging. A distinction that LSS practitioners must consider with the services industry is that services are activities or a series of activities (Seddon et al., 2011). Service is often an intangible, non-heterogeneous product consumed by the customer synonymously upon delivery (Deithorn & Kovach, 2018; Sunder, 2016). To overcome these challenges, practitioners can view services as a system and apply the LSS principles and tools accordingly (Caiado et al., 2018).

The first principle of Lean and LSS is to create customer value. Practitioners of LSS in the services industry must quantify the customer’s feelings and perceptions. Since service and delivery are inseparable, the practitioner must be mindful of the waste created if it forces the customer to wait (Sunder, 2016). LSS tools such as SIPOC, process mapping, and value stream mapping help identify waste areas within a service organization (Sony, 2019; Sunder, 2016). No matter the industry, manufacturing, transactional, or services, LSS organizations aim to achieve a competitive position through organizational efficiencies and customer value.

As with Six Sigma deployments, few organizations succeed in implementing LSS (Galli, 2018a). One reason provided by scholars is that organizations often underestimate the size of their projects. Many organizations are over-ambitious and tend to implement projects that affect too many people or are too big or complicated (Galli, 2018a). When LSS projects fail, a primary cause of the failure is the organization’s leadership’s lack of support (Antony, Rodgers, et al., 2019; Galli, 2018a). Inherent in all projects are the risks of poor-quality data collection, poor project selection, and poor project management. Additional areas of risk cited by critics include poor change management and lack of project alignment with the organization’s strategy and goals (Galli, 2018a). If LSS practitioners can manage change effectively, employee morale will improve with employee and management buy-in and the likelihood of the LSS project’s success (Sony, 2019).

McKinsey 7-S and Lean Six Sigma Consolidated

The McKinsey 7-S framework is an organizational tool for strategic organizational alignment. Kaplan (2005) noted that implementers use the McKinsey 7-S framework to assess and monitor changes taking place within an organization, encouraging a culture of continuous improvement. However, three weaknesses of the McKinsey 7-S framework are that the model does not inherently consider external influences, does not address the distribution of resources, nor are there specific tools to aid with a McKinsey 7-S implementation (Errida & Lotfi, 2021). LSS is also an organizational change management framework. However, LSS considers external influences, addresses resource distribution, and provides practitioners tools to aid an LSS implementation (Çiğal & Saygili, 2022). However, LSS is a project-oriented framework, and critics of LSS claim that many LSS projects fail due to a lack of stakeholder engagement, poor implementation, and project organization (Pacheco et al., 2015; Sony et al., 2019). For an LSS project to succeed, the LSS practitioner must address inherent risks. Comparing the McKinsey 7-S factors and LSS's inherent risks, I noted that each of the LSS project's risks aligned with the McKinsey 7-S framework factors: strategy, structure, systems, style, staff, skills, and shared values (Galli, 2018a; Galli & Kaviani, 2018; Waterman et al., 1980). Table 3 illustrates how the McKinsey 7-S factors might align with LSS principles and framework to address inherent risk.

Table 3

Alignment of Lean Six Sigma Inherent Risks With the McKinsey 7-S Factors

McKinsey 7-S Factor	LSS Principle	Inherent Risks	Comments
Strategy			
Vision & Mission; Goals & Objectives; Strategic plan.	Systematically undertake improvement activities. Find the problem and focus on it to provide value to the customer. Remove variation and bottlenecks.	Poor alignment with business goals. Poor initial project selection	Core to both McKinsey 7-S & LSS in the sustainment of competitive advantage.
Structure			
Centralization or decentralization; Size; Ownership.	Manage & improve process flows using analysis tools & DMAIC.	Sustainment of project measurement. Poor resource alignment	Inflexible hierarchies do not respond to changes in the market (Singh, 2013). LSS is agile, whereas

McKinsey 7-S Factor	LSS Principle	Inherent Risks	Comments
			McKinsey 7-S can be static
Systems			
Technology; Content; Platform support; Documentation.	Manage & improve process flows using analysis tools & DMAIC. Remove non-value-added steps. Systematically undertake improvement activities.	Sustainment of project measurement. Lack of accurate or complete data.	LSS provides tools to measure the completeness and accuracy of data. 7-S can lead to overly complicated systems.
Skills			
Management skills; Technician skills; Vendor education.	Involve and equip people in the process by using blackbelt implementers and trainers —	Lack of training	Applying the correct skills to a problem is core to the LSS model if the organization is to achieve its

McKinsey 7-S Factor	LSS Principle	Inherent Risks	Comments
	education of vendors in LSS principles.		organizational objectives.
Staff			
Recruiting & hiring; Training & development; Trust.	Communicate clearly and train team members. Build effective teams	Poor human resource management	
Style			
Organizational culture; Leadership; Top management support.	Be flexible and responsive. Requires leadership support and buy-in to succeed.	Poor organizational and team leadership	McKinsey 7-S requires all systems to align with each other, aiding in organizational and team alignment.
Share values			
Shared beliefs; Culture	Belief in the outcome & the need for change.	Poor organizational and team leadership.	McKinsey 7-S requires all systems to align

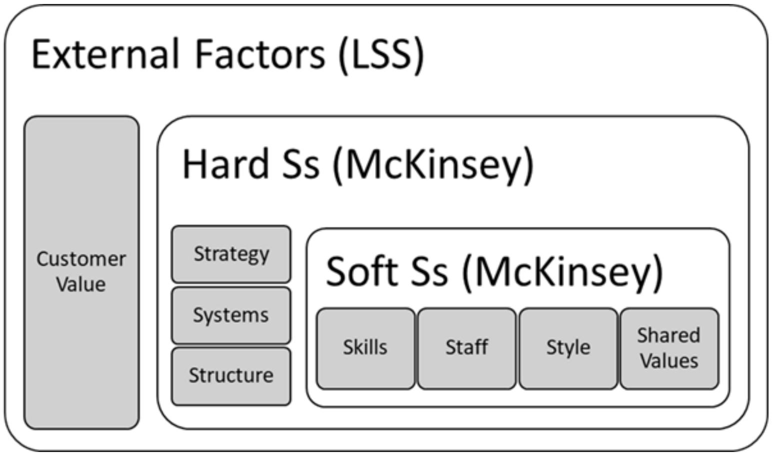
McKinsey 7-S Factor	LSS Principle	Inherent Risks	Comments
	Only value-added projects supported	Poor initial project selection	with each other, aiding in organizational and team alignment. McKinsey 7-S can align with organizational shared values, encouraging project selection prioritization.

Note. Adapted from Galli (2018a) and Waterman et al. (1980).

Figure 1 illustrates how the LSS and the McKinsey 7-S frameworks might synergize to provide offshore wind leaders with a framework and tools to reduce costs and provide value to their customers. By combining the two frameworks, an organization can address the inherent risks of project management, the influence of external factors, and the alignment of internal resources to reduce waste. Thereby obtaining a culture of continuous improvement, providing customer value, and maintaining organizational alignment.

Figure 1

Lean Six Sigma and McKinsey 7-S Integrated



Note: Figure 1 illustrates how the LSS and the McKinsey 7-S frameworks might synergize to provide offshore wind leaders with a framework and tools to reduce costs and provide value to their customers.

The application of LSS in the literature is plentiful. Many scholars have explored or examined using LSS or the McKinsey 7-S frameworks to understand the effect of cost reduction efforts, organizational change, and value-add propositions to improve teamwork or generally improve customer experience industries. For example, Deithorn and Kovach (2018) explored the applicability of LSS on revenue collection in the oil and gas industry. The offshore oil and gas industry is similar to the offshore wind industry in that revenues are generated from services performed, and maximized profits depend upon reduced cycle times (Deithorn & Kovach, 2018). Deithorn and Kovach concluded that using the LSS philosophy, the case study company could have reduced errors by up to 50% in the billing process. Sony (2019) conducted a multiple case study exploring LSS in the power sector. Sony conducted five case studies, applying LSS philosophy and methodologies in generation, transmission, and electrical energy distribution. He concluded in all five cases the participants successfully implemented LSS. Furthermore, he found LSS was an essential methodology for the power industry's generation, transmission, and distribution sectors.

The most ambitious application of Lean philosophy and methodology in the offshore wind industry concluded in December 2017 (LEANWIND Consortium, 2017). With a budget of €10 million, experts from multiple sectors, including oil and gas, maritime, shipping, and offshore wind industries, created a consortium for the primary purpose of reducing costs across the offshore wind life-cycle and offshore supply chain through the application of lean principles (LEANWIND Consortium, 2017). The consortium based its project on four principles, customer needs, reducing or eliminating waste, seeking improvement, and approaching improvements holistically. The consortium's project began in 2013 and concluded 4 years later (LEANWIND Consortium, 2017). The team successfully applied Lean principles to each critical stage of an offshore wind farm's life cycle, including installation, operations, maintenance, to decommissioning. The team measured the cost reduction using an industry cost measure, the LCOE, to compare results (LEANWIND Consortium, 2017).

Alternative Frameworks

When I considered the conceptual framework for my study, in addition to McKinsey 7-s and LSS, I evaluated four additional frameworks. I contemplated Lean, Six Sigma, Total Quality Management (TQM), and Resource-based-view (RBV) theory. My experiences in the renewable energy industry influenced my choice of framework. I chose McKinsey 7-S augmented with LSS because of the frameworks' complementary internal and external focus and the structure, tools, and flexibility the combined frameworks promise to deliver in a project-driven, innovative, and data-driven renewable energy industry. I did not select Lean, as the Lean framework did not have the structure or tools to maximize cost reductions (Pacheco et al., 2015). Conversely, I did not choose Six Sigma due to the complexity and cost of implementation, coupled with its inflexibility.

I also considered Total Quality Management (TQM), conceptualized by Edward Deming in the 1950s (Dahlgaard-Park et al., 2018). As a predecessor of Lean and Six Sigma, the TQM model promised to provide a disciplined approach to cost reductions in the offshore wind industry. The TQM model addresses corporate culture, emphasizing customer satisfaction and continuous improvement where all employees participate (Andersson et al., 2006). The model focuses on people, processes, partnerships, and products through culture, communication, and commitment (Dahlgaard & Dahlgaard-Park, 2006).

Unlike Six Sigma and Lean, which are project-focused, to implement TQM, an organization must engage all organization members, from top management to the shop floor worker (Andersson et al., 2006). When an organization does not have that level of trust and engagement, implementing TQM is limited (Dahlgaard & Dahlgaard-Park, 2006). Although the TQM model addresses the organizational ways of managing people and business processes to ensure customer satisfaction, the TQM model must be applied holistically and does not directly address waste. I chose LSS as the framework because it is project-focused and incorporates Lean's first principle of eliminating waste. Both of these perspectives align with the environmental consciousness of the renewable wind industry (Giroux & Landry, 1998).

I also considered the Resource-Based View (RBV), a combination of analyzing a company's internal resources with its competitive environment (Barney, 1991). RBV theory focuses on the company's internal valuable, rare, imperfectly imitable, and non-substitutable resources to gain a competitive advantage (Varadarajan, 2023). I rejected the RBV theory for two reasons, its internal focus and because critics emphasized the lack of consistent measures in the pursuit of competitive advantage (Almada & Borges, 2018).

The European Renewable Energy Climate

The 2015 Paris Agreement, signed by 174 countries and the European Union in April 2016, was the first to unite most of the globe's nations for a common cause (United Nations Framework Convention on Climate Change, 2015, 2016). By accelerating investment and intensifying actions, the agreement's goal was to combat climate change by reducing global carbon emissions (Leggett, 2019). Through collective agreement, the parties committed to holding greenhouse gas (GHG) induced emissions to almost net zero by the second half of the 21st century (Leggett, 2019). To get to net zero, the GHG-induced increase in global temperature must hold below 2°C. Each party pledged to reduce their GHG emissions under a fair distribution effort. For example, before the United States withdrew from the agreement, the US pledged to reduce GHG emissions to

26-28% below the 2005 levels in 2025. Similarly, the European Union pledged to reduce GHG emissions by at least 40% compared to 1990 (Leggett, 2019).

The 2015 agreement made renewable energy generation a priority for most participants to meet the 2℃ goal; most participants have invested in natural energy resources that do not deplete; this includes energy sources from wind, solar, wave, geothermal, and water. Foundational to the Paris Agreement is the concept that developed countries financially help undeveloped countries in the global effort (Zhang et al., 2017).

The withdrawal of the United States from the agreement in 2017 undermined the agreement's universality, set a bad precedent for global climate cooperation, and made it hard for developing countries to mitigate climate change due to a reduced funding pool (Zhang et al., 2017). Some scholars believe that the U.S.'s actions could cost the world a window of opportunity to mitigate climate change. The remaining participants are left to burden the efforts while the U.S. gets a free ride (Zhang et al., 2017). As a result, scholars believe that China will strengthen its position as a clean energy movement leader and retain its dominance in the renewable markets (Lacal-Arántegui, 2019; Zhang et al., 2017).

The Offshore Wind Industry

Despite the withdrawal of the U.S. from the Paris Agreement, the European Union's leaders aggressively targeted their Paris Agreement goals. In 2015, Offshore wind installed capacity in Europe contributed 5% to the total renewable energy generated that year (Lande-Sudall et al., 2019). Between 2015 and 2019, offshore installed capacity in Europe increased by 100% to 22,072 MWhs (WindEurope, 2020). Built as a demonstration project, the Danes constructed the first offshore wind farm in 1991 in Vindeby, Denmark. The Vindeby offshore wind farm consisted of 11 400-450 KW wind turbines for a total of 5 MW (Topham, Gonzalez, et al., 2019). Since then, the United Kingdom, Germany, and Denmark have embraced offshore wind technology. In 2019, these countries led offshore wind generation in Europe, contributing 45%, 35%, and 8% of installed capacity, respectively (Aldersey-Williams et al., 2019; WindEurope, 2020). On January 20, 2021, on his first day in office, President Biden signed the instrument to bring the United States back into the Paris Agreement (Blinken, 2021)

One of the determining factors for governments when selecting the most appropriate form of energy for their energy portfolios is the LCOE. The LCOE is the cost over the lifetime output. The LCOE allows governments and investors to compare the lifetime costs of renewable and fossil fuel energy sources (U.S. Energy Information Administration, 2020). However, many assumptions are made in calculating the LCOE of a project. Factors include federal tax credits, integration costs, air pollution costs, social costs of carbon, and other additive mechanisms that practitioners do not consistently apply across all energy sources. In 2022, the LCOE of a new offshore wind project was $105.38 per MW USD and $136.51 per MW USD without the federal tax credit. That same year, the LCOE of a new coal plant was $82.61 per MW USD and $101.25 per MW USD depending on the assumptions underlying the calculation of the formula; the latter incorporated additional mechanisms, such as air pollution, water pollution, land use, and environmental impacts (Aldersey-Williams & Rubert, 2019; U.S. Energy Information Administration, 2022).

Historically, the LCOE of an offshore wind facility per MW USD was high (International Renewable Energy Agency [IRENA], 2018). Even with subsidies or other tax incentives, companies offering offshore wind struggle to compete with companies offering other energy resources. However, the LCOE of offshore wind is declining as technologies improve, the rate of learning increases, the industry matures, and economies of scale develop across the value chain (Aldersey-Williams et al., 2019; IRENA, 2018; Musial et al., 2019). For offshore wind to be more competitive in the future, the LCOE needs to decline.

There are five stages in the life cycle of an offshore wind farm (Jiang, 2021). The first phase is the predevelopment and consenting stage, followed by the production and acquisition phase. If the project is viable after steps one and two, the project will move to the installation and commissioning phase. Once constructed, the ownership and operation of the offshore wind farm move from the developer to the “off-taker.” This fourth phase is the O&M phase of the life cycle. The cycle concludes with the decommissioning and disposal phase (Jiang, 2021). At each phase, there are opportunities for offshore wind leaders to reduce the LCOE of their plants. The challenge for the offshore industry is optimizing costs over the wind farm’s life cycle.

At each stage of the offshore wind farm cycle, offshore wind farm leaders have unique opportunities to apply the LSS strategies framed by the McKinsey 7-S model to reduce costs. Inputs into the LCOE calculation vary from stage to stage. Most offshore wind leaders capitalize on their development costs between the predevelopment and commissioning stages (CAPEX). The extent to which offshore wind leaders can minimize CAPEX depends on the design, structure, engineering, and wind farm placement (Bhattacharya, 2019). Variables such as seabed depth, turbine, substructure type, cables, project design, wind farm capacity, and distance from shore can significantly impact the LCOE of a project (Ennis & Griffith, 2018).

Offshore wind farm predevelopment activities begin approximately 5 years before the installation phase (Shafiee et al., 2016). The outcome of the predevelopment phase is to determine technical and economic feasibility. During this phase, an offshore wind project manager would conduct geographical and bathymetric surveys, perform meteorological mast and wind monitoring, create engineering designs, undertake construction management, and incur insurance and finance costs (Jiang, 2021).

A successful project requires public acceptance (Virtanen et al., 2022). The onshore wind industry faces challenges such as blade and turbine noise, the not-in-my-backyard (NIMBY) syndrome, excessive land use, animal habitat loss, and bird and bat mortality (Solman et al., 2021). The offshore wind industry has similar challenges; marine life habitat loss, marine response to turbine noise, interruption of migration patterns, bird collision risk, and mortality (Baulaz et al., 2023). Therefore, during the consenting phase, the program manager, through public relations and marketing, must obtain the necessary licenses and perform activities to ensure public approval, such as conducting environmental impact assessment studies (Gonzalez-Rodriguez, 2017).

In the pursuit of community and customer acceptance, offshore wind leaders deploy strategies to provide employment opportunities, tax benefits, infrastructure construction, and procurement opportunities within local communities (Alam et al., 2023). Increasingly, many offshore wind developers employ benefit-sharing programs through specific community investments that transfer directly to the local community. By including the public in these projects, offshore wind leaders can listen to the customer's voice and create long-term sustainable ventures and social acceptance (Virtanen et al., 2022).

During the production and acquisition phase, the program manager ensures the procurement of the foundations, the substructures, power transmission systems, the Supervisory Control and Data Acquisition (SCADA) monitoring systems, and the turbines (Jiang, 2021). Wind farm design, turbine capacity, and substructure type can significantly impact the LCOE of a project (Vieira et al., 2019). As the farms are *en situ* further and further from shore, the distance adds to cabling costs, transmission losses, and inefficiencies in O&M. The ease of access to onshore services and support facilities will determine how the O&M team completes its maintenance and repair planning.

In the offshore wind industry, due to the lack of offshore wind-specific expertise, the limited sources of supply have led to vertical integration of the supply chain (D'Amico et al., 2017). Furthermore, suppliers have controlled outsourcing components to preserve intellectual property (Sovacool & Enevoldsen, 2015). Logistical operators, such as port operators, installers, and vessel suppliers, are also limited in offshore wind farm assembly, installation, and commissioning. Resource restrictions or availability problems cause bottlenecks (D'Amico et al., 2017; Sovacool & Enevoldsen, 2015). Disruption in the supply chain leads to costly delays in construction and commissioning.

Offshore wind project procurement requires careful coordination between vendors, transporters, and installers (D’Amico et al., 2017). Once procured, the installation of the plant and commissioning activities can commence. Opportunities to minimize the LCOE of a project vary on the structure and the turbine type selected (Van Buren & Muskulus, 2012; Van de Kaa et al., 2020). The two main types of installation are bottom-fixed or floating platforms, and the two main types of wind turbines are the direct drive turbine and the gearbox wind turbine (Díaz et al., 2022; Van de Kaa et al., 2020).

Bottom-fixed installations are attached directly to the seabed, while mooring systems anchor floating structures (Díaz et al., 2022). Floating installations allow the construction and O&M teams to perform most construction or significant repairs onshore at a service and support facility. Whereas with the bottom-fixed platform, all major building repairs must happen at sea. The installation choice affects the project's construction and O&M phases, as does the turbine selection (Kausche et al., 2018). Turbine selection can significantly influence where a project incurs costs in its lifecycle. Recent developments in direct drive turbine technology could substantially reduce O&M costs. Experts argue that direct drive turbines have a more significant potential for technological advancement than their gearbox counterparts due to lower weight and fewer potential for gearbox losses, thereby making them more efficient (Van de Kaa et al., 2020).

Once commissioned, or even before commissioning, the O&M phase of the offshore wind farm lifecycle begins. The owner may choose to operate and maintain the farm themselves. Alternatively, the owner could hire a third-party manager to perform asset management and repairs, and maintenance functions (Sovacool & Enevoldsen, 2015). Part of the O&M ramp-up period requires the offshore wind leader to employ talented managers, engineers, technicians, and support staff for the project to function. The structure, systems, and staff must be in place for the farm to operate efficiently. The offshore wind leader must strategically minimize failures while maximizing the availability of maintenance crews, spare parts, and vessels. The offshore wind leader must have systems in place to be reliably informed about the weather and other external factors. They must deploy the highest production maintenance strategy. Depending on the type of off-taker agreement, the offshore wind leader needs to understand the economic parameters, such as the electricity process and subsidies that impact the electricity generation of their offshore wind farm (Seyr & Muskulus, 2019).

An offshore wind farm typically has a designed lifetime of 20 to 25 years (Topham & McMillan, 2017). At the end of a wind farm's lifecycle, an offshore wind owner is responsible for disposing of the asset. This last phase is the decommissioning and recycling phase. The decommissioning phase is the installation phase in reverse without damaging the environment from the removal. At the end of the decommissioning phase, the project ceases operations and returns the environment to its original state before the project was deployed (Topham, McMillan, et al., 2019). All the turbines, towers, blades, platforms, substations, cables, foundations, other components, and any onshore support and service facilities are removed and recycled as much as possible (Topham & McMillan, 2017).

Repowering strategies allow offshore wind leaders to reduce the future CAPEX expenses of the new offshore wind farm. Decommissioning costs can be significantly high, and some offshore wind leaders choose to extend the project’s useful life by repowering the wind farm (Topham, McMillan, et al., 2019). By repowering an offshore farm, the components are removed and replaced with more powerful wind turbines while keeping most electrical systems with longer expected asset lives (Topham & McMillan, 2017). For example, the estimated lifetime of a gravity-based foundation is 100 years, while the estimated lifetime of an electrical system is 40 years (Topham, McMillan, et al., 2019).

Offshore Wind Leaders’ Operations and Maintenance Strategies

Operating expenses (OPEX) contribute between 17% to 33% of an offshore wind farm’s LCOE (Stock-Williams & Swamy, 2019). Some maintenance strategies used by offshore wind farm leaders are similar to those used by their onshore counterparts and can significantly reduce wind turbine costs (Shafiee & Sørensen, 2019). The purpose of a maintenance strategy is to retain or restore an asset to perform optimally (Shafiee & Sørensen, 2019). Every offshore wind leader must consider accessibility, reliability, weather, lost power production, potential damage, scheduling inspections and repairs, and formulate technician and transport strategies when selecting the most effective method for their site (Raknes et al., 2017).

The level of risk that an offshore wind farm owner is willing to accept dictates how that leader will mitigate that risk through maintenance strategies. Under a risk-based maintenance strategy, offshore wind leaders balance the cost of maintaining an asset versus the opportunity cost of lost revenues. Specific maintenance strategies include calendar-based preventive maintenance, predictive or conditioned-based maintenance, and unplanned corrective and reactive maintenance (Shafiee & Sørensen, 2019).

A calendar-based preventive maintenance strategy follows a predetermined set of tasks over preset periods. The risk of calendar-based preventive maintenance strategies is that the offshore wind leader risks the possibility of unplanned corrective maintenance occurring between the cycles. Unplanned maintenance is costly (Asgarpour & Sørensen, 2018). Under condition-based maintenance scenarios, the offshore wind leader relies on predicting component failure rates before they occur. The reliability of each wind turbine component requires state-of-the-art fault detection condition monitoring. When a fault occurs, the asset fails to perform at its optimal capacity, which reduces revenues (Asgarpour & Sørensen, 2018). Some tools used by leaders include vibration sensors, hydraulic oil and temperature sensors, oil analysis, inspections, modeling, and monitoring (Asgarpour & Sørensen, 2018). Using reliability and performance measurements, the offshore wind leader can use technology and data integration to perform component tracking (Shafiee & Sørensen, 2019). For an offshore wind leader to achieve ideal performance and profits, offshore wind O&M services must be optimized effectively.

A significant difference between offshore and onshore wind maintenance is an offshore wind leader's economic dependence on support vessels to deploy their chosen strategy. Vessel chartering makes up 70% of total O&M costs for an offshore wind farm (Stålhane et al., 2017). With onshore wind, the crews must travel across well-marked terrain with the support of a maintenance vehicle. In the maritime environment, the offshore wind leader depends on the availability of marine vessels suitable for shuttling parts and technicians to and from the asset to shore. The time between chartering a jack-up vessel and availability can be months, leading to production delays and lost revenues (Stålhane et al., 2017).

Understanding the environmental conditions is critical in the marine environment in selecting the suitable supporting vessel, as does the maintenance crew's size, the scheduled travel time, and chosen maintenance strategy. Occasionally, some technician crews reside on vessels for 2 to 3 weeks at a time. The type of chosen vessel will impact work shift organization, spare part stock management, and technical support (Gonzalez-Rodriguez, 2017). Finally, the offshore wind farm design and structure also influence the O&M strategy (Kausche et al., 2018).

As offshore wind farms become further from shore, the turbines become more powerful, and the number of turbines deployed grows. Researchers performing skills gap analyses predict that the need for O&M services will rise through 2030 (Swift et al., 2019). The Global Wind Energy Organisation (GWO) estimated that per MW for each project, an offshore wind leader needs approximately two and a half industry-standard trained workers (Lee et al., 2020). The offshore wind environment is traumatic, hazardous, and challenging for employees (Virtanen et al., 2022). GWO expects offshore wind leaders to know and understand the specialized health and safety regulations unique to the industry as a leader in health and safety regulations. Furthermore, GWO expects all employees to undergo extensive annual training to adhere to those regulations (Mette et al., 2018).

As with vessel management, how offshore wind farm leaders manage their labor force depends on the type of platform design, size of the turbine, distance from shore, and maintenance strategy (Gonzalez-Rodriguez, 2017). Aside from logistical challenges, leaders must understand the ability of technicians to work under severe conditions safely. The working conditions offshore are not the same as for onshore wind. Physical demands and stressors, adverse working environments, employees' general health, and propensity to motion sickness are much higher for maritime employees than onshore employees (Scheu et al., 2018). Offshore wind leaders need to balance employees' welfare against the profitability of offshore wind farms; this will influence which strategies those leaders deploy.

The COVID-19 pandemic added complexity to offshore wind farm leaders' deployment of effective strategies. In 2020, the COVID–19 virus showed how fragile global economies could be. The pandemic caused unprecedented economic and social challenges (Global Wind Energy Council, 2020). Governments and businesses worldwide struggled to balance uprisings and safety for their citizens. Pre-COVID-19, wind as an energy resource became competitive globally (Hosseini, 2020). Post-COVID-19, the industry must lobby for carbon pricing initiatives to compete with fossil fuels (Global Wind Energy Council, 2020). The influence on the energy markets and regulation changes may influence offshore wind leaders' strategic decisions.

Global governments consider electricity generation an essential public service and believe renewable energy can achieve sustainable economic recovery (Global Wind Energy Council, 2020). However, with lower fossil fuel prices, decreased budgets, and disruptions in the supply chain, many generating facilities and facilities under construction experienced temporary interruptions post-COVID-19. Solar power plant installations were most significantly impacted, as China and East Asia manufacture most solar panels, connectors, modules, and cells (Hosseini, 2020). In the United States, wind industry lobbyists pushed for extending the production tax credit set to expire at the end of 2020. In May 2020, due to COVID-19, the lobbyists convinced Congress to extend the credit one more year, making the COVID-19 impact on the wind industry less significant (U.S. Internal Revenue Service, 2020).

However, the COVID–19 pandemic highlighted areas of concern for the wind industry; in particular, employees working in close-quartered environments are more susceptible to contracting the COVID-19 virus than employees who can keep apart (Centers for Disease Control and Prevention, 2020). In the offshore wind industry, segregation from others is not possible. Employees must travel to and from maritime vessels to the turbine sites to efficiently maintain and operate the assets. Offshore wind leaders must develop strategies to safely protect their employees in the boats’ confined workspaces and the turbines.

The risk of lost revenue has prompted some innovative leaders to partner with other industries to take advantage of the artificially created habitats to support crab, lobster, and mussel farming (Roach et al., 2018). An offshore wind farm leader must maximize revenue and reduce costs to maximize profitability. To provide customer value, offshore wind leaders must balance maintenance postponements and their effect on income, weather delays, supply shortages, customer requests, or mitigate unsafe working conditions. O&M offshore wind leaders often reconcile between an asset manager's need to show short-term generation profits and the need to plan around long lead times for critical repairs.

Transition

The 2021–2022 global energy crisis is among the most significant in a series of cyclical energy shortages experienced since 1970. it is more important than ever for offshore wind leaders to ensure the safety and efficiency of their entrusted assets. In section one, I discussed the specific business problem that some offshore wind farm leaders lack strategies to manage their O&M costs. I presented the purpose statement, the nature of the problem, and specific interview questions that I can ask my participants to understand what strategies offshore wind leaders use to manage O&M costs. I explored the McKinsey 7-S and the LSS frameworks as strategies for offshore wind leaders in my literature review. I then expanded on the offshore wind industry and presented specific challenges that the industry at its leaders face when minimizing costs and maximizing safety.

In section two, I discuss the role of the researcher, participant qualifying criteria, the research design method, and population and sampling. I also discuss the ethical considerations which impact the research method and design, data collection techniques, and data organization. Finally, in section two, I discuss how I will achieve reliability and validity in my study. In section three, I present my findings, recommendations, implications for social change, and conclusions.

Section 2: The Project

Purpose Statement

The purpose of this qualitative multiple case study was to explore the strategies offshore wind farm leaders use to manage O&M costs. The targeted population consisted of six offshore wind leaders who have implemented strategies that successfully manage O&M costs for offshore wind farms located in Europe. The implications for positive social change include the potential to provide local communities with the environmental and economic benefits of offshore wind energy, leading to both direct and indirect economic growth for benefiting citizens and families.

Role of the Researcher

In qualitative research, the researcher is the primary data collection instrument (Houghton et al., 2013; Merrian & Tisdell, 2016). A researcher must comply with all ethical research standards and ensure that all participants are treated respectfully. Fouka and Mantzorou (2011) emphasized that the researcher's responsibility is to protect the participants' liberty and values and prevent human exploitation. It is the responsibility of the researcher to retain the anonymity of the participants, when applicable, and maintain participant confidentiality. I ensured that all participants provided informed consent, that participation was voluntary, and the participants understood the purpose of the research. All participants could withdraw from the study at any time without consequences.

Researchers must have a questioning stance to work and life, a high tolerance for ambiguity, and a capacity for careful observation to think inductively and deductively (Merrian & Tisdell, 2016). In qualitative research, the research process is inductive. In an inductive process, the researcher gathers data to build concepts, theories, or hypotheses. As the research instrument, the researcher automatically influences the study's data quality (Houghton et al., 2013). Bias is inherent in all research. The researcher's responsibility is to identify those biases, mitigate them when possible, and document and explain how those biases impact the study. A researcher's bias can affect the outcome of the study directly through the act of researching. When a researcher distinguishes and monitors biases, an informed reader can draw their conclusions (Merrian & Tisdell, 2016).

I chose the offshore wind industry as it is an emerging industry in the United States, and I wanted to know more about it. I am most familiar with O&M strategies for grid-scale onshore wind and solar farms. I have worked in the renewable energy industry since 2005. I have worked solely for a United States-based renewable energy subsidiary of a globally recognized utility company during that time. The company is responsible for developing, generating, and operating renewable energy resources. As a proponent of renewable technologies, I was fortunate to enter the United States renewable energy industry at its initial growth stage. I have watched the company grow and become profitable over that period. Throughout my tenure, I have prepared audited financial statements, created new departments, established corporate policies to strengthen internal controls, and helped to design and implement the company's ERP system. I help employees develop leadership skills and expand their knowledge of the industry in my current role.

The targeted population for this study consisted of O&M leaders who had operated wind farms located in Europe. Potential participants must have supervised or managed a European offshore wind farm for a minimum of 2 years. As a globally recognized renewable energy company employee, I have developed a network of O&M leaders in grid-scale onshore wind and solar maintenance practices, but not offshore wind. In December 2018, my employer formed a joint venture with another energy company to build and operate an offshore wind farm in the United States. I am aware of this arrangement, but I am not involved with this venture.

Consequently, to mitigate participant bias, I contacted acquaintances in Europe and the United States to solicit participants who met my study criteria. I am not involved, nor do I influence decisions made in Europe. There was a possibility a participant may also work at my company. I interviewed participants to understand strategies that reduce costs in the offshore wind industry. I was responsible for ensuring I met all the ethical standards and moral values prescribed by the Belmont Report and Walden University’s Institutional Review Board. As my participants were not deemed vulnerable, I did not foresee the level of care given not to harm as high as for the nurses mentioned by Fouka and Mantzorou (2011). However, I did need to ensure the confidentiality of the participants. The industry is highly competitive, and my participants must trust the intent of my research to receive unbiased answers.

I interviewed my participants via the Internet and the videoconferencing platform GoToMeeting. Initially, I planned to use video conferencing to record my participants’ responses and reactions to the questions. However, due to privacy laws, I recorded my participants with audio only and transcribed the interviews using the transcribing tool within GoToMeeting. I believed face-to-face in-person interviews were impossible due to the logistics and expense of conducting an hour-long interview from California to Europe. However, as a renewable energy employee, I was able to visit an O&M facility in Europe later in the year. I conducted my interviews using the video conferencing tool GoToMeeting. I intended to back up the GoToMeeting video recordings with Snagit to ensure a quality recording. However, Snagit is also a video recording software, and therefore, I could not use it. I relied on my notes, the transcripts, and the voice recording produced by the GoToMeeting recording application for my source data. I transcribed the data captured via the GoToMeeting platform using the GoToMeeting transcription tool application. I validated each transcription manually and documented discrepancies to mitigate material and personal bias and ensure accuracy and completeness. I interviewed six participants via GoToMeeting.

To ensure consistency between each participant’s interview, I used interview protocols with established questions and procedures as defined in Appendix B. An interview protocol is a script that guides the interviewer through the interview process (Jacob & Furgerson, 2012). I recorded all interviews once I received informed consent from the participants (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). I took notes during the interview and observed any hesitancy in the participants’ willingness to be recorded. I invited 152 candidates to participate in my study. Of the 152 candidates, I invited 146 candidates via the Linkedin platform and asked six candidates directly through email, in addition to directly inviting candidates through the mail message system on LinkedIn. Of those invited through LinkedIn, I received three acceptances. However, one participant later withdrew as they did not feel qualified, and three individuals helped recruit others but did not themselves participate. Of the email requests, I received three acceptances. I also requested that I connect with the individuals on the platform. Of all the individuals who accepted my connection request, one volunteered to be part of my study. I documented all outliers in my study results so readers can draw their own conclusions.

After I validated the transcripts, I examined the data for patterns, insights, and concepts to define an initial set of codes (Yin, 2018). Once I had manually coded each sentence in the data, I used the computer software Atlas.ti for the emergence of additional themes. I uploaded the files into the qualitative data analysis and research software and documented the reasons for defining the initial codes and subsequent codes that emerged from the software analysis (Yin, 2018). I drew my conclusions from the findings.

Participants

The participants and the researcher must form a partnership of trust and cooperation (Kingsley et al., 2010). The risk of participant disengagement was a concern for my research due to the logistics and time differences between myself and the participant pool, as noted by Yu et al. (2020). Therefore, I used purposive sampling to understand what strategies offshore wind farm leaders used to manage O&M costs, minimize disengagement, and maximize trust and cooperation. Purposive sampling is a non-probability sampling technique where participants are selected based on the characteristics of a population and the objective of the study (Etikan, 2016). My participants had to be associated with an offshore wind farm's O&M function for at least 2 of the last 5 years. Additionally, they had to have had a relationship with a European operating offshore wind farm, not an offshore wind farm under construction. The participants had to be individuals who had the authority to make significant decisions related to an offshore wind farm and were responsible for ensuring that the wind farm was operating at its optimal capacity.

I used purposive sampling to enroll my participants based on their LinkedIn profiles. I sought participants by performing a keyword search through the social platform LinkedIn to ensure that the pool of participants were qualified for the study. The keywords I used were *asset manager*, *chief, controller, director, England, Europe, foreman, forewoman, head of, lead, maintenance, manager, operations, operations and maintenance, operations manager, offshore, supervisor, UK,* and *wind.* I contacted the participants through LinkedIn mail. I sent them the invitation in the communication (see Appendix A) and the informed consent form. In the invitation, I asked the participants if I could contact them directly using my Walden University email, and all participants said "yes."

I also sought participants by contacting trade associations such as the European Wind Energy Association and my colleagues in Europe and the United States. I contacted these candidates through introductions from colleagues or direct email contact, and three participants accepted. As with the LinkedIn pool of candidates, I sent an invitation to participate (see Appendix A) and an informed consent form.

I maintained a participant journal for both population sources to document the date I contacted a candidate, their responses, and if they declined or accepted the invitation. I logged their names, company, and years of experience in the journal. I assigned each candidate a number and then a participant number to the candidate once the candidate returned the informed consent form. After that, I referred to each participant by that number. I did this to preserve the participants' integrity. I have stored the participant journal and the balance of the study separately.

I ensured my participants were protected by following the Belmont Report's principles by maintaining respect for persons, beneficence, and fairness throughout my study (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). To maintain participant trust, I demonstrated transparency with each participant regarding their privacy during and after publication, as Høyland et al. (2015) recommended. Since I did not pay my participants to participate, I ensured I followed the protocols described in Appendix B and Appendix C precisely. Once the participant agreed to partake in my study, I established a common ground. I expressed sincere gratitude for their time and determined the best communication protocols. I provided the background and details of my study and reminded them that they could withdraw at any time.

Research Method and Design

Research Method

Three research methods are available for scholarly studies: qualitative, quantitative, and mixed methods (Yin, 2018). Qualitative researchers seek to gain insight and an understanding of a phenomenon through narrative data collection. The qualitative method is process-oriented, non-numerical, and flexible (Caggiano & Weber, 2023). Deriving generalizations about the population from a qualitative sample is not straightforward. Qualitative researchers use data-gathering techniques, including open-ended questions, field notes, narratives, semistructured interviews, and observation (Yin, 2018).

Quantitative researchers use controlled, numerical data to understand the phenomenon under study. Using closed-ended questions and highly structured, representative sampling, objective, numerical, and measurable techniques, quantitative researchers test hypotheses about relationships between variables (Brunsdon, 2018; Story & Tait, 2019). Researchers use the quantitative method to make statistical generalizations about the population (Yin, 2018). The quantitative method was not in accord with this study.

The mixed methods method integrates the qualitative and quantitative research methods (Timans et al., 2019). Mixed methods researchers incorporate multiple theories and perspectives into the study. Using mixed methods, a researcher can draw on the strengths of both qualitative and quantitative methods (National Institutes of Health Office of Behavioral and Social Sciences, 2018).

Yin (2018) posited that the qualitative method provides the most in-depth understanding of narrative data. I selected the qualitative method to draw in-depth meaning from the research question by asking open-ended questions to understand the phenomenon. Quantitative researchers ask closed-ended questions and test hypotheses.

Therefore, the quantitative and the mixed-methods approaches are unsuitable for drawing conclusions for this study's research question.

Research Design

Research design links the research question to the data collected and analyzed (Yin, 2018). I considered four qualitative research designs for my qualitative study: (a) case study, (b) phenomenological, (c) ethnographic, and (d) narrative. I chose the case study design because it provides a thick, rich description of the phenomenon under study and identifies and explains the "what," "how," and "why" of a social phenomenon or issue bounded by space or time (Boblin et al., 2013; Yazan, 2015; Yin, 2018). The type of case study depends on the size of the bounded case and the intent of the study (Boblin et al., 2013). A researcher can choose from single or multiple case designs within the case study design. I chose a multiple-case design. The multiple-case design allowed me to analyze data types and collection sources within and among cases and provided greater data saturation (Yin, 2018).

According to researchers, there is no case study design template that novice researchers can follow (Yazan, 2015). Yin, Merrian, and Stake have proposed various case study designs, from the most restrictive to the most flexible (Yazan, 2015). I followed Yin's five-component design, the most restrictive, for my multiple case study (Yin, 2018). Unlike Stake's approach, Yin (2018) recommended that the researcher plan and design the study before data collection can begin. Under Yin's method, the researcher remains detached, neutral, and independent of the research, limiting researcher bias (Boblin et al., 2013).

Before choosing the multiple case study design for my research, I explored other qualitative designs. The phenomenological design was not suitable, as this design is for researchers who want to gain insight into a phenomenon through people's recollections and interpretation of the meanings of participants' lived experiences with phenomena (Moustakas, 1994). Neither was the ethnographic design relevant because it allows researchers to explore the social or cultural behaviors, attitudes, and beliefs of groups or communities (Lau et al., 2022). Finally, the narrative design was inappropriate, as narrative scholars tell the personal stories of participants' individual experiences (Smith & Monforte, 2020). Since I sought to identify, contrast, and compare different organizational situations, neither the phenomenological, ethnographic, nor narrative designs are appropriate for this study.

Data saturation occurs when adding new information requires no new themes or codes and would provide enough information that a qualified researcher could replicate the study and obtain similar results. When the data becomes thick and rich, the data saturation point occurs. The data saturation point differs for every study design (Fusch & Ness, 2015). It is through triangulation that I obtained data saturation. Triangulation uses multiple methods or data sources to understand the phenomenon under study (Campbell et al., 2020). There is a direct link between triangulation and data saturation (Fusch & Ness, 2015). However, there is a risk that the case study design may not link the collected data to the prescribed criteria for interpreting the findings (Yazan, 2015; Yin, 2018). I documented the results using a data saturation grid as recommended by Fusch and Ness (2015). If additional topics were to appear after six participant interviews, I would have expanded the participant pool to obtain data saturation. I reached data saturation with six participants.

Population and Sampling (Qualitative Only)

In a quantitative design, the researcher can make inferences about the population using probability sampling techniques and obtaining statistical generalization (Berndt, 2020; Bhardwaj, 2019; Merrian & Tisdell, 2016). Statistical generalization is unavailable to the qualitative researcher because a case study or studies are too few to be considered an adequate sampling unit (Yin, 2018). Instead, through duplication, qualitative researchers can obtain analytical generalization through nonprobability sampling and by relating their findings to theory, a theoretical construct, or a sequence of events and transferring those constructs to a similar set of circumstances to get the same result (Merrian & Tisdell, 2016; Yin, 2018).

Nonprobability sampling techniques are appropriate when the researcher does not want to answer questions like how much and how often but wants to understand what occurred (Merrian & Tisdell, 2016). Types of nonprobability sampling include purposeful sampling, quota sampling, convenience, and consecutive sampling. When a researcher chooses purposeful sampling as their sampling technique, the researcher assumes that the researcher wants to discover, understand, and gain as much insight as possible about the phenomenon under study. They must be prudent in their sample selection to learn the most about the phenomenon (Merrian & Tisdell, 2016).

I chose to use the purposeful sample technique for my study. Quota sampling is a semi-purposive sampling technique that requires a full understanding of, and access to, the entire population (Berndt, 2020). The number of offshore wind leaders is finite. Still, the total population is unknown, so quota sampling was inappropriate. Neither was convenience sampling appropriate, as convenience sampling may not provide the desired saturation level within a reasonable time frame (Brewis, 2014). Consecutive sampling is convenience sampling until saturation is obtained (Thewes et al., 2018).

Since I had a finite length of time to complete my study, purposeful sampling was the most appropriate technique. The researcher must first decide upon the inclusion criteria to create a purposeful sample. For my research, the participants must have had experience for at least 2 of the last 5 years running an offshore wind farm’s O&M function in Europe to participate. Additionally, they must have had the authority and responsibility to make significant decisions to ensure the wind farm operated optimally.

Data saturation occurs when the researcher recognizes that they have heard themes in multiple prior interviews (Fusch & Ness, 2015). Critics often criticize qualitative researchers for not justifying their sample size decisions (Boddy, 2016). Since qualitative researchers do not base their sample sizes on statistical generalizations, they must decide their study’s optimal sample size. Two cases may be enough; however, scholars warn of the shaman effect, where a specialist in a field can overshadow the results (Fusch & Ness, 2015). I selected six participants from LinkedIn, my professional association, and my contacts using the purposive sampling method for my study. I met the criterion for choosing a sample size when data saturation occurred. Sample data saturation occurred when each participant could no longer provide new insight into the research question (National Institutes of Health Office of Behavioral and Social Sciences, 2018). Had data saturation not occurred after six participants, I would have continued to pull candidates from the population using the purposive method until I reached data saturation (Gibbs et al., 2007). I achieved data saturation with six participants.

Ethical Research

Since the researcher is the primary research instrument in qualitative research, the study's validity, reliability, credibility, trustworthiness, and ethics depend heavily on the researcher (Merrian & Tisdell, 2016). Ethically, the researcher's responsibility is to protect the participant's liberty and values and prevent human exploitation (Fouka & Mantzorou, 2011). However, researchers have taken advantage of vulnerable participants throughout history, such as children, prisoners, individuals with impaired decision-making capacity, and economically disadvantaged individuals. For this reason, in 1979, the United States government created the Belmont Report to establish ethical research principles for using human subjects (participants) in research (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

There are three fundamental research principles framed in the Belmont report. These are respect for persons, beneficence, and justice. Out of respect for persons, the researcher must protect all persons' autonomy, treat all participants with courtesy and respect, and always obtain informed consent or assent from each participant before gathering data (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979). The researcher must document every participant's informed consent form and acceptance. An informed consent form must describe the research intent, participant selection criteria, research procedures, provisions that protect the participants’ privacy, incentives for participation, and the study’s volunteerism aspects (Koonrungsesomboon et al., 2016). The informed consent form for my study is in Appendix B. The Belmont Report requires researchers to ”do no harm,” to comply, I included a statement in the informed consent form that the participant could rescind consent from the study at any time, and I defined those withdrawal steps (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1979).

I complied with these requirements in the informed consent form in Appendix B, stating that the study is voluntary and there is no compensation for participation. A characteristic of my research is that my participants reside in a foreign country. I anticipated that there might be video conferencing phone charges that the participants may incur to participate in the interviews. To “do no harm,” I provided a toll-free phone number within the GoToMeeting invite so that participants may call without incurring any charges if not on the web.

To ensure the participants’ privacy, I assigned each participant a numeric identifier, which I used to identify the participants’ responses to the interview questions. I stored all participant details separately from the case study database to retain the participants’ confidentiality. I kept any electronic data on my password-protected computer and backed it up regularly on a password-protected external hard drive. I locked all physical data and the external hard drive in a file cabinet in my home office. I am the only person with access to the file cabinet. Upon approval of my study, I received Walden University’s Institutional Review Board’s approval number 04-28-21-0758566. I will store the information for 5 years. At the end of the 5 years, I will shred, erase, and destroy all physical and electronic records.

Data Collection Instruments

There are six types of data collection instruments in case study research; documentation, archival records, interviews, participant observation, direct observation, and physical artifacts (Yin, 2018). I considered all of these data collection instruments in the design of my study. For research to be reliable and valid, the researcher should seek saturation and triangulation (Fusch & Ness, 2015). My chosen data collection instruments needed flexibility and resilience to achieve these goals.

First, I considered the documentation and the archival record data collection instruments. These data collection instruments offer researchers an unobtrusive view of the case context without interference from the researcher. Documentation and archival records are good sources of information when access and privacy are not an issue (Yin, 2018). However, both these data collection types were limited to me, I was logistically distanced from my participants, and access is a weakness of these data collection instruments (Yin, 2018). Since I had limited access to corporate documentation for my study, I used documentation readily available to the public, such as public financial statements, websites, and newspaper articles, to triangulate my findings.

The data collection instruments, direct and participant observation, can each provide immediate and meaningful feedback contextually. A strength of the observation techniques, direct and participant, is that the researcher can gain meaningful real-time data from their participants and their environments. However, these data collection instruments are time-consuming and require researchers to be passive or active observers (Yin, 2018). COVID-19 has limited the use of observation as a data collection instrument. I chose not to use participant observation as a primary data collection instrument because of logistical barriers and the need to protect my participants' health and safety, especially from the COVID-19 pandemic. Since I did not have the opportunity to observe the participants in their everyday settings, I used direct observation to the extent I could during the video-recorded semistructured interview. During the interviews, I noted the participant's behavior, facial expressions, and mannerisms. I reinforced my observations when I transcribed the interviews from the recordings. All my participants agreed to video conferencing.

In qualitative research, the researcher is the primary collection instrument (Houghton et al., 2013). As the primary data collection instrument, I conducted semistructured interviews to obtain data for my study. Interviews allow participants to tell their stories and expand on their human experiences (Jacob & Furgerson, 2012). Interview formats range from the structured interview, a rigidly formatted interview conducted in the same way for each participant, to the unstructured interview, which is more like an everyday conversation. A semistructured interview combines the structured and the unstructured interview formats (DiCicco-Bloom & Crabtree, 2006). In a semistructured interview, the researcher uses formal interview protocols and asks open-ended questions (DeJonckheere & Vaughn, 2019). Interview protocols allow the researcher to maintain homogeneity and consistency between interviews to reduce bias (Fusch & Ness, 2015).

I used semistructured interviews with open-ended questions as a data collection instrument, allowing participants to answer freely and openly. To ensure that I treated each participant the same, I used the interview protocol described in Appendix B. I interviewed each participant individually and not as part of a focus group. Researchers use focus groups to gain insight into a phenomenon in a social setting. I chose not to use a focus group to retain the participants' anonymity, maintain control over the interview process, and focus on the individual rather than the group. To achieve validity for my study, I used direct observation and documentation collected from public sources to support my findings from the semistructured interviews.

Data Collection Technique

Data collection is the process of collecting quality evidence that will credibly support or refute the research question. The researcher's goal with their data collection technique is to ascertain sufficient evidence to establish data reliability and credibility and achieve saturation (Smith, 2018). According to Yin (2018), there are four principles of data collection (a) to use multiple sources of evidence, (b) to create a case study database, (c) to maintain a chain of evidence, and (d) to exercise care when gathering data from social media. I incorporated these principles into my study in the following ways.

First, I considered how I would gather data from multiple sources of evidence. Yin (2018) recommended at least two sources of evidence. By extrapolating data from multiple sources, I ensured that I triangulated the data and increased my study's reliability, as suggested by Fusch and Ness (2015). I chose semistructured interviews, direct observation of the participants, and publicly available documentation in my study design for my data collection instruments. I collected my data using these collection instruments using the following techniques. I transcribed video-recorded semistructured interviews, member checked the data gathered with each participant, took notes, and documented any observations recorded during the interview process. Furthermore, I reviewed any publicly available documentation to support or refute my findings and provided a two- to three-page summary of my findings to each participant.

During the interviews, I presented myself professionally and conducted all the interviews at the same time of day, between 7 to 9 a.m. pacific standard time. I conducted my interviews online using videoconferencing and ensured my background was conservative and professional. I conducted each interview in a comfortable environment free from distraction. I conducted each interview using the interview protocols described in Appendix B and recorded each interview using the GoToMeeting platform tools. After each interview, I transcribed the recording and documented my observations, feelings, and emotions about the interview and participant. I described any biases that I experienced when interviewing the participant. Once transcribed, I ensured each interview’s credibility and accuracy by sending the transcription to the participant via email for a transcript review.

The transcript review process allows the participant to comment on the interview and correct the transcription if necessary. This process reinforces the relationship between the researcher and the participant, strengthening communication lines and opening avenues for future interactions. To ensure no undue stress fell upon the participant, I took care not to overburden them and provided notice in the informed consent form (see Appendix B) that they could withdraw at any time. I ensured that I correctly shared the transcript with the correct participant to ensure accuracy (Hagens et al., 2009).

I increased my research’s reliability and validity by following member checking protocols (see Appendix C). Member checking is a technique researchers use to provide credibility to their research. Member checking is the synthesis of the participants’ interviews, the findings, and the researcher's understanding of the interview outcome. In the member checking interview, the participant and the interviewer have an opportunity to clarify any misunderstandings, disclose any new revelations, and reduce the risk of the inclusion of researcher bias. Member checking can add time constraints for both the researcher and the participant (Birt et al., 2016). After the interview, the participant may regret the information disclosed and wish to withdraw from the study (Birt et al., 2016). As with the transcript review protocols, I reminded the participant that they could withdraw from the study at any time, as disclosed in the informed consent form (see Appendix B). Should they decline to participate in the member checking process but still wish to participate in the study, I will document the event in the case study database notes. In my study, ten individuals responded positively to my invitation to participate. I received seven acceptances, including one individual who later withdrew and one who contacted me voluntarily to participate. In all of the other positive responses, three individuals indicated they would be willing to help find participants but not participate themselves.

Yin’s fourth principle of data collection mandates I exercise due care while gathering data from social media and online sources (Yin, 2018). Therefore, for any data I collected from these sources, I asked who, what, when, where, and why the information is public and considered the motives behind the publication of the information (National Center for Complementary Health and Integrative Health, 2018). Finally, when available, I reviewed the participant’s public-facing websites and financial statements to validate the participant’s comments and triangulate my findings.

Data Organization Technique

Yin (2018) described four principles of data collection. I have discussed how I used multiple sources of evidence and exercised due care to collect evidence from online sources. The following sections include information on how I maintained a chain of evidence, created a case study database, and organized the database to strengthen my study’s credibility and reliability.

A case study database is a formalized collection of case study notes, recordings, documents, narratives, memos, and other evidence collected during fieldwork (Yin, 2018). Within the case study database, the researcher should catalog each piece of evidence, sourced, dated, and coded consistently so other informed researchers can follow and replicate the researcher’s conclusions (Yin, 2018). My case study database contains my notes and copies of referenced documents included in the manuscript. In the database, I stored a redacted participant journal, recordings, and transcripts of all the participant interviews, participant observation documentation, a saturation log, and a memo journal containing my thoughts, feelings, and personal biases. I also stored the analytical themes, codes, analysis, and research findings. I used the Atlas.ti software to organize these documents as it allowed me to code, annotate, record memos, and store files in a centralized location.

One consideration for my study was my participant's confidentiality; therefore, I stored the unredacted participant log in a password-protected Excel file. Each participant had a unique numerical code. This numerical code replaced the participants' names in the redacted participant log and other identifiable data, such as site location, email address, or gender. Upon completing the study, I will store the information for 5 years. At the end of the 5 years, I will shred, erase, and destroy all physical and electronic records.

Data Analysis

Data analysis involves taking the evidence and drawing insightful conclusions to help me answer the research question: What strategies do offshore wind farm leaders use to manage O&M costs? Data analysis makes key themes inherent in the data visible (Thomas, 2006). For data analysis to be credible, the researcher should ensure triangulation and saturation (Fusch et al., 2018; Fusch & Ness, 2015). Triangulation is the process of achieving research credibility through multiple sources, methods, theories, or new investigators to provide various measures of the same evidence. A researcher should use triangulation to focus on evidence analysis and critically reflect on the guiding questions to enhance the appropriateness and credibility of the research. Researchers can use four kinds of triangulation in qualitative research: methods triangulation, triangulation of sources, analyst's triangulation, and theory perspective triangulation (Campbell et al., 2020).

I chose to triangulate my research using multiple data sources and, within method triangulation, to explore the findings' consistency by examining data over different time frames, various sources, or other people's views within the same research method (Campbell et al., 2020). I did not select between-method triangulation, as this type of triangulation is most appropriate for mixed methods research, which by design supposes qualitative and quantitative methods (Bekhet & Zauszniewski, 2012). In my research design, I considered two theoretical frameworks, the McKinsey 7-S and the LSS frameworks combined, as illustrated in Figure 1. I explored these frameworks together to mitigate both weaknesses, furthering theoretical triangulation in my design. Finally, I did not choose analyst triangulation; as analyst, or investigator, triangulation requires multiple specialists to analyze the same data to mitigate bias (Fusch et al., 2018). As a doctoral student, this triangulation method is not available to me.

Since I triangulated my data from multiple sources, to achieve saturation, I needed to identify as many themes and concepts across the data until no new themes or concepts appeared (Fusch & Ness, 2015). My data analysis process incorporated procedures for identifying themes, concepts, and outliers. As part of my data collection technique, I digitally stored all the videos, transcripts, research articles, memos, publicly available archival records, and personal journals in a case study database in the qualitative data analysis software (QDAS) Atlas.ti. Using QDAS computer software to help researchers identify themes and data analysis is an accepted practice in qualitative research. A benefit of QDAS programs is that they allow the researcher to analyze the data using more complex coding schemes. However, a shortcoming of QDAS programs is that they can lull the researcher into a false sense of security, assuming that the “machine” will find all possible themes and codes (Woods et al., 2016).

In qualitative data analysis, researchers analyze the data in three steps. First, the researcher can apply open coding techniques to the collected data to search for possible concepts or themes. Relevant and irrelevant themes may emerge. When too many open coding descriptions exist, the researcher can become overwhelmed or confused, and the coding becomes meaningless. Throughout the open coding step, the researcher should consider the study’s topic and identify the core concepts related to that topic to prevent confusion and allow for more granular data analysis (Glaser, 2016). To minimize my dependence on the software to link the text, documents, and analysis intelligently, I created a word cloud to identify the modal words used in the interview transcripts and documents upon completing my fieldwork. I compared these “codes” with the codes I identified during my literature review. These codes include words such as *challenges, corrective maintenance, cost reduction, COVID-19, differences, electricity, environment, financing, government, incentives, labor, levelized cost of energy (LCOE), life cycle, Lean, Lean Six Sigma, maintenance cost, McKinsey 7-S, models, offshore, onshore, operation and maintenance, opportunities, predictive maintenance, preventive maintenance, revenue, Six Sigma, stakeholders, strategies, subsidies, supply chain, taxes, training, vessels, and weather*.

Once the researcher completes the open coding step, the next step is identifying connections between the codes and grouping them into families; this is axial coding. In the final step, the researcher further connects the families of codes and creates a story for interpretation; this is selective coding. Axial and selective coding can help the researcher identify connections between codes. When these three steps are complete, the researcher can help make sense of the data (Gläser & Laudel, 2013). As I performed the open coding step, I maintained awareness to look for similarities or differences. After openly coding the evidence, I created coding groups or families to clarify the data and refine the analysis. I then looked for stories to write up my findings. As previously noted, for data analysis to be credible, the researcher should ensure triangulation and saturation in the data (Fusch et al., 2018; Fusch & Ness, 2015). When no new themes became apparent, I reached saturation. In the next section, I discuss how I achieved reliability and validity in my study,

Reliability and Validity

For research to be meaningful, the data collected and the findings presented must be trustworthy and worthy of the reader's attention. In quantitative research, the researcher generates a hypothesis and designs their study so that the results are measurable, authentic, observable, and replicable. They do this to achieve reliability and validity (Fan, 2013). The rigor and richness of the results depend on the validity of the data instruments' demonstrated accuracy, the researcher's authenticity, and the analysis's strength. Using mathematically proven techniques to ensure replicability, the researcher can claim generalizability in their study (Golafshani, 2003).

Unlike quantitative research, a limitation of case study research is the lack of generalizability (Yin, 2018). In qualitative research, the researcher is the data collection instrument (Merrian & Tisdell, 2016). The researcher aims to achieve richness, rigor, and depth in meaning from the phenomenon under study. The researcher’s goal must be to deliver viable, reliable, and ethical research through exhaustive data gathering and analysis (Yin, 2018). Qualitative researchers use the concepts proposed by Lincoln and Guba (1985) to describe trustworthiness in qualitative research. These criteria are credibility, transferability, dependability, and confirmability. Unlike reliability and validity in quantitative research, these concepts are not measurable (Fan, 2013). Through dependability, the researcher can attain reliability, and through transferability, they can achieve external validity. The research must also be credible and authentic, and it is only until the researcher achieves all three states that confirmability occurs (Thomas & Magilvy, 2011).

Reliability

For a study to be considered reliable, the study’s results must be consistent and dependable (Fan, 2013; Heale & Twycross, 2015). Another researcher asking the same research question under similar circumstances should draw consistently similar conclusions over time that accurately represent the population under study (Golafshani, 2003; Merrian & Tisdell, 2016). The concept of dependability aligns with the quantitative concepts of consistency and replicability. To replicate the findings, a comprehensive set of notes, or audit trail, allows other researchers to examine the research’s processes and conclusions (Houghton et al., 2013; Lincoln & Guba, 1985). By replicating a study’s results, researchers minimize the conscious or unconscious bias influencing the original research. The exact replication of a case study is not possible. Due to the passage of time and other circumstances, another researcher replicating the study may come to a similar conclusion as the author, but not an identical one (Merrian & Tisdell, 2016).

Validity

The measurement protocols and instruments' assessment give a study validity in quantitative research (Fan, 2013; Heale & Twycross, 2015). In qualitative research, the replicability or transferability of the research establishes validity. A study's replicability is enhanced if the findings can be transferred to another context or situation and retain the original researcher's inferences (Houghton et al., 2013). This concept is transferability. A researcher can achieve transferability through thick, rich descriptions. Therefore, it is the foremost researcher's responsibility to provide a rich description of the study's research methods, participants, setting, processes, observations, and analysis so that an informed consumer may make inferences from the findings (Houghton et al., 2013). Fusch and Ness (2015) posited that data saturation could provide validity in qualitative research. Data saturation occurs when the researcher unveils no new themes after interviewing and analyzing the data.

Credibility

To achieve credibility, the researcher must answer the following questions. Are the results believable to the reader of the research? Has the researcher provided enough evidence for the reader to understand the phenomenon under study, and are the findings credible from the reader's perspective? Are any biases disclosed? Are the limitations of the study identified? Credibility is similar to internal validity in quantitative research (Lincoln & Guba, 1982; Thomas & Magilvy, 2011). To be credible, the reader must be confident in the truth behind the author’s findings and presented facts (Lincoln & Guba, 1985). Throughout the data analysis process, the researcher must preserve a chain of evidence to maintain trustworthiness, credibility, and confidence in the research (Yin, 2018). One way to ensure credibility in qualitative research is to perform member checking procedures. Member checking is when the researcher transcribes the interview and presents the transcripts, with any interpretations, to the participant for remarks (Chase, 2017). I incorporated member checking in my design protocols, detailed in Appendix C. I sent the participants a copy of their transcript and an interview summary after each interview. Of the six participants, only two validated transcriptions were error-free. The four others chose not to respond.

Confirmability

Confirmability occurs once dependability, transferability, and credibility have occurred (Thomas & Magilvy, 2011). Establishing confirmability depends on the confidence that the participants’ narrations and not the researcher’s biases make up the study. Researchers can provide confirmability by maintaining a sense of openness and reflexivity (Thomas & Magilvy, 2011). A researcher can further the credence and confirmability of their study through triangulation (Thomas & Magilvy, 2011; Wray et al., 2007). Triangulation uses multiple data sources, methods, analysts, or theories that converge on the same set of facts or findings (Yazan, 2015; Yin, 2018). In my study, I used data, within-method, and theoretical triangulation.

I addressed my study’s dependability by documenting my methods, processes, participants, memos, biases, observations, evidence, and findings in my case study database stored in the QDAS Atlas.ti. I used thick descriptions to enhance the transferability of my study for future researchers. To strengthen credibility, I member-checked my interviews and looked for similarities among all the interviews. When no new themes emerged, I achieved saturation, which enhanced validity. I ensured that I did not lead the participants but asked for clarification when needed to ensure clarity. I triangulated my sources to further the confirmability of evidence and obtain data saturation. Finally, I maintained a reflexive journal to document my thoughts and biases and to support my decisions.

Transition and Summary

In section two, I restated the purpose statement to explore offshore wind leaders' strategies to manage O&M costs. I discussed the role of the researcher, who the participants were, and my research design and method. I discussed the importance of ethical research, population, sampling, and the data collection instruments and techniques I used to gather data. I then discussed my data analysis strategy and how I achieved reliability and validity in my study. In section three, I present my findings and analysis of the identified themes and their relationship to the research question. I discuss the applications to professional practice and social change implications. I identify and describe any recommendations for action and my recommendations for further research. Finally, I include a personal reflection on my doctoral experiences.

Section 3: Application to Professional Practice and Implications for Change

Introduction

This multiple case qualitative study aimed to explore strategies that offshore wind leaders use to manage O&M costs. To explore these strategies, I combined two strategic frameworks, the McKinsey 7-S and the LSS frameworks. By combining the frameworks, I strengthened my analysis as the McKinsey 7-S framework provided internal managerial alignment and focus, complimented by the continuous improvement focus and DIMAC tools and methods developed within the LSS framework (Çiğal & Saygili, 2022; Waterman et al., 1980).

I collected data from semistructured interviews, participant observation, archival records, and digital artifacts. I interviewed six offshore wind leaders responsible for European offshore wind farms' management, operation, or economic performance. I used the data collected from participant observation, organizational documentation, and archival records to support the interview responses from the participants. From the analysis of the semistructured interviews, I identified four themes. I categorized these themes as cost-saving strategies as follows: (a) operations and environmental monitoring to enhance financial planning, (b) infrastructure risks that affect performance and influence management strategies, (c) contractual risk management strategies, and (d) stakeholder management. In the following section, I have described my findings based on the participants' responses and the artifacts collected.

Presentation of the Findings

I conducted semistructured interviews to answer the research question, what strategies do offshore wind farm leaders use to manage O&M costs? I asked the participants of my study seven interview questions designed to answer this research question. To determine if a participant was qualified to participate in the study, each participant must have had operations and managerial maintenance responsibility with an offshore wind farm for at least 2 of the last 5 years. Each participant had to have had a relationship with a European operating offshore wind farm, not an offshore wind farm under construction. Each participant had to be an individual who had the authority to make the decisions related to an offshore wind farm and was responsible for ensuring that the wind farm was operating at maximum capacity and profitability.

I selected my potential participants using the LinkedIn platform and through my renewable energy industry contacts. I invited all potential participants to participate (see Appendix A) and provided an informed consent form. I gave each possible participant a unique identification number, one through 153. Of the 153 potential participants contacted, seven individuals responded positively to an interview.

Initially, I had seven participants. However, I had one participant withdraw from the study as they felt they were not qualified to participate based on the criteria. Of the remaining six participants, all met the required criteria. Five participants were directly involved in the operations of a European offshore wind farm. The sixth participant was an energy consultant who had previously operated offshore wind farms in Europe. The remaining six participants provided consent through e-mail or by signing the informed consent form. I renumbered these participants P1 through P6.

I conducted semistructured interviews following the interview procedures outlined in Appendix B. Each of the participants was given a code number P1 to P6. During the interviews and throughout the discussion, due to the COVID-19 pandemic and associated protocols, I could not conduct my interviews in person; therefore, I conducted my semistructured interviews virtually using the GoToMeeting platform. I recorded each participant using audio recording and without video. Using the GoToMeeting platform, I had the system transcribe the recordings. I validated the transcriptions by listening to the recording, comparing the transcription, and adjusting as needed. I then wrote a brief synopsis of each interview based on my understanding of the participant's discussion. After I transcribed the interviews and based on the member checking protocols in Appendix C, I sent each participant copies to validate and respond to based on their interpretation of the interview. Out of the six participants, only two followed up with corrections, one by e-mail and the other by e-mail and telephone.

I then summarized each interview according to the interview questions and then by emerging themes. Based on the results, I compared the responses provided by each participant and looked for similarities and differences. I manually coded each transcript based on the overarching themes I had identified in my summaries. These overarching themes were operational planning and monitoring, logistics, contracts, and stakeholder management. Upon completing my preliminary analysis, I opened-coded the data using Atlas.ti 23, resulting in 424 open codes.

I grouped the codes into 20 code groups to make sense of the data. I based each code group upon the frameworks, specifically, the seven factors of the McKenzie 7-S model, the eight types of waste of Lean, the five phases of the DMAIC approach from Six Sigma, and keywords, phrases, sentences, and paragraphs discussed by the participants. Out of the 20 codes, I identified four themes. These themes are (a) operations and environmental monitoring to enhance financial planning, (b) infrastructure risks that affect performance and influence management strategies, (c) contractual risk management strategies, and (d) stakeholder management. I further identified 18 emergent subthemes. In qualitative research, a subtheme is a secondary or subsidiary theme that emerges within the broader framework of the main theme. While connected to the central theme, the subthemes explore specific aspects, variations, or perspectives related to the main theme, providing additional depth, complexity, or exploration of related ideas. Subthemes highlight the nuances or offer alternative viewpoints within the larger thematic context. Subthemes provide a more detailed analysis of the theme and can describe the hierarchy within the data (Kiger & Varpio, 2020). I describe each theme and associated subthemes in the following sections.

Case study research often combines six data collection instruments: documentation, archival records, interviews, participant observation, direct observation, and physical artifacts (Yin, 2018). Furthermore, to obtain saturation, a researcher must triangulate data (Fusch & Ness, 2015). To achieve saturation, I triangulated my data using participant observation, archival records, and digital artifacts collected from the participants. I collected 203 archival documents and digital artifacts. These archival documents and digital artifacts consisted of articles, e-mail messages between executives, training materials, videos, strategic O&M studies, vessel specifications, conference presentations, and research and development materials. I coded these materials similarly to the participants' interviews with the same code groups.

From the semistructured interviews, I gathered information on the participants' experiences with operating an offshore wind farm, managing stakeholders, and their recommendations for future improvements. As the semistructured interviews were not video recorded, I observed each participant as I conducted the semistructured interview. I took notes on the participant's reactions to each question. By examining archival records and digital artifacts, I obtained information on various aspects, including vessel design, operational planning and monitoring, and safety protocols. Through the analysis of provided videos, I captured data on the performance of offshore windfarm leaders during maintenance tasks and their approach to safety training. In addition to these sources, I extensively explored O&M studies, conference papers, and research and development materials, enabling me to obtain crucial information on operations monitoring planning, statistical techniques employed to identify efficiencies, strategies for vessel alignment, overcoming supply chain shortages, and the most recent technological advancements in the field.

As an overarching theme, all participants compared onshore to offshore wind farms. Each participant discussed the differences in the technologies from different perspectives revolving around the emerging themes. P1, with the most offshore experience, stated, "The strategy was, I'd say probably, in a nutshell, was to take onshore

O&M practices and just marinized them and take them offshore. Really. It was a very naive industry." P1 stated early on, "From an O&M provider's perspective, it was still very much concentrating on the wind turbine itself and taking onshore practices and just delivering them offshore." The other five participants mirrored this perspective reflecting on early processes and practices. P2 and P6 viewed the challenge from the personnel perspective. According to P2, "There is typically a challenge to convert personnel that has worked in onshore winds and to convert them into offshore winds." P6 agreed with P2, stating, "The type of skills that are out there in managing, you know, the transmission onshore is basically the offshore portion, which might have some challenges in the early development of the industry finding the appropriately skilled labor, in order to maintain the balance of plant." In comparison, P3 and P5 discussed the logistical issues related to offshore. P3 stated, "It's much harder to work offshore than it is to work onshore." P5 echoed P3's statement: "The offshore realm is a lot different than the onshore, regarding the access to the turbines." Finally, P4 approached the difference between the technologies from both a maintenance strategy and a stakeholder's point of view. P4 stated that "any maintenance offshore is much more complicated than onshore" and "onshore people hate the wind turbine because sometimes they make huge noise depending on the wind direction and the angle."

The combined frameworks of this study are the McKinsey 7-S and LSS frameworks. In addition to looking for emerging themes, I noted areas where participants mentioned engaging in one or both frameworks' conceptual elements as I conducted the interviews. I noted when participants followed the frameworks' philosophies and identified areas where they could improve following the McKenzie 7-S or LSS frameworks.

Many participants highlighted improvement areas aligned with the combined frameworks. For example, P1 discussed participating in a 4-year study to evaluate O&M costs involved in a project. P1 explored human activity, shift patterns, working processes, and organizational structure in this study and later discussed corporate culture and how the lack of a shared value significantly damaged the company's ability to acquire new contracts. Likewise, P2 noted supply chain bottlenecks consistent with the LSS concept of Muda, or waste. Other participants also reported areas where monitoring and analyzing data were compatible with DMAIC analysis tools. In the following sections, I will discuss the findings relating to the four themes revealed and my study's frameworks.

Theme 1: Operations and Environmental Monitoring to Enhance Financial Planning Efficiencies

The first theme that emerged was related to operations and environmental monitoring to enhance financial planning efficiencies. Five of the six participants identified the importance of general planning as a cost-saving strategy both in the long and short term. Additionally, four participants discussed four additional subthemes in specialized planning areas related to weather, supply chain, maintenance, and turbine monitoring. Table 4 shows the number of participants and their response relationship.

Table 4

Coding of Participants' Responses Related to Subthemes of Theme 1

Subtheme	Participant[a]	Response[b]
Long- and Short-Term Financial Planning	5	86
Weather Impact Planning	4	37
Supply Chain Monitoring and Planning	4	11
O&M Planning	4	10
Asset Monitoring	3	15
Total	5	159

Note. [a] Number of offshore wind leaders who contributed responses linked to the subthemes.[b] Number of times participants responded to subthemes

During the interview, P1 described the emergence of the offshore wind industry in Europe over the past 25 years. During the early years, the offshore wind farm leaders' carbon-copied onshore processing protocols to operate offshore wind farms. Quickly realizing that this strategy would not work in the offshore environment, P1 described how their company took a project and analyzed it for 4 years. The goal was to understand the O&M activity in the offshore environment. According to P1, the team "looked at every aspect of human activity, from shift patterns to working processes. We looked at solution techniques from other industries, oil and gas, and Dutch flower distribution." In alignment with the McKinsey 7-S framework, P1 demonstrated that in the study, they explored systems, structure, skills, staff, style, shared values, and strategy, and also they used many of the DMAIC tools aligned with the LSS approach (Çiğal & Saygili, 2022; Waterman, 1982). As an outcome of the study, understanding planning and the size of the wind farm dictated the cost-saving strategies and operating protocols. According to P1, the lack of short-term and long-term planning had significantly cost the industry.

P3 confirmed, “As with every business, you know, you have a business plan…. where you inform your managers what you need to spend, and then you spend it. That is the only strategy that I know works.” Complementing financial planning, P3 stressed that offshore wind farm leaders must “consider the weather, the wave height, the wind speed, the reliability of the wind turbines, and the capability of the logistic we are planning.” P2 and P3 discussed how asset reliability is critical, especially in offshore wind. P3 stated, “If your asset is unreliable, you will have more uncertainty about the repair time because of the weather.” P6 noted that if you “don’t understand how your plant operates, that will not lead to a very good outcome. You need to be proactive, and you have to manage that interaction, particularly when outsourcing all O&M to third parties.”

Four of the participants discussed predictive maintenance and other maintenance strategies. These strategies included preventive, corrective, odometer-based, predetermined, and condition-based maintenance. P1, P3, and P5 emphasized thorough and proper maintenance schedules are needed to minimize unscheduled turbine faults, which would help achieve as much uptime as possible. The four participants agreed that contractual agreements generally determined the type of maintenance performed, whether the contracts were turbine supply agreements or O&M agreements. P5 stressed the importance of selecting the correct turbine type at the outset since direct drive turbines required less O&M than their traditional gear-box counterpart.

Additionally, P1 described how following the OEM service manuals was not the most cost-effective maintenance approach. One strategy that P1 described was minimizing unnecessary maintenance activities while ensuring optimal performance by going through the OEMs manual. They examined each service individually to determine what was essential and what they could take away—refining their maintenance strategy to be cost-effective for the customer and the OEM. All four agreed that effective maintenance strategies depended on the correct monitoring tools.

The three hard factors in the McKinsey 7-S framework are strategy, systems, and structure. One strategy P3 and P5 used for future offshore wind capital investment was to invest in software tools that allowed the company to model 30 to 35 years of an offshore wind farm's operation. Software tools enable companies to run statistical analyses, such as Monte Carlo simulations, to determine potential outcomes under multiple scenarios. P3 emphasized, "And that is key to your expenditure and how you will manage it later. So, again, it's about, I think it's data, reliability data, and it's about being the right tool to model the accessibility and reliability of your assets." With these software systems and structures in place, offshore wind leaders, such as P3, can use the DMAIC tools utilized in the LSS framework to minimize O&M costs and maximize revenues.

Similarly, P2 built their company's strategy by listening to the voice of the customer (VOC), as in LSS. They developed foundation monitoring tools and applied the knowledge from these data to anticipate costs earlier in the assets' life cycle. They could negotiate better contract terms with vendors. P2 stated, "what we see right now in the market is that customers are increasingly interested in understanding how these assets will age. It's not something that is well understood, especially with the foundation. So, developers are, I would say, more proactive than they were in the past in thinking about the required solutions during operations, but they are doing that even before construction."

The dominance of the Danish companies in the offshore wind industry created supply chain issues and niche markets, which further influenced planning, as noted by P1, P2, and P6. Concentrated expertise in one area can create bottlenecks. Bottlenecks create long lead times and can impact overall costs (Subramaniyan et al., 2020). Reducing waste (Muda) is fundamental in the LSS framework (Oey & Lim, 2021). P2 recognized that these bottlenecks could create the underutilization of capabilities or skills for the offshore wind farm leader and emphasized that planning for these bottlenecks was critical.

Through the intentional underutilization of capabilities, P3 and P4 suggested that wind farm operators often let multiple assets lay idle until it became economically feasible to engage logistical resources such as helicopters or other repair vessels. For example, P5 stated, "You don't want a service operation vehicle (SOV) for five turbines, obviously, but there is a balance that has to be struck between response time" and, therefore, revenues. The second emerging theme was infrastructure risks affecting performance and influencing management strategies. Alternatively, P1, P2, and P6 described how offshore wind leaders managed costs and mitigated the supply chain risks by negotiating the dangers with the original equipment manufacturer (OEM) using fixed-cost O&M contracts. Contractual risk management strategies was the third theme that emerged from my data.

Theme 2: Infrastructure Risks that Affect Performance and Influence Management Strategies

The second theme that emerged was related to infrastructure and logistical strategies. Within this theme, I identified three subthemes to provide more detail to support theme two. The three subthemes were related to environmental factors, geographical location, and transportation limitations. Table 5 depicts the frequency and quantitative response by the participants for the theme and subthemes related to infrastructure risks that affect performance and influence management strategies. I will discuss the findings related to these subthemes in the following section.

Table 5

Coding of Participants' Responses Related to Subthemes of Theme 2

Subtheme	Participant[a]	Response[b]
Environmental Factors	6	79
Geographical Location	6	66
Transportation Limitations	5	91
Total	6	236

Note. [a] Number of offshore wind leaders who contributed responses linked to the subthemes.

[b] Number of times participants responded to subthemes

Five participants addressed the complexity of selecting vessels and equipment. All six participants discussed environmental and geographical issues and how the location and size of the asset impacted costs. All six participants indicated that well-managed and deployed transportation strategies significantly impacted O&M costs.

The size and location of the wind farms led to multiple logistic problems. According to P5, “there’s definitely not a one size fits all strategy.” Adding, “I mean, the offshore realm is slightly different. Well, it’s a lot different than the onshore realm regarding access to the turbines. With onshore turbines, obviously, you can get in a service truck, you can load up your tools, and you can go out on relatively short notice. The offshore access strategy is quite a bit different.” P3 agreed, stating, “The O&M base’s size, the type of O&M facility you need onshore to support your offshore operation, the type of helicopter you need, and the type of contract you need. You know it is different if you need 100 or 400 helicopter hours annually.” All agreed that the complexity of the logistics increased as the turbines increased in MWs and the distance from shore.

P1, P2, P3, and P5 discussed common cost-saving strategies depending on the wind farm size. For example, P1 and P2 spoke about transitioning from crew transfer vessels (CTVs) to service operation vessels (SOVs) as the sites were built farther and farther from shore. For sites closer to the coast, ten miles or less, crew transfer vessels, small ships designed to transport up to 12 technicians daily were practical. However, as sites became larger and farther from the mainland, long-term residential vessels, SOVs, which are large hotel-type ships, were more economical. P5 stated, “SOVs work well for, you know, projects that are out from shore quite a way. And you’re able to basically have a mobile workforce complete with inventory safety, all the back-office functions onboard as well for weeks at a time. So in regard to the O&M. Really, you have to take all those factors into consideration in formulating what works best for that particular project.”

The participants agreed that the efficiency of the maintenance strategy was highly dependent upon the ability to predict errors and reduce logistical complications. For example, P3 stated, “the efficiency of your maintenance strategy will have a considerable impact. When maintaining offshore wind assets, you must know how many technicians you need, how many boats you need, the type of boats you need, and how many times you will need to change any equipment. As a result, if your maintenance strategy is correct and you can predict errors, you may reduce your logistics setup. Meaning, you know, the number of vessels you need, the numbers of days you are using them, the number of technicians, and the number of helicopters you will use.”

Five participants stressed that the choice of vessel and equipment could lead to long lead times. They emphasized that extended access lead times to cranes, helicopters, crew transfer vessels (CTV), and service operation vessels (SOV) could significantly impact operations costs. Under the LSS framework, to achieve constant flow, the leaders must manage process throughput to identify any bottlenecks and roadblocks (Subramaniyan et al., 2020). Not all vessels function the same way in all conditions. For example, from a maintenance perspective, P5 described the differences between the various vessel types and the limitations of helicopters, hovercraft, CTVs, and SOVs.

All vessel types are dependent on the weather. Environmental influences such as weather, time of year, and wave height contribute to the selection equation. P3 iterated, “you’re not always able to repair the broken wind turbines because of the weather. And, you know, there are access issues offshore.” P3 further stipulated how important “the ability to predict or anticipate any shutdown of any wind turbine is key," adding, "you know your maintenance strategy will have a huge impact on your expenditure."

Theme 3: Contractual Risk Management Strategies

The third theme that emerged was related to contractual risk management strategies. I identified three subthemes to provide greater clarity. The three subthemes were business influences, contract type, and terms and conditions. Table 6 depicts the frequency and quantitative response by the participants for the theme and subthemes related to contractual risk management strategies. I will discuss the findings related to these subthemes in the following section.

Table 6

Coding of Participants' Responses Related to Subthemes of Theme 3

Subtheme	Participant[a]	Response[b]
Business Influences	6	70
Contract Type	6	60
Terms and Conditions	6	32
Total	6	162

Note. [a] Number of offshore wind leaders who contributed responses linked to the subthemes.

[b] Number of times participants responded to subthemes

All the participants discussed contracts as they related to agreement types, terms and conditions, and business influences. The evolution of contract types and terms grew out of necessity to protect stakeholders, reduce costs, and maximize profits. Since the inception of offshore wind farms in Europe, according to P1 and P5, the trend has been for the original equipment manufacturer to offer 10 to 20-year O&M contracts to the asset owners for the exclusive right to perform the O&M function for the site. With such agreements, the owners did not have the supply concerns that would have accompanied site self-management. P2 stated, “I think it’s important to mention that manufacturers made their money out of service agreements, not the turbine supply agreements.” Indicating no incentive for the OEM to renegotiate or release the service agreements to other vendors. P2 further stated, “they sell turbines at a loss and then recoup everything during the maintenance. Their entire profit model depends on the service agreements, so for them, it’s extremely important to continue delivering that.” Such agreements made budgeting for offshore wind asset owners more predictable but more costly, as stated by P3.

According to P1, the first maintenance contracts written by the OEMs were availability-based, not well-written, and excluded weather considerations in the calculations. Under these contracts, an OEM’s sole responsibility was maintaining the turbine. Based on availability meant that provided the original equipment manufacturers could make the turbines “available” to produce energy, the original equipment manufacturer had fulfilled its obligations. Neglecting the maintenance of the balance of the plant. P6, a specialist in the O&M of the offshore balance of plant (BOP) structures, confirmed this gap. P6 emphasized that asset owners and offshore wind farm leaders needed to fill the O&M requirements for the BOP structures, such as monitor cables and substations. Industry leaders later determined that a production-based contract was more practical than an availability-based one, as a turbine could be available but not produce energy.

P1 stated that control of the transportation and logistics contracts generally meant that the contract holder could control the site and all the associated arrangements. According to P1, this control depended on interpreting the exemption clauses and frequently resulted in disputes. In the early contracting environment, P1 disclosed that there would be personnel from both the OEM and the asset owner, which doubled the staff on site and led to inefficiencies by doubling the team, adding to the unnecessary motion of people and creating waste. At first, this was for the lifetime of the contract. Subsequently, P2 and P6 confirmed that some asset owners insist that their staff shadow the OEM for several years so that knowledge transfer can occur and there is a smooth hand-off when the asset owner assumes control of the O&M contract.

The need for evolution in the contracting process and increased asset control and response times is evident. There is a demand for well-defined power purchase agreement (PPA) pricing and clearly defined liquidated damages. As the contracting process became more sophisticated and additional areas of concern became evident, asset owners increasingly wanted more and more ownership of the transportation, balance of plant, and lifetime intention contracts. As P1 stated, “the cost is the same. The asset owner would go well, hold on a minute; you are charging me 30% more for an O&M contract. And you go well, that’s the boat, and they’d go well, we can make a saving on that we’ll take the boats off you.”

As the needs arose, contracts gradually included conflict and intellectual property issues. For example, P6 described situations where the asset owner, the vendor, and the OEM might develop some technique to reduce weekly person-hours. For example, the team may have discovered how to fix a unique blade or bearing issue. Revenue streams from the jointly developed technique had to be agreed upon contractually before operations. A clear definition of any contractual modifications regarding the treatment of intellectual property between the parties was of utmost importance. The fourth theme I identified in the data related to the stakeholders. In the following section, I will discuss the stakeholder relationships and impacts on the offshore wind industry.

Theme 4: Stakeholder Management

The fourth theme that emerged was related to stakeholder management. From this theme, I identified seven stakeholder groups or subthemes. Each participant described their relationships with various stakeholder groups. These stakeholder groups were staff, competition, government, industry, vendor, asset owners, and customers. Table 7 depicts the frequency and quantitative response by the participants for the theme and subthemes related to stakeholder management. I will discuss the findings related to these subthemes in the following section.

Table 7

Coding of Participants' Responses Related to Subthemes of Theme 4

Subtheme	Participant[a]	Response[b]
Staff	5	97
Competition	5	40
Government	5	21
Industry	5	8
Vendor	2	82
Asset Owners	2	36
Customer	2	30
Total	5	314

Note. [a] Number of offshore wind leaders who contributed responses linked to the subthemes.

[b] Number of times participants responded to subthemes

Effective stakeholder management and engagement are vital in the offshore wind industry as they are pivotal in reducing operational and maintenance costs. Stakeholders include employees, customers, project developers, investors, suppliers, local communities, and regulatory bodies. Offshore wind farm leaders must cultivate strategies that effectively manage and engage stakeholders, guaranteeing active participation in project decision-making and addressing their specific requirements and concerns. By prioritizing comprehensive stakeholder involvement, leaders of offshore wind farms can optimize their operations and ensure the overall success of the projects.

Five of the participants mentioned the subtheme staff 97 times. The participants cited staff as a stakeholder in relationship to overstaffing, understaffing, safety, and training as critical drivers of costs. The participants noted poor planning, changes in project scopes, and over (under) estimation of the workforce needed as the main factors in the inefficiencies in headcount. To understand these inefficiencies, P1 undertook a 4-year study exploring every aspect of human activity, from shift patterns to working processes in the offshore wind environment. P1's team concluded that it was essential to clearly understand each worker's roles and responsibilities and ensure their skills and experience matched the project's needs. Consequently, the team worked with their human resources department to update all their roles and job descriptions.

The offshore wind farm leaders hired military and marine personnel, including captains, to fulfill many roles, but many lacked the skills to perform duties offshore. Several participants mentioned that these inequalities in staffing might be related to the competency level of the technicians and back-office staff and the lack of available qualified employees. For example, P1 mentioned that early on, "the training of staff and maybe transfer of staff salary levels weren't great at that point, and you couldn't transfer some skills there, but then you had a lack of specific training for the wind industry." From this need, the Global Wind Organization (GWO) developed basic safety training, which typically included courses on working at height, sea survival, first aid, fire safety, and manual handling. GWO designed these courses to ensure workers have the necessary skills and knowledge to work safely in the offshore environment and respond appropriately in an emergency. According to P1, “there’s an extremely high standard of health and safety within the onshore industry that got taken over by the offshore industry. And I think it jumped to another level, especially with the offshore training for working in an offshore environment. But so, I would say that there was an extremely safe industry to work in. A lot of good works being done there on working offshore and a lot of work has been done on making the actual wind turbine a lot safer.”

The offshore wind industry is becoming increasingly competitive as technological advances and economies of scale have driven down costs and increased efficiency. More customers, including governments, utilities, and corporations, seek to reduce their carbon footprint and meet renewable energy targets. The competitive nature of the industry has also led to greater innovation and collaboration as companies work together to develop new technologies and approaches to meet the demands of the market. For example, P1 and P5 described incidents where offshore wind owners and OEMs have collaborated to improve efficiencies and minimize costs. P5 shared how some larger companies discuss forming partnerships to reduce these costs. P1 additionally described how some OEMs are looking to deploy a maintenance vessel across multiple projects in a service train to serve two to three customers without returning to shore.

The offshore wind industry is an industry of continuous improvement, learning, and growth. Stimulated by government incentives and environmental fervor, the offshore wind industry needed to develop effective strategies quickly. Five participants identified the offshore oil and gas industry as one of the primary resources for helping to establish effective offshore wind farm strategies. Reaching out to other sectors and modifying processes and procedures enabled the industry to advance. For example, stated P1, “The one big thing we learned on the project was that working with oil and gas was that you should not be going offshore; that is the best strategy for servicing offshore wind turbines.”

Engineers face challenges in developing renewable energy, particularly onshore and offshore wind, as an independent energy resource due to the intermittent nature of the source energy. One participant described how the offshore wind industry and the renewable sector at large could not exist in a vacuum and must rely, to some degree, on fossil fuel and nuclear technologies. This is especially true given the current state of renewable industry technologies. Balancing fossil fuel and nuclear technologies is necessary to ensure that energy providers can deliver power to stakeholders when and where it is needed.

The relationship between asset owners and vendors, including the original equipment manufacturer (OEM), is crucial in the offshore wind farm industry. As the industry has matured and wind farm sites have grown in size and complexity, P3 noted that asset owners must be financially sound enough to withstand potentially damaging events, which is essential for the survival of a wind farm. P1, P2, and P5 similarly highlighted the need for agreed-upon contractual obligations, as disputes around terms could significantly reduce profitability.

As competition in the industry intensified, vendor strategies evolved. Some companies became overconfident in their approach to new projects due to their success in winning European offshore wind farm projects. However, losing some key contracts served as a wake-up call for these companies. For example, P1 initially noted, “We became very good and arrogant at one point because we had won every European offshore wind farm project, and it was only when we lost a couple of key ones that the honeymoon was over. I think we became a little bit arrogant in our approach to new projects. We could hack the price up and wait and see what happens.” P1 highlighted the challenge of balancing strategy and execution in the wind farm industry. To evaluate the strategy was challenging, according to P1, “in an environment where we were very successful in winning new projects. It was a given that the OEM service contract was handed over to us.” Despite these challenges, effective collaboration between asset owners and vendors remains crucial for the long-term success of offshore wind farms.

Applications to Professional Practice

The specific business problem for my study is some offshore wind farm leaders lack strategies to manage O&M costs. The offshore wind industry is a rapidly growing sector that requires a high level of professional practice to ensure effective and efficient operations. As the participants discussed, the industry faces numerous operations and environmental monitoring challenges to enhance financial planning efficiencies, infrastructure risks that affect performance and influence management strategies, contractual risk management strategies, and stakeholder management. To overcome these challenges, offshore wind leaders could adopt a professional practice combining the

McKinsey 7-S and LSS frameworks described in this study. Applying the McKinsey 7-S and LSS frameworks can help offshore wind industry leaders achieve optimal performance by considering critical elements that affect their success. In this study, I explored the application of these frameworks in the offshore wind industry.

The McKinsey 7-S framework analyzes seven critical elements within an organization: strategy, structure, systems, skills, staff, style, and shared values (Burger & Blažková, 2020). In the offshore wind industry context, these elements are critical in addressing logistical challenges and ensuring all stakeholders are aligned and working towards a common goal. Stakeholders are a crucial element of the offshore wind industry, and effective stakeholder management and engagement are essential for minimizing O&M costs. Stakeholders include various groups, such as employees, customers, project developers, investors, suppliers, local communities, and regulatory bodies. Offshore wind industry leaders can use shared values, style, staff, and skills of the McKinsey 7-S framework to align with the stakeholders' needs and concerns. They can apply the LSS framework to ensure that stakeholder input is incorporated into process improvements, for example, through the voice of the customer.

The participants discussed that the offshore wind industry requires continuous asset monitoring to function optimally and prevent potential safety hazards. This involves tracking the performance of turbines, substations, and other components to identify issues and implement timely corrective actions. The McKinsey 7-S framework can be helpful by providing a holistic view of the organization's structure and how it supports the company's goals. For example, offshore wind leaders can develop a strategy that prioritizes asset monitoring and invest in systems and equipment that facilitate data collection and analysis. They can also create a structure that promotes collaboration between different departments involved in asset monitoring, such as maintenance, operations, and engineering. Shared values such as safety and quality can be promoted throughout the organization to foster a culture of responsibility and accountability. In addition, offshore wind leaders can hire staff with the skills and expertise required to monitor and maintain offshore wind assets effectively.

The participants noted that the offshore wind industry also faces logistical challenges related to the transportation, installation, and maintenance of wind turbines and other equipment. These challenges require careful planning and coordination to ensure all activities are completed on time and within budget. The LSS framework can be helpful by providing a systematic approach to process improvement and waste reduction. The framework comprises five phases: Define, Measure, Analyze, Improve, and Control (DMAIC) (Stojanović & Milovanović, 2020). Offshore wind leaders can use the DMAIC process to identify bottlenecks in their logistical operations and implement improvements to streamline their processes.

For example, in the Define phase, offshore wind leaders can identify the key stakeholders involved in their logistical operations and define their requirements and expectations. In the Measure phase, they can collect data on their current logistical processes to identify areas of waste and inefficiency. In the Analyze phase, they can use statistical tools and techniques to identify the root causes of these issues. They can implement process improvements in the Improve phase, such as better transportation planning or more efficient installation techniques. In the Control phase, they can monitor their processes and measure their performance to ensure sustained improvements.

The offshore wind industry constantly evolves, with new technologies and innovations emerging to improve wind turbines and other equipment’s efficiency and performance. Offshore wind farm leaders must deploy strategic thought to stay current on developments and remain competitive. As the participants noted, understanding the technological environment is critical to the success and profitability of the offshore wind farm. The Mckinsey 7-S framework can help offshore wind leaders develop strategies that prioritize innovation and invest in research and development to stay ahead of the curve. They can also create a structure that facilitates collaboration between different departments involved in technology development, such as engineering, research, and product development. Shared values such as sustainability and innovation can be promoted throughout the organization to foster a culture of creativity and continuous improvement.

Contractually, offshore wind farm leaders must incorporate clever wording in contracts to encourage cooperation and innovation in this evolving environment. The McKinsey 7-S framework can help organizations ensure that their strategy and structure align with contractual obligations. In addition, offshore wind farm leaders can use the LSS framework to identify areas where they can make process improvements to fulfill contractual obligations more efficiently.

Implications for Social Change

Offshore wind has significant implications for social change in Europe. Social change is any substantial change in a society’s social behavior, beliefs, customs, and values (Kavanagh et al., 2021). Implications of social change occur through cultural transformations, political instability, economic consequences, changes in social structure, and environmental impact (Kavanagh et al., 2021). The findings of my study show that social change may occur through any of these elements.

Social change can have significant economic consequences. Offshore wind projects require considerable infrastructure, including ports, transmission lines, and maintenance facilities. Applying the LSS and McKinsey 7-S frameworks can help identify opportunities for reducing the overall cost of offshore wind energy production, making it more economically viable. The development of this infrastructure can have positive social and economic impacts, creating new economic opportunities and promoting local infrastructure development.

Technological changes and demographics can impact the labor market and create new economic opportunities or challenges. By providing a more cost-effective and sustainable energy source, offshore wind energy can help to drive economic development and support social change initiatives. As I discussed in theme one, the participants emphasized the importance of operations and environmental monitoring to enhance the financial planning efficiencies of offshore wind assets to minimize operational costs. This would require offshore wind leaders to make technological and human resource investments in developing the structures and systems needed to monitor and analyze the data efficiently, promoting positive social change.

Furthermore, by applying the LSS framework, offshore wind farm leaders can help identify improvements in operational efficiencies, which can reduce the overall cost of offshore wind energy production. These improvements can create more opportunities for local job creation as offshore wind leaders invest in new technologies and processes to improve their operations. Subsequently, it positively impacts the local economy and helps drive social change by providing new employment opportunities.

Social change can significantly impact the environment, either positively or negatively. Offshore wind energy is crucial to mitigating climate change and reducing greenhouse gas emissions (NYSERDA, n.d.; United Nations, 2022; World Meteorological Organization, 2022). Applying the McKinsey 7-S framework can help identify strategies for reducing the environmental impact of offshore wind energy production, such as using more sustainable materials and practices. By minimizing O&M costs, offshore wind energy can become even more competitive with traditional energy sources, which can help to drive greater adoption and reduce the overall environmental impact of energy production (Alam et al., 2023).

Offshore wind projects can significantly impact local communities, including changes to the natural environment, economic development, and visual impacts. Engaging with local communities and stakeholders is essential to consider their concerns and interests. Offshore wind farm leaders can apply the shared values element of the Mckinsey 7-S framework and listen to the voice of the customer to align these values.

Consequently, community engagement can lead to more socially acceptable and sustainable offshore wind projects.

When social change occurs through political instability and economic independence, the impact is positive or negative. For example, the invasion of Ukraine by Russia exacerbated the energy situation in Europe (Alam et al., 2023). The European community has an opportunity to promote self-sufficiency through offshore wind power. By generating clean and sustainable energy, offshore wind can reduce Europe’s dependence on imported fossil fuels, creating a more secure and stable energy supply. This can have significant social, environmental, and economic benefits for European countries, reducing their vulnerability to energy price shocks and geopolitical instability.

Overall, offshore wind power has significant implications for social change in Europe. By promoting energy independence, creating employment opportunities, mitigating climate change, engaging with local communities, and promoting infrastructure development, offshore wind can help promote sustainable and equitable development in Europe.

Recommendations for Action

This study aimed to explore the research question; what strategies do offshore wind farm leaders use to manage O&M costs? Through semistructured interviews with participants, I identified four themes. The findings of this study support the general business problem that mismanaged O&M activities for offshore wind farms result in increased costs and that some offshore wind farm leaders lack strategies to manage O&M

costs. I will discuss further recommendations based on each theme in the following section.

Recommendations that emerged from theme one evolved around the importance of developing clear and well-defined plans for offshore wind operations and environmental monitoring to enhance financial planning. Offshore wind farm leaders should prioritize operations and environmental monitoring to enhance financial planning efficiencies as short and long-term cost-saving strategies. Offshore wind farm leaders should consider planning for specialized areas related to weather, supply chain, maintenance, foundations, the balance of plant, and turbine monitoring. Investing in monitoring tools would allow offshore wind leaders to simulate offshore wind farm operations for 30 to 35 years to identify O&M cost-saving opportunities and mitigate the uncertainty of repair time due to weather conditions. Furthermore, anticipating costs earlier in the asset’s life cycle would lead to better contract terms with vendors and prevent bottlenecks and long lead times.

Based on the findings related to the infrastructure risks that affect performance and influence management strategies subthemes, offshore wind leaders should consider the complexity of selecting vessels and equipment, environmental issues, location, wind farm size, and transport considerations when developing an infrastructure risk mitigation strategy for their wind farms. When choosing the most cost-effective vessel type, they should consider wind farm size and distance from shore. Leaders should manage process throughput to identify bottlenecks and roadblocks and assess the impact of environmental factors such as weather, time of year, and wave height on the selection of vessels and equipment. Additionally, predicting errors and reducing logistical complications can increase efficiency and lower O&M costs.

Offshore wind farms are complex projects that require careful planning and execution to manage O&M costs. To ensure smooth and successful site management, offshore wind leaders must pay attention to contractual risk management strategies. Based on findings related to this theme, four recommendations have emerged. Firstly, offshore wind leaders should clearly define all contract terms and conditions to avoid future disputes and help both parties understand their obligations. Secondly, leaders should establish effective communication channels between OEMs, asset owners, and other stakeholders to ensure that knowledge transfer can occur smoothly. Thirdly, the agreement should address the balance of plant (BOP) structures if appropriate. The O&M requirements for the BOP structures, such as monitoring cables and substations, should be fulfilled to avoid potential issues, ensure efficient operations, and outline cost responsibilities. Finally, offshore wind farm leaders should consider having a production-based contract instead of an availability-based contract.

Four recommendations for future action emerged from the fourth theme, stakeholder management. Firstly, develop effective stakeholder management and engagement strategies. Given the importance of stakeholders in the offshore wind industry, offshore wind farm leaders must develop effective stakeholder management and engagement strategies to involve all stakeholders in project decision-making and address their needs and concerns. Secondly, leaders must improve staff training and competency levels. They must ensure their employees are adequately trained and have the necessary skills and experience to match the project's needs. Hiring military and marine personnel to fulfill many roles may not be enough, and companies may need to provide specific training for the wind industry. Thirdly, offshore wind leaders must collaborate to develop new technologies and approaches to meet the market's demands. Offshore wind farm leaders may need to form partnerships to reduce costs and improve efficiency, and innovation should be encouraged. Finally, offshore wind farm leaders must address the conflict between wanting to be the best and most efficient and the reality of cost-cutting and understaffing.

These findings can be disseminated through a combination of traditional and digital methods. Publishing the study in a relevant academic journal or presenting the findings at conferences and workshops can effectively reach a targeted audience within the offshore wind industry. Additionally, digital methods such as social media, email newsletters, and website postings can extend the reach of the findings to a broader audience, including stakeholders and the general public.

Recommendations for Further Research

While this study provides valuable insights into the offshore wind industry's O&M practices and the strategic decisions made by industry leaders, several recommendations for further research could improve business practice and generalizability. Firstly, increasing the sample size by including a more significant number of offshore wind farms and industry leaders in the study could enhance the generalizability of the findings. A larger sample size would allow a more representative analysis of the industry's O&M practices and strategic decision-making processes.

Secondly, including a diverse range of industry leaders and offshore wind farms from different regions could provide a more comprehensive understanding of the industry’s challenges and opportunities and the impact of various policy interventions and support schemes.

Thirdly, future studies could take a quantitative approach to access more comprehensive and accurate O&M cost data, particularly as turbine warranty agreements expire. A quantitative approach would allow for a more thorough analysis of the industry’s financial performance and help companies optimize their O&M strategies to improve profitability. Finally, studies could be conducted in other regions with developing offshore wind industries, such as Asia and the Americas, to compare and contrast strategic decision-making processes and identify best practices for sustainable growth.

Reflections

Throughout my journey toward completing my Doctor of Business Administration, I encountered several challenges and experiences that have shaped my perspective on the research process. These include recognition of bias, time, family support, my academic contribution to the offshore wind industry, COVID-19, and the responsibility of being a Doctor of Business Administration. This section outlines my reflections on these challenges and experiences.

One of the most significant challenges I faced during my doctoral research was recognizing and addressing my biases. I constantly questioned my assumptions and preconceptions, challenged my biases, and sought feedback from colleagues to ensure that my study remained objective and unbiased. As a researcher, it is crucial to acknowledge that our personal experiences, beliefs, and values can influence the research process and outcomes. Therefore, I found it essential to engage in critical self-reflection throughout the research process to recognize potential biases and mitigate their impact on the research.

Throughout the years, I have strongly advocated for renewable energy. As an independent researcher, I acknowledged this bias. I held myself out as objectively as possible while I conducted the study. Within the six members of my participant group, I encountered opposing views on the relevance and importance of renewable energy and its positioning in the energy portfolio. For example, one participant discussed the strategic policy issues between renewable energy, fossil fuels, and nuclear energy. This participant emphasized that renewable energy strategies must encompass the global energy portfolio and not be isolated, as discussed in many papers and articles referenced throughout my study.

Time management was another significant challenge during my doctoral journey. Balancing work, family responsibilities, and research demands require effective time management skills. I had to develop a structured and disciplined approach to my research to ensure that I met the deadlines while balancing my other responsibilities. In addition, I had to be flexible and adapt to unexpected challenges, such as delays in data collection or unanticipated personal events. Ultimately, my ability to manage my time effectively was critical to completing my doctoral thesis.

I undertook this journey to find purpose and growth by contributing to the academic literature. I endeavored to master the doctoral process and strove to understand a scholar’s depth and commitment to achieving quality publications. In the process, I acquired new skills and a depth of understanding of the level of commitment from myself and my support team. Pursuing a doctorate is an intense and challenging process that can significantly affect personal relationships. The journey was often stressful. I often lost focus. The support of my family was invaluable during my doctoral journey. My family’s understanding and support helped me manage the demands of the research process while maintaining a healthy work-life balance. They provided emotional support, encouraged me to persevere during challenging times, and celebrated my achievements. Their support was a crucial factor in my success.

One of my key goals in pursuing a Doctor of Business Administration was to contribute academically to the offshore wind industry. The industry is rapidly growing, and there is a need for rigorous research to inform decision-making and policy development. My doctoral research focused on combining and applying the Mckinsey 7-S and LSS frameworks for assessing the economic viability of O&M offshore wind activities, which can inform investment decisions and promote sustainable development in the industry.

I was fortunate to conduct my study during the COVID-19 pandemic. Society was unprepared for such a global event. The essence of daily life changed in a matter of months. The uncertainty of what followed elevated stress levels, and emotions ran high. I was privileged because I was able to interview participants under these conditions and learn how they mitigated the risks involved with the safety of their personnel while protecting their assets and minimizing costs. As an essential service, employees of the renewable energy industry can not “work from home.” I had to learn how to reach and engage these participants. Since traditional in-person interviewing techniques were not an option, I had to learn new ways of communicating and performing virtual research on a global scale as an independent researcher. The research method of observation was limited. Therefore, I had to distinguish participant involvement through speech inflection and emphasis on their chosen topics. I relied on artifacts and public data to validate participants’ responses.

Finally, completing my doctoral thesis has brought a sense of responsibility and accountability. I recognize that my research begins my journey toward making an academic contribution to the offshore wind industry. As a Doctor of Business Administration, I must use my knowledge and expertise to impact industry and society positively. Therefore, I must continue learning, researching, and collaborating with stakeholders to promote sustainable development and responsible business practices.

In conclusion, completing a Doctor of Business Administration study is a challenging and rewarding experience that requires significant commitment, perseverance, and dedication. My challenges and experiences during my research journey have shaped my perspective on the research process and have helped develop my responsibility as a Doctor of Business Administration. Recognition of bias, effective time management, family support, academic contribution to the offshore wind industry, COVID-19, and responsibility are all critical aspects of the doctoral journey that have contributed to my personal and professional growth. I am privileged to have completed this journey, and I thank everyone for their support. I am most grateful to my Chair for allowing me to draw on her strength and knowledge to complete this process and to remember my why.

Conclusion

In conclusion, applying the combined McKinsey 7-S and LSS frameworks is crucial in the offshore wind industry to ensure optimal performance. Through these frameworks, offshore wind farm leaders can evaluate critical elements such as enhanced operational, environmental, and financial planning and monitoring of assets, environmental, geographical, and transportation logistics challenges, stakeholder management, and contractual transactions and obligations, leading to more effective and efficient operations.

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Appendix A: Invitation

Dear Invitee,

My name is Heather Shimp. I am a doctoral student at Walden University.

I am kindly requesting your participation in a doctoral research study that I am conducting titled: Offshore Wind Industry Leaders' Operations and Maintenance Management Strategies. The intention is to explore the strategies that help offshore wind leaders to keep operating costs at a minimum.

The study involves participation in a 30 to 45-minute semistructured interview, followed by 30 to 45 minutes of validation procedures, framed as a transcript review or a follow-up interview. Participation is entirely voluntary, and you may withdraw from the study anytime. The study is completely confidential.

If you would like to participate in the study, please read the Informed Consent letter below and return to me via email at heather.shimp@waldenu.edu to set up a mutually agreeable time to discuss strategies to minimize the operations and maintenance costs at your offshore wind farm.

Your participation in the research will be of great importance for positive social change to provide coastal communities increased economic growth and self-sufficiency.

Thank you for your time and consideration.

Sincerely,

Heather Shimp, MBA, CPA, Doctoral Student, Walden University

Appendix B: Interview Protocol

Interview date:

Interview start time:

Interview end time:

Modality of the interview:

Code for the participant:

Preferred method of participant communication:

Protocol:

1. I will open the interview with an introduction and validate that the participant has provided consent. What I will say.

   > “Hello, my name is Heather Shimp, and I am a doctoral student at Walden University. I am conducting research around strategies that European offshore wind industry leaders use to manage their operations and maintenance functions. You were selected to participate in this study because of your experience as a European offshore operations and maintenance wind farm leader. I want to thank you for volunteering and agreeing to be part of the research study and providing me your consent by email. I would like you to be aware that in my corporate role, I work for a renewable energy company that may compete with your organization. If, because of this or for any other reason, you do not feel comfortable sharing information with me, as a participant, I want you to know that you can withdraw at any time. I am required to hold in the strictest confidence

your identity, the identity of your organization, and the information that you provide. Therefore, to protect your privacy, I will store your identity separately and any information provided to me. I will preserve the information on a hard drive stored in a locked cabinet at my home for a period no less than 5 years, after which the hard drive will be destroyed."

2. I will then provide the participant with a brief background of my study, and what to expect during the interview, what I will say.

    "This interview should take about 30 to 45 minutes. During that time, I will ask you a series of questions about the strategies that leaders use to operate an offshore wind farm successfully. These questions were previously provided to you in the consent form. We will review them again together as we proceed through the interview. Please respond freely and openly, sharing your thoughts, recollections, opinions, experiences, and strategies that you have used to implement O&M strategies successfully. As we talk, I will record the interview and take detailed notes."

3. I will then request permission to record the interview. I will ask the participant if they consent to be recorded. If the interview is by phone, I will ask for permission to record the audio and take notes. If the participant declines to be recorded, then I will ask permission to take detailed notes, and I will inform the participant that the interview may take a little longer than the anticipated 30 to 45 minutes as I will have to stop every so often to update my notes.

4. I will ask the participant if they agree to be recorded. If they agree to be recorded, then I will press the record button, introduce the participant, notate the date and time of the interview, and ask permission of the participant to be recorded what I will say.

    “Hello, first I would like to let you know that I have begun the recording. Do I have your permission to video record this interview?”

    Participant response “Yes.”

    “Thank you for the recording, today is (insert day and month), and the current time is (time). I am Heather Shimp, and I would like to introduce Participant X (Code number of the participant). Today I will interview Participant X about their experiences as an operation and maintenance offshore wind leader. Are you ready to begin?”

5. I will then begin with the first question. During the interview, I will watch for non-verbal cues and paraphrase as needed the participant’s responses as I ask them the seven probing, open-ended questions.
    a. What strategies have you used to manage your offshore wind O&M costs?
    b. How have you addressed the key barriers that prevent the implementation of your organization’s strategies to manage your offshore wind O&M costs?
    c. How did you assess the effectiveness of your organization’s strategies to manage offshore wind O&M costs?

   d. What strategies did you find to be most effective for the management of your offshore wind O&M costs?
   e. What strategies were least effective in the management of your offshore wind O&M costs?
   f. What modifications, if any, did you apply to the strategies you used for the successful management of your offshore wind O&M costs?
   g. What else would you like to share with me about your organization’s strategies to successfully manage offshore wind O&M costs?
6. Once the participant has answered the questions to the best of their ability, I will wrap up the interview by thanking the participant for their time what I will say.

   “Thank you for participating in this interview today. Please do not hesitate to reach out to me if you have any questions using the contact information, I provided on the consent form.”
7. I will then describe what will happen next, what I will say.

   “In the next few days, I will transcribe this interview and send a copy to you for your review. I expect the transcription to take no more than three business days. Please review and provide comments and confirmation that you agree or disagree with the transcription. In addition, I will summarize your responses to each question and would like the opportunity to meet with you briefly to discuss my interpretation of your answers and to provide you an opportunity to clarify or expand on your responses.

8. If the participant agrees, I will schedule a follow-up interview on an agreed-upon time and date.
9. I will then conclude the interview and stop recording what I will say.

> "Thank you for spending time with me today. This concludes our interview. Before I turn off the recording, do you have any further comments?"

10. If the response is no, then I will terminate the recording. If the response is yes, then I will let the participant respond.

Appendix C: Member Checking Protocol

Interview date:

Interview start time:

Interview end time:

Modality of the interview:

Code for the participant:

Preferred method of participant communication:

Protocol:

1. Before the second interview, I will provide a copy of the transcript and the synthesis to the participant by email.
2. I will open the interview by thanking the participant for meeting with me again. I will once again validate that the participant has provided consent to participate, what I will say.

> “Hello, thank you, Participant X (insert the participant code number), for taking the time to speak with me again to further my understanding of the interview that we conducted on (insert date of interview) at (insert time of interview). I want to thank you for volunteering and agreeing to be part of the research study and providing me your consent by email. I want to remind you that if you do not feel comfortable sharing information with me as a participant, I want you to know that you can withdraw at any time. I am required to hold in the strictest confidence your identity, the identity of your organization, and the information that you provide. Since we last

> spoke, I sent you a copy of the transcript for your review, and I have summarized the information you provided me, organized by question. Did you receive the transcript and the synthesis?" the participant will respond yes or no. If "no," then I will offer to resend. If they respond "yes," then I will continue to the next step.

3. I will then provide the participant with what to expect during the interview, what I will say.

> "This interview should take about 20 to 30 minutes. During that time, I will review the questions that we discussed last time and read my interpretation of your answers. As we talk, additional questions may arise related to other information that I found during the synthesis process. Please respond freely and openly, sharing your thoughts, recollections, opinions, experiences, and strategies that you have used to implement O&M strategies successfully. As before, I will record the interview and take detailed notes."

4. I will then request permission to record the interview. I will ask the participant if they consent to be recorded. If the interview is by phone, I will ask for permission to record the audio and take notes. If the participant declines to be recorded, then I will ask permission to take detailed notes, and I will inform the participant that the interview may take a little longer than the anticipated 20 to 30 minutes as I will have to stop every so often to update my notes.

5. I will ask the participant if they agree to be recorded. If they agree to be recorded, then I will press the record button, introduce the participant, notate the date and time of the interview, and ask permission of the participant to be recorded what I will say.

    > "Hello, first I would like to let you know that I have begun the recording. Do I have your permission to video record this interview?
    >
    > Participant response "Yes."
    >
    > "Thank you for the recording, today is (insert day and month), and the current time is (time). I am Heather Shimp, and I would like to re-introduce Participant X (Code number of the participant). Today I will walk through each question with Participant X, and I will discuss my interpretation of each question. Participant X will acknowledge or correct me as we progress. Are you ready to begin?"

6. I will then begin with the first question. During the interview, I will watch for non-verbal cues as the participant responds to the seven probing, open-ended questions, as noted in the interview protocols in Appendix B. After each question, I will ask.

    > "Did I miss anything? Is there anything that you would like to add?"

7. Once the participant has answered the questions to the best of their ability, I will wrap up the interview by thanking the participant for their time what I will say.

> "Thank you for participating in this interview today. Please do not hesitate to reach out to me if you have any questions using the contact information, I provided on the consent form."

11. I will then describe what will happen next, what I will say.

> "In the next few weeks, I will finish my doctoral thesis and submit it to the Chief Academic Officer for review and approval. Once approved, I will send you a published copy via email."

12. I will then conclude the interview and stop recording what I will say.

> "Thank you for spending time with me today. This concludes our interview. Before I turn off the recording, do you have any further comments?"

13. If the response is no, then I will terminate the recording. If the response is yes,