

QATAR UNIVERSITY

COLLEGE OF ENGINEERING

STDYING THE BARRIERS AFFECTING THE LEAN IMPLEMENTATION IN
THE CONSTRUCTION INDUSTRY IN QATAR USING RELATIVE
IMPORTANCE INDEX

BY

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A project Submitted to
the College of Engineering
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Engineering Management

June 2024

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ABSTRACT

AL-EMADI, NOORA, N., Master: June : 2024, Master of science in Engineering Management.

Title: Studying the Barriers affecting the lean implementation in the construction industry in Qatar using Relative Importance Index

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Lean implementation in the construction industry has gained significant attention worldwide due to its potential to improve efficiency, reduce waste, and enhance project outcomes. However, various barriers often impede the successful adoption of lean practices, particularly in dynamic environments like Qatar's construction sector. This study investigates the hierarchy of barriers affecting lean implementation in the Qatari construction industry using the Relative Importance Index (RII) methodology.

The research methodology involved administering a survey to industry professionals representing diverse roles and sectors within the construction domain in Qatar. The survey focused on identifying the perceived importance of different barriers to lean implementation using a Likert scale. Data collected from the survey were analyzed using the RII approach, which allowed for the systematic ranking of barriers based on their relative importance.

The survey findings revealed several key barriers that significantly impact lean implementation in the Qatari construction industry. Notably, lack of top management commitment emerged as the most critical barrier, followed by an unsupportive organizational culture and inadequate training or awareness about lean principles. These findings underscore the pivotal role of leadership engagement and organizational

culture in driving successful lean initiatives. Additionally, challenges related to stakeholder communication, financial constraints, and resistance to change were identified as notable barriers hindering lean adoption in the Qatari context.

The RII analysis provided a structured framework for prioritizing these barriers based on their perceived importance, offering valuable insights for industry stakeholders and policymakers. By understanding the hierarchical nature of these barriers, construction organizations can develop targeted strategies to address the most critical challenges and facilitate smoother lean implementation processes.

This study contributes to the existing body of knowledge on lean implementation in the construction industry, particularly in the context of Qatar, by providing empirical evidence of the key barriers and their relative importance. The findings offer practical implications for industry practitioners, project managers, and policymakers seeking to enhance the effectiveness of lean practices in construction projects. Ultimately, overcoming these barriers can lead to improved project outcomes, enhanced competitiveness, and sustainable growth in the Qatar construction industries.

DEDICATION

*I dedicate this work to my lovely family: my father, my mother and all my children
(Shahad and Mohammed), who have always been patient and supportive of me.*

ACKNOWLEDGMENTS

I would like to extend my deepest gratitude to all those who have played a part in the successful completion of this master project. Foremost I am immensely thankful to my supervisor, Dr.Tarek El Mekkawy for his invaluable guidance, support, and encouragement throughout the entire duration of this project. His expertise, feedback, and unwavering belief in my abilities have been instrumental in its completion.

I am also appreciative to the faculty members of Lean Construction Institute-Qatar for their valuable insights and assistance in sharing the survey among the participants. My heartfelt appreciation goes out to all the participants who generously dedicated their time and share their insights to complete the survey. Their contribution has been indispensable in shaping the findings and conclusions of this study.

Lastly, I am grateful to my family and friends for their unwavering support, understanding, and encouragement throughout this journey. Their belief in me has served as a constant source of motivation and inspiration.

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1. INTRODUCTION

1.1 Background

The Construction industry is a vital pillar of any economy, and Qatar is no exception. In Qatar, the construction sector holds significant importance, standing as the second-largest contributor to the country's Gross Domestic Product (GDP), following agriculture. However, issues like project delays, cost overruns, and quality defects persist due to highly complex and fragmented construction processes. To address these challenges, Qatar has adopted some valuable measures to encourage innovation in this field, considering the geopolitical climate in the area. The construction industry in Qatar was motivated to innovate in line with the 2030 Qatar National Vision, which sets ambitious economic and development targets for the country to achieve. However, realizing these goals requires unlocking efficiency and productivity improvements across the construction sector value chain.

The construction sector in Qatar was estimated to be worth \$52.5 billion in 2022 as per the data displayed on the GlobalData website. An annual growth rate (AAGR) of more than 3% is anticipated for the sector in 2024–2027.

Investments in key sectors such as transportation, renewable energy, healthcare, education, oil and gas sectors are expected to drive market growth in Qatar from 2025 to 2027. Additionally, collaborative efforts between the Public Works Authority (PWA-Ashghal) and the Qatar General Electricity and Water Corporation (Kahramaa) on various government-funded projects in 2024 are set to transform the nation's infrastructure landscape. These initiatives are poised to fuel further expansion in the construction sector, contributing to Qatar's economic development and progress. Lean

construction has emerged as an important approach to improve productivity, reduce waste and enhance value in construction projects. Principles like continuous improvement, just-in-time delivery, and process standardization can yield significant benefits if implemented properly. Recognizing this potential, lean techniques have been piloted in public infrastructure projects by the Public Works Authority (Ashghal), specifically for roads and highways construction, with promising results like faster project delivery, improved quality and cost savings.

When it comes to reducing waste, environmental considerations are just as critical as traditional project constraints such as scope, time, budget, and quality. The construction industry, globally, is notorious for generating significant amount of waste therefore, eliminating non-value-adding activities becomes paramount for construction projects to operate more efficiency. In Qatar's construction sector, there is an abundance of project management tools and systems in place. However, many of these systems need to prioritize optimizing workflow efficiency and waste reduction.

PWA-Ashgal has made strides in this direction by implementation Lean methodology, and the outcomes have been promising. Lean construction principles have the potential to transform the local construction industry and address its challenges, not limited to the Road program managed by PWA-Ashghal. However, despite the potential benefits, numerous barriers hinder the effective implementation of lean construction initiatives in various countries worldwide and driving positive change in the construction sector. However, lean construction adoption remains limited to just a few public agencies, with minimal uptake in Qatar's private real estate and construction companies. A key barrier has been the various challenges faced in properly implementing lean methodologies. Studies in other Middle Eastern countries like KSA and UAE highlight issues like lack

of top management commitment, inadequate training, resistance to change, and financial constraints that hinder effective lean execution.

While some research exists on barriers to lean in the wider Gulf region, there is a gap in understanding these challenges specific to the context of Qatar and its construction sector environment. Addressing this knowledge gap is vital to promote lean construction as a crucial means for meeting national efficiency goals.

The study will concentrate on the requirements and obstacles of applying lean management across all phases of construction. A comprehensive analysis of the challenges is necessary to implement lean construction principles and raise the likelihood of successfully removing waste.

The primary objective of this study to pinpoint and evaluate the significant challenges hindering the effective implementation of lean methodology within Qatar's construction sector. By employing the Relative Importance Index (RII), this research endeavors to offer customized recommendation aimed at surrounding these obstacles and fostering a conducive environment for successful adoption of lean construction practices.

1.2 Problem Statement

Qatar has set ambitious goals to transform its construction sector under the Qatar National Vision 2030. This includes aims to foster innovation, boost productivity, ensure timely project delivery, and reduce waste. However, Qatar's construction industry continues to underperform on key metrics like project delays, cost overruns, and quality defects. These systemic issues obstruct the construction sector's ability to act as a trigger for Qatar's economic growth and diversification objectives. Lean

construction techniques have demonstrated global success in driving productivity and efficiency gains in construction projects across planning, design, and execution phases. Yet lean adoption in Qatar remains minimal, primarily restricted to public agencies like Ashghal, that adoption also is even limited to the implementation stage of the construction process while to reap benefits of lean it can even be used in all phases of construction.

The limited use of lean construction in Qatar highlights crucial knowledge gaps regarding the barriers faced by construction organizations in implementing lean methods. This is problematic, as without addressing these obstacles, Qatar will continue to lag in construction performance, holding back its aims for an innovative, sustainable and productive construction sector. Therefore, this study aims to identify, analyze and prioritize the key barriers hindering effective lean construction adoption across Qatar's building sector and challenges for its adoption in all phases of construction. It will engage key industry stakeholders to shape customized strategies to overcome these barriers across all project lifecycle phases, setting the stage for more widespread lean construction implementation in Qatar. Furthermore, This study addresses this knowledge gap by identifying and prioritizing the major hurdles, providing customized strategies to overcome them. The study outputs can guide policy, training programs, demonstration projects and public-private collaboration models in form of a mitigation plan which is needed to enable construction stakeholders to integrate lean techniques, improving productivity, efficiency, quality, and competitiveness.

1.3 Aim

The project aims to support Qatar's construction sector in realizing improved efficiency, productivity, and quality through enhanced adoption of lean construction principles and

practices across all phases of construction. With a rigorous data-backed approach, the study aims to provide realistic and actionable solutions for construction firms, government agencies, and policy-makers to promote lean initiatives.

1.4 Objective

The key objectives of the study are:

1. Identify and prioritize major barriers to lean construction adoption in Qatar through a questionnaire survey and Relative Importance Index analysis.
2. Provide a mitigation plan for construction stakeholders in Qatar to overcome top barriers to promote lean construction practices.

The goal is to find and propose solutions to provide actionable insights that assist in creating an enabling environment for lean construction across all phases to address efficiency challenges.

2. Literature review

2.1 Definition of Lean:

Lean is a management philosophy that originated in the manufacturing sector, particularly pioneered by Toyota in the 20th century. The core idea of lean is to maximize customer value while minimizing waste (Womack, J. P., & Jones, D. T. 2010) (Demirkesen, S., & Bayhan, H.G. 2020). It focuses on continuously improving processes and eliminating anything that doesn't add value from the customer's perspective (Lamming, R., & Hampson, J. 2016).

In the realm of lean principles, "waste" denotes to any activity or resource allocation that does not directly enhance value for the customer. This waste can take on diverse forms, such as overproduction, surplus inventory, idle waiting periods, unnecessary

transportation, excessive processing, defects, and underutilized skills or talent.

Lean principles emphasize the importance of:

1. **Identifying Value:** Understanding what the customer truly values in a product or service.
2. **Eliminating Waste:** Removing any steps or processes that do not contribute to delivering value.
3. **Streamlining Processes:** Optimizing workflows to reduce inefficiencies and improve productivity.
4. **Empowering Employees:** Encouraging employee involvement in problem-solving and continuous improvement efforts.
5. **Pursuing Perfection:** Striving for ongoing improvement and innovation to achieve excellence in operations.

In construction, lean construction is a methodology adapted from lean manufacturing principles, tailored to suit the unique needs of construction sector. It focuses on optimizing value and reducing waste every stage of the construction process. This strategy prioritizes continuous improvement, teamwork, and efficient workflows to boost effectiveness and output across all project phases and stages. Fundamentally, lean construction strives to pinpoint and provide precisely what the customer values, while eradicating tasks that do not align with this value. This entails eradicating diverse forms of waste, including overproduction, surplus inventory, idle time, superfluous transportation, excessive processing, errors, defects and untapped expertise.

2.2 Overview of Lean Construction Principles and Practices:

Lean construction is a management approach that aims to optimize efficiency and minimize waste in construction projects. Lean construction draws heavily from lean

manufacturing principles, emphasizing continuous improvement, collaboration, and value delivery throughout the project lifecycle. Key principles and practices associated with lean construction include waste reduction, improved productivity, enhanced collaboration, increased quality, better risk management, client satisfaction, sustainable practices, continuous improvement, cost savings, and adaptability.

Waste reduction is a fundamental aspect of lean construction, focusing on identifying and eliminating waste in all forms, including materials, time, and effort (Ballard, G., & Howell, G. 2004). By reducing waste, construction projects can achieve significant cost savings and more efficient resource utilization. Improved productivity is another crucial benefit of lean construction, achieved through streamlining processes and emphasizing value-added activities (Alarcon & Jardim, 2012). This leads to shorter project durations and faster delivery times, enhancing overall project efficiency.

Enhanced collaboration is a hallmark of lean construction, promoting communication and cooperation among project stakeholders, including architects, engineers, contractors, and subcontractors (Lean Construction Institute). Collaboration helps identify potential issues early and facilitates the discovery of innovative solutions, contributing to project success. Moreover, lean construction emphasizes increased quality throughout the construction process, aiming to reduce errors, defects, and rework (Alarcon & Diethelm, 2012). Higher quality outcomes result in greater client satisfaction and improved project outcomes.

Another vital facet of lean construction is sustainable practices, which advocate for environmentally conscious construction techniques, reducing resource usages, and waste generation. Through the adoption of sustainable practices, construction endeavor can alleviate their environmental footprint and play a role in fostering a more sustainable future.

Continuous improvement is a core principle of lean construction, emphasizing the ongoing evaluation of processes and the pursuit of optimization (Lean Construction Institute). This culture of continuous improvement fosters innovation and drives efficiency gains over time.

Cost savings are a significant benefit of lean construction, achieved through waste reduction, improved productivity, and enhanced collaboration. By reducing costs, lean construction contributes to the overall profitability of construction projects and enhances stakeholder value. Lastly, adaptability is essential in lean construction, promoting flexibility in response to changing project requirements or external factors. This adaptability enables teams to adjust quickly to unforeseen challenges and maintain project momentum, ensuring project success.

Therefore, lean construction principles and practices offer numerous benefits for construction projects, including waste reduction, improved productivity, enhanced collaboration, increased quality, better risk management, client satisfaction, sustainable practices, continuous improvement, cost savings, and adaptability. By embracing lean construction principles, construction projects can achieve greater efficiency, effectiveness, and sustainability, ultimately delivering higher value to clients and stakeholders.

2.3 Benefits of Lean Construction:

Lean construction is a management philosophy and set of principles aimed at optimizing efficiency and minimizing waste in construction projects. Here are some of the key benefits:

1. **Reduced Waste:** Lean construction emphasizes identifying and eliminating waste in all forms, including materials, time, and effort. This leads to significant cost savings

and more efficient resource utilization.

2. Improved Productivity: By streamlining processes and focusing on value-added activities, lean construction can boost productivity throughout the project lifecycle.

This can result in shorter project durations and faster delivery times.

3. Enhanced Collaboration: Lean construction promotes collaboration and communication among project stakeholders, including architects, engineers, contractors, and subcontractors. This collaboration helps to identify potential issues early and find innovative solutions more effectively.

4. Increased Quality: By emphasizing quality at every stage of the construction process, lean principles help reduce errors, defects, and rework. This results in higher-quality outcomes and greater client satisfaction.

5. Better Risk Management: Lean construction encourages proactive risk identification and mitigation strategies. By continuously monitoring and analyzing project risks, teams can address potential problems before they escalate, leading to smoother project execution.

6. Client Satisfaction: Lean construction focuses on delivering value to the client by aligning project goals with customer needs and expectations. This customer-centric approach enhances client satisfaction and builds trust and long-term relationships.

7. Sustainable Practices: Lean construction encourages sustainable practices by minimizing resource consumption, reducing waste generation, and promoting environmentally friendly construction methods. This helps to mitigate the environmental impact of construction projects.

8. Continuous Improvement: At the heart of lean construction lies the principles of continuous improvement, wherein teams continuously assess processes and strive for enhancement. This philosophy cultivates innovation and sustains a cycle of ongoing

efficiency improvements.

9. **Cost Savings:** By reducing waste, improving productivity, and enhancing collaboration, lean construction ultimately leads to cost savings for project stakeholders. These savings can be significant and contribute to the overall profitability of construction projects.

10. **Adaptability:** Lean construction principles promote flexibility and adaptability in response to changing project requirements or external factors. This enables teams to adjust quickly to unforeseen challenges and maintain project momentum.

Overall, the adoption of lean construction practices can result in more efficient, cost-effective, and sustainable construction projects that deliver higher value to clients and stakeholders.

2.4 Barriers to Lean Construction Implementation

Implementing lean construction principles can face several barriers, which can vary depending on factors such as project complexity, organizational culture, and industry norms. Some common barriers include:

C1. Lack of funds: Implementation lean construction necessitates financial resources for infrastructure, professional salaries, promotional activities, and training investments. Employing a dedicated lean specialist can facilitate successful implementation. Financial challenges encompass inflation, inadequate funding, volatile construction markets, insufficient social infrastructure, low remuneration, and organizational reluctance to invest in employee training and development. (Bashir et al., 2010) (Mossman ,2009) (bayhan et al. 2019).

C2. Challenges in teamwork and conflicting goals in Lean: In lean applications, inefficient processes often stem from a lack of coordination and collaboration among

team members, coupled with conflicting goals when adopting lean methods (Abdullah et al., 2009) (Jadish et al. 2014) (bayhan et al. 2019).

C3. Pressure and stress related to deadlines: The pressure to meet deadlines in construction projects can subject employees to stress, potentially leading to incorrect or incomplete implementation of lean practices (Sarhan and fox 2013) (Howell et al 2017) (bayhan et al. 2019).

C4. Stakeholder communication issues: Ineffective communication results from exclusion of stakeholders from project processes, impacting decision-making and Lean procedures adversely (Jadish et al 2014) (Howell et al 2017) (bayan et al. 2019).

C5. Unsupportive organizational culture: While lean principles find applications across various industries, distinct learning curves may be experienced by different groups due to the diverse backgrounds of lean practitioners, depending on the sectors requirements (Abdulwahab Alyousef, 2019) (Abdullah et al., 2009) (Mossman ,2009)

C6. Lack of Top Management commitment and support (poor management): Challenges in lean implementation may arise due to actions by top management and resistance to adopting lean methods (Abdullah et al., 2009) (Mossman ,2009) (Bashir et al. 2010).

C7. Education: Inadequate Training/lack of awareness: Most government authorities still lack a solid knowledge of lean principles and their benefits, which negatively impacts lean investment decisions (Eriksson,2010) (Abdullah et al., 2009) (Almanei et al.,2017)

C8. Lack of customer-focused and process-based performance measurement systems: Although the industry tends to measure success by adhering to rules, completing deadlines, and cutting costs, customer pleasure has yet to get much attention. Schedule and cost are two traditional project performance criteria

inappropriate for continuous improvement since they could be more effective at identifying the root causes of productivity and quality reductions (Abdullah et al., 2009) (Harshil S. Thakkar and Vismay A. Shah, 2021) (saad 2011).

C9. Adherence to traditional management concepts due to time and commercial pressure: In the construction business, lean is still a relatively new idea. As a result, some practitioners are hesitant to adopt lean methods because they are either unaware of their potential benefits or are satisfied with their current goals and objectives (Radhika R and S. Sukumar 2007) (Saad, 2011) (Abdullah et al., 2009)

C10. Market condition: Market fluctuations may have a detrimental effect on businesses' ability to implement Lean best practices, which could reduce customer satisfaction (Jadish et al 2014) (Howell et al 2017) (bayan et al. 2019).

C11. Inefficiency in resource planning and contract type: Ineffective resource planning can lead to waste and affect the Lean adoption process. Contracts undermine lean concepts since they foster adversarial interactions between the parties (Saad, 2011) (Radhika R and S. Sukumar 2007) (Mossman ,2009)

Addressing these barriers requires a concerted effort from all project stakeholders, including leadership commitment, investment in training and education, fostering a culture of collaboration and innovation, and adapting lean principles to suit the unique needs of each project.

2.5 Construction industry in Qatar:

The construction sector holds significant importance in fostering economic growth and development worldwide, and Qatar is no exception to this trend. Aligned with the ambitious Qatar National Vision 2030 (QNV2030), the country has placed a strong emphasis on innovation within the construction industry to drive economic

diversification and promote sustainable development. This literature review explores the measures adopted by Qatar to encourage innovation in its construction industry, the market dynamics, project management practices, and challenges associated with implementing innovation initiatives.

2.6 Innovation in Qatar's Construction Industry:

Qatar's construction industry has witnessed significant advancements driven by its commitment to QNV2030. This vision emphasizes sustainable development, economic diversification, and social progress. As a result, the construction sector has become a key driver of Qatar's Gross Domestic Product (GDP), attracting substantial investments and fostering innovation across various domains (Qatar National Vision 2030).

Qatar construction market has experienced significant growth driven by investments in vital sectors such as transportation, renewable energy, healthcare, education, oil and gas. These strategic investment have only boosted economics development but have also contributed to the expansion and enhancement of infrastructure and services essential for the country's sustainable growth. According to a report by Global Construction Perspectives and Oxford Economics (2022), the construction market in Qatar was estimated to be worth \$52.5 billion in 2022, with a projected annual growth rate exceeding 3% for the period 2024–2027. These investments not only contribute to economic growth but also support the realization of Qatar's strategic development goals.

2.7 Project Management Practices:

In Qatar, effective project management plays a vital role in ensuring the successful execution of construction projects, especially considering the scale and complexity of

infrastructure endeavors and projects in the country. Robust project management tools and systems are essential for optimizing workflow efficiency and minimizing waste throughout the construction process. Entity like the Public Works Authority (PWA-Ashghal) and the Qatar General Electricity and Water Corporation (Kahramaa) oversee significant construction projects funded by the government, underscoring the importance of efficient project management practices (PWA-Ashghal, 2023).

To enhance project management practices, Qatar's construction industry has embraced Lean methodology. Lean construction techniques focus on maximizing value and minimizing waste throughout the project lifecycle. A study by Alarifi et al. (2021) examined the implementation of Lean construction principles by PWA-Ashghal and reported optimistic results. The application of Lean principles has led to improved project efficiency, cost savings, and enhanced stakeholder satisfaction.

2.8 Challenges and opportunities:

Despite strides in fostering innovation and improving project management practices, Qatar's construction industry encounters several challenges, notably in effectively in implementation of Lean construction initiatives. While Lean principles have shown efficacy in enhancing project outcomes in certain contexts, their adoption remains restricted due to various barriers. As highlighted by Cheng et al. (2020), factors such as organizational culture, resistance to change, and a dearth skilled manpower as barriers to Lean construction implementation in Qatar and other nations.

Another significant challenge is the entrenched traditional mindset prevalent in the construction sector, often resists change and innovation (Alarcon, 2019). Implementing lean principles necessitates a cultural shift towards collaboration, continuous improvement, and waste reduction, potentially met with resistance from stakeholders

accustomed to conventional practices.

Moreover, the complex regulatory environment and contractual arrangements in Qatar's construction industry pose additional hurdles. These intricacies can impede the seamless adoption of lean construction techniques, as they may clash with existing contractual frameworks or necessitate significant adjustments to effectively accommodate lean principles effectively (Odeh & Battaineh, 2020). Addressing these challenges requires concerted efforts to foster a culture of innovation, invest in workforce development, and streamline regulatory processes to facilitate the successful implementation of lean construction initiatives in Qatar's construction landscapes.

Additionally, Qatar's construction industry experiences fluctuating demand and resource availability, driven by factors such as economic conditions, government policies, and mega-event projects like the FIFA World Cup 2022 (Alkaabi et al., 2021). These fluctuations can pose challenges for lean construction implementation, as they may disrupt workflow optimization and resource planning efforts.

Moreover, the diverse workforce in Qatar's construction sector, involving expatriate workers from various cultural backgrounds, language barriers, and skill disparities, can complicate the effective implementation of lean practices (Khanzode et al., 2018). Effective communication and training programs tailored to the needs of a multicultural workforce are essential for overcoming these challenges.

Despite these obstacles, there are efforts to promote lean construction in Qatar. For example, organizations such as the Qatar Green Building Council (QGBC) and the Ministry of Municipality and Environment (MME) have been advocating for sustainable and efficient construction practices, including lean construction techniques.

Additionally, some construction companies in Qatar have embraced lean principles and have achieved notable success in improving productivity, reducing waste, and enhancing project delivery efficiency (Alarcon, 2019).

However, to address the challenges facing lean construction in Qatar effectively, ongoing collaboration among stakeholders, including government entities, industry associations, contractors, and consultants, is crucial. Furthermore, investing in education, training, and capacity building initiatives focused on lean construction principles can help foster a culture of continuous improvement and innovation within the Qatar construction industry.

Moreover, environmental sustainability has emerged as a critical consideration in Qatar's construction industry. With the sector being one of the largest contributors to waste generation globally, there is a growing emphasis on reducing the environmental impact of construction activities. Zhang et al. (2018) highlighted the importance of integrating environmental considerations into project management practices to address sustainability challenges effectively. Strategies such as waste reduction, recycling, and green building design are increasingly being adopted to mitigate environmental impacts and promote sustainable development in Qatar's construction sector.

Several other opportunities exist for innovation and growth. One prominent opportunity stems from the government's commitment to infrastructure development and sustainability initiatives, particularly in preparation for major events like the FIFA World Cup 2022 (Alkaabi et al., 2021). The significant investment in infrastructure projects creates a beneficial environment for the adoption of advanced construction technologies and methodologies, including lean construction techniques.

Moreover, Qatar's Vision 2030 emphasizes economic diversification and knowledge-

based growth, presenting opportunities for construction companies to explore new sectors such as healthcare, education, and tourism (Al-Maamari et al., 2020). These emerging sectors require specialized construction solutions, offering avenues for innovation and differentiation.

Additionally, Qatar's strategic location as a regional center for trade and commerce positions its construction industry to benefit from international partnerships and collaborations (Hassanain et al., 2019). Leveraging global expertise and best practices can enhance the competitiveness and capabilities of local construction firms.

Furthermore, the increasing focus on sustainability and green building practices presents opportunities for integrating environmentally friendly construction techniques and materials into projects (Alarcon, 2019). Qatar's commitment to sustainability, as reflected in initiatives like the Qatar National Vision 2030 and the Qatar Green Building Council (QGBC), underscores the importance of adopting sustainable construction practices (Qatar Green Building Council, n.d.).

Additionally, the increasing trend of digitalization within the construction industry presents opportunities for the adoption of advanced technology such as Building Information Modeling (BIM), virtual reality (VR), and augmented reality (AR) these technologies offer enhancements in project planning, design, and execution (Baird et al., 2021). Embracing digital tools and processes has the potential to enhance efficiency, minimizing errors, and foster collaboration among project stakeholders.

In conclusion, Qatar's construction industry presents various opportunities for growth and innovation, driven by government initiatives, economic diversification efforts, sustainability goals, international collaborations, and technological advancements. By

capitalizing on these opportunities and addressing the associated challenges, stakeholders can contribute to the industry's sustainable development and competitiveness in the global market

Qatar's construction industry plays a vital role in driving economic growth and achieving the objectives outlined in QNV2030. Through strategic investments, innovative practices, and effective project management, Qatar has positioned itself as a regional leader in infrastructure development. However, challenges such as the effective implementation of Lean construction initiatives and addressing environmental sustainability remain areas of focus for the industry. By overcoming these challenges and leveraging opportunities for innovation, Qatar's construction sector can continue to thrive and contribute to the country's sustainable development goals.

2.9 Examples of Lean construction projects in Qatar:

2.9.1 Hamad International Airport (HIA) Expansion Project:

One notable project in Qatar that has implemented lean construction technology is the Hamad International Airport (HIA) Expansion Project. The project, aimed at expanding Qatar's primary international airport to accommodate the country's growing air traffic demands, employed lean construction principles to enhance efficiency and productivity throughout the construction process (Qatar Airways, 2016).

Lean construction techniques were integrated into various aspects of the project, including planning, scheduling, and resource management, to streamline operations and minimize waste. For instance, the project team utilized Last Planner System (LPS) methodologies to improve coordination among subcontractors and optimize workflow sequences, leading to reduced project delays and cost overruns (Coulter, 2018).

Additionally, Building Information Modeling (BIM) technologies were leveraged to enhance collaboration among project stakeholders and facilitate real-time decision-making, contributing to improved project outcomes (Rybkowski et al., 2019).

By adopting lean construction practices, the HIA Expansion Project achieved notable successes in terms of project delivery efficiency and quality. The project was completed on schedule and within budget, despite its complexity and scale, demonstrating the effectiveness of lean methodologies in large-scale construction projects in Qatar (Qatar Airways, 2016). Moreover, the implementation of lean construction techniques has set a precedent for future construction projects in Qatar, encouraging industry-wide adoption of lean principles to enhance productivity, minimize waste, and improve project outcomes.

2.9.2 Msheireb Downtown Doha:

Msheireb Downtown Doha as a groundbreaking sustainable development project, reimagining the urban landscape in the heart of Qatar's capital city. Embracing the principles of lean construction, the project exemplifies efficiency, sustainability, and innovation in urban development. By integrating lean practices into its construction processes, Msheireb Downtown Doha aims to optimize project delivery, minimize waste, and maximize value for stakeholders (Msheireb Properties, n.d.).

At its core, lean construction principles are evident in the collaborative planning and continuous improvement initiatives undertaken throughout the development. Through value stream mapping and just-in-time delivery methods, the project streamlines construction processes, ensuring resources are utilized efficiently and effectively (Alarcon, 2019). This lean approach not only enhances productivity but also contributes to sustainability goals by reducing material waste and environmental impact.

Moreover, lean construction techniques facilitate the integration of advanced

technologies and innovative solutions into the project. Building Information Modeling (BIM) and digital construction tools are utilized to enhance coordination among project stakeholders, optimize design decisions, and improve construction sequencing (Kassem et al., 2020). These digital innovations align with lean principles, enabling real-time collaboration and data-driven decision-making to drive project success.

By incorporating lean construction principles into its development framework, Msheireb Downtown Doha demonstrates Qatar's commitment to fostering sustainable urban environments and advancing construction practices in alignment with global best practices. As a flagship project in the region, its success showcases the transformative potential of lean construction methodologies in large-scale urban development initiatives.

2.10 Gaps in Existing Body of Knowledge

Significant progress is noted in implementing lean principles in construction projects in Qatar as well as worldwide, still several areas remain underexplored or insufficiently understood.

One significant gap in the literature pertains to the adaptation of lean construction principles to the specific contexts of emerging economies, such as Qatar. While studies have demonstrated the successful application of lean techniques in developed countries, there is a need for research that explores the unique challenges and opportunities for lean implementation in rapidly growing economies with diverse cultural, regulatory, and socio-economic contexts (Achal, 2016).

Furthermore, the integration of digital technologies, including Building Information Modeling (BIM), Internet of Things (IoT), and Artificial Intelligence (AI), with lean construction practices represents an area with significant potential but limited empirical

evidence. Research focusing on the interactions between lean principles and digital innovations could offer insights into how technology can enhance the efficiency, effectiveness, and sustainability of lean construction processes (Kassem et al., 2020). Additionally, there is a gap in understanding the human factors and organizational dynamics that influence the successful adoption and sustained implementation of lean practices within construction firms. While lean construction emphasizes collaboration, continuous improvement, and employee empowerment, studies examining the socio-cultural aspects of lean implementation, including leadership styles, organizational culture, and employee engagement, are relatively scarce (Yan et al., 2019). Addressing these gaps in the existing literature is crucial for advancing the theory and practice of lean construction and promoting its widespread adoption in the construction industry. By filling these knowledge voids, researchers can contribute to the development of more effective strategies for the lean implementation tailored to the specific context and challenges faced by construction firms, particularly in emerging economics like Qatar.

3. Research Methodology

3.1 Research Design

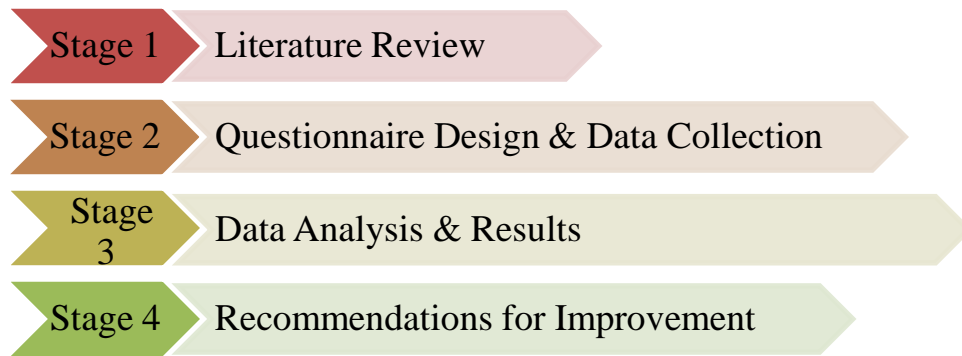


Figure 1. Research Methodology

Stage 1: Literature Review

Figure (1) above provides the stages of research methodology stage by stage, in stage 1 about review all relevant papers published in the last decade. Identify and categories factors related to implementing Lean management.

Stage 2: Questionnaire Design & Data Collection

Design a questionnaire to gather data on the relative levels of importance of the predetermined factors using the Relative Importance Index (RII) method.

- Define sample size
- Collect and sort data

The questionnaire would be divided into two parts:

1. General Information
 - Respondents' years of experience
 - Level of education
 - Knowledge of the Lean concept
 - Type of organization

- Job titles
- Project divisions

2. The Importance of the Barriers in Implementing Lean

- Assess the importance of each barrier using a 5-point Likert scale:
 - Not Important (1)
 - Low Important (2)
 - Moderately Important (3)
 - High Important (4)
 - Extremely Important (5)

Stage 3: Data Analysis & Results

Analyze the collected data using the Relative Importance Index (RII).

Tabulating survey information in following sections:

- Survey Results
- RII and Rank Analysis
- Key Findings

Stage 4: Recommendations for Improvement

Based on the analysis, provide recommendations and mitigation plans to overcome top barriers to promote lean construction practices in Qatar.

3.2 Data Collection Approach

3.2.1 Questionnaire Design

The questionnaire utilized in this study was meticulously crafted to collect data on the barriers hindering the implementation of lean practices in Qatar construction industry. Its design underwent a systematic process to guarantee validity, reliability, and efficacy in capturing the required information.

Initially, an extensive review of literature was conducted to identify and categorize the potential barriers to lean implementation in the construction sector. These barriers were then structured into a comprehensive list, laying the groundwork for the questionnaire design.

The questionnaire comprised two main sections:

General Information: This section aimed to collect demographic and background information about the respondents. It included inquiries regarding their years of experience in the construction field, education attainment, knowledge of lean concepts, type of organization they work for, job titles and roles, and the project involvement. Such information was pivotal for discerning potential variations in perceptions based on respondents' characteristics.

Importance of Barriers in Implementing Lean: This section centered on evaluating the perceived importance of each identified barrier to lean implementation. Respondents were tasked with rating the importance of each barrier using a 5-point Likert scale.

The utilization of the Likert scale afforded respondents the ability to express their perceptions accurately, furnishing a quantitative measure for subsequent analysis using the Relative Importance Index (RII) methodology.

Subsequently, the finalized questionnaire underwent meticulous preparation for distribution, taking in to account factors such as layout, flow, coherence, and

respondent comprehension. Clear and concise instructions were provided throughout the questionnaire to guide respondents and ensure the accuracy of their responses.

3.2.2 Sampling Method

A combination of stratified random sampling and snowball sampling techniques was employed to obtain a representative sample of construction professionals in Qatar. The target population included individuals working in various roles and organizations within the construction industry. Initially, a stratified random sampling approach was used, stratifying the population based on factors like organization type, project divisions, and company size. Within each stratum, a systematic random selection of companies was made, and professionals from those companies were invited to participate. Additionally, a snowball sampling method was utilized, where respondents were requested to share the survey with their professional networks, increasing the sample size and diversity

3.2.3 Survey Administration

The survey was administered online using the SurveyMonkey platform. The survey link (<https://www.surveymonkey.com/r/QRMQF8N>) was distributed to potential respondents via email, professional networks, and industry associations. The survey was open for responses for a period almost one month. Reminders were sent at regular intervals to increase the response rate. Respondents were assured of confidentiality and anonymity of their responses.

3.3 Data Analysis Methods

3.3.1 Relative Importance Index

The Relative Importance Index (RII) is a statistical tool utilized in survey research used to determine the relative importance of various factors or variables based on respondents perceptions or preferences. It serves as a means to quantify the significance of various attributes within a dataset, aiding researchers in identifying key factors of interest.

The RII is calculated using the following formula:

$$R = \frac{\sum W}{A \times N}$$

Where: W : weight given to each factor by the response. the weight ranging from 1 to 5.

A : highest weight (5)

N : total number of respondents (72)

Construction researchers commonly apply the (RII) to assess the relative importance of quality factors by analyzing structured questionnaire responses. The Likert scale points correspond to the value of W, representing the weighting attributed to each factor by the respondent. This methodology allows researchers to quantify the importance of different factors and prioritize area for improvement or intervention within the construction industry. The table below shows the ranking scale used for data measurements.

Table 1. Five-point Likert Scale

Not	Low	Moderate	High	Extremely
Important	important	Important	Important	Important
1	2	3	4	5

It is a valuable tool in the construction industry for assessing stakeholders' perceptions, preferences, and priorities regarding various aspects of construction projects. By using RII to prioritize factors such as project planning, risk management, supplier selection, sustainability, and stakeholder engagement, construction firms can make informed decisions and enhance the overall success of their projects.

3.3.2 Rank Analysis

After computing the RII for each barrier, the barriers were ranked in descending order based on their RII values, following the approach outlined by Chen et al. (2010), Table (2) bellow illustrates the importance derived from RII analysis

Table 2. Importance Level from RII

Importance level	RII
HIGH (H)	$0.8 < \text{RII} < 1.0$
High-Medium (H-M)	$0.6 < \text{RII} < 0.8$
Medium (M)	$0.4 < \text{RII} < 0.6$
Medium-Low (M-L)	$0.2 < \text{RII} < 0.4$
Low(L)	$0.0 < \text{RII} < 0.2$

- The table shows the Relative Importance Index RII of the factors along with corresponding ranking which indicates the barriers with an RII value above 0.8 were categorized as highly important barriers.
- Barriers with an RII value between 0.6 and 0.8 were categorized as high-medium
- Barriers with an RII value between 0.0 and 0.2 were categorized as low importance barriers.

The ranking provides valuable insights into perceived significance of each barriers in hindering the implementation of lean practices within the construction sector. By prioritizing barriers according to their RII values, stakeholders can focus their efforts on addressing the most critical obstacles first, thereby enhancing the likelihood of successful lean implementation initiatives. The top 3 barriers with the highest RII values were identified as the most critical barriers to Lean implementation in the Qatari construction industry.

Statistical tests, such as e.g., Kruskal-Wallis test, Mann-Whitney U test, were performed to identify significant differences in the perceived importance of barriers among different groups.

4. Result and Analysis

4.1 Survey Results

The survey aims to explore the barriers affecting the implementation of lean principles within Qatar's construction industry. Lean methodologies, geared toward enhancing efficiency and productivity to minimizing waste, hold significant potential for

improving construction process. Recognizing and addressing these barriers is essential for optimizing project outcomes in Qatar's construction sectors. Therefore, the study seeks to achieve several objectives. Firstly, it aims to pinpoint the key barriers impeding the effective of lean practices in Qatar's construction sector secondly, it endeavors to gauge the perceived importance of these barriers among professional and stakeholders within the construction sectors. By doing so, it aims to prioritize barriers for targeted intervention and mitigation efforts.

The survey targets a diverse range of professionals and stakeholders involved Qatar's construction industry, encompassing various sectors such as employers/clients, contractors, consultants, designers project managers/construction managers, facility management/operations, finance/banking, developers, legal affairs, universities (research and development), among others. By soliciting input from individuals with diverse backgrounds and expertise, the survey aims to capture a broad spectrum of perspectives on the barriers to lean implementation in Qatar's construction segment.

Overall, the survey endeavor to generate valuable insights that can inform strategies and initiatives aimed at surmounting barriers and fostering the successful integration implementation of lean principles in construction projects in Qatar. By addressing these barriers head-on, stakeholders can unlock the transformative potential of lean methodologies, thereby enhancing the efficiency, sustainability, and overall quality of construction endeavors in the country. The total numbers of responses received were 72, based on which the data is analyzed and comprehend.

The survey conducted among professionals in the construction industry in Qatar presents a comprehensive overview of their demographics and insights into lean management principles and implementation barriers. Impressively, an overwhelming majority of respondents (97%) display a deep familiarity with Lean Management

Principles, reflecting a strong foundation for adopting lean practices across construction projects in Qatar as it shows in figure (2) below. This high level of familiarity suggests a readiness within the industry to embrace modern management methodologies for enhancing operational efficiency and productivity.

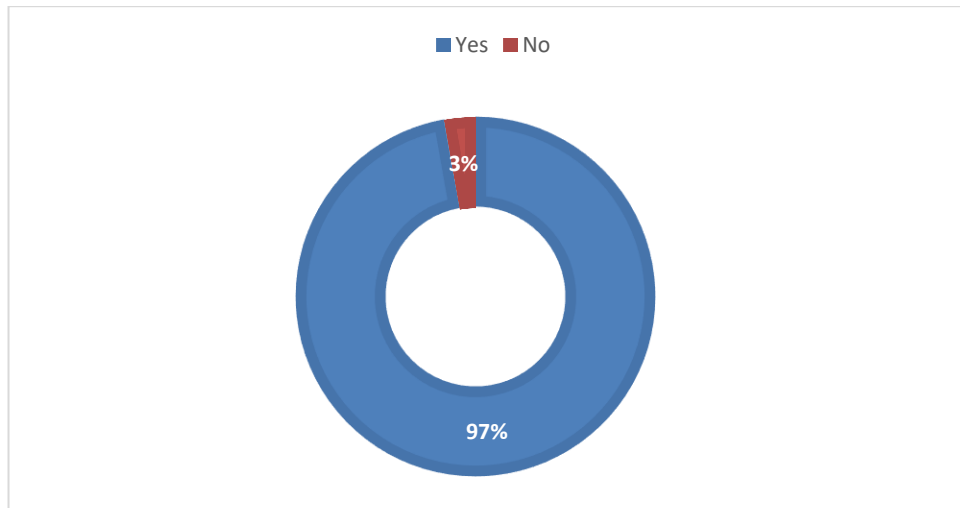


Figure 2. Familiarity with Lean Management Principles

Delving deeper into the demographic composition of respondents, figure (3) represents the private sector emerges as the dominant sector, with 61.11% of respondents hailing from this segment. This sectoral distribution provides valuable context for understanding how sector-specific dynamics may influence perceptions and practices within the Qatari construction industry.

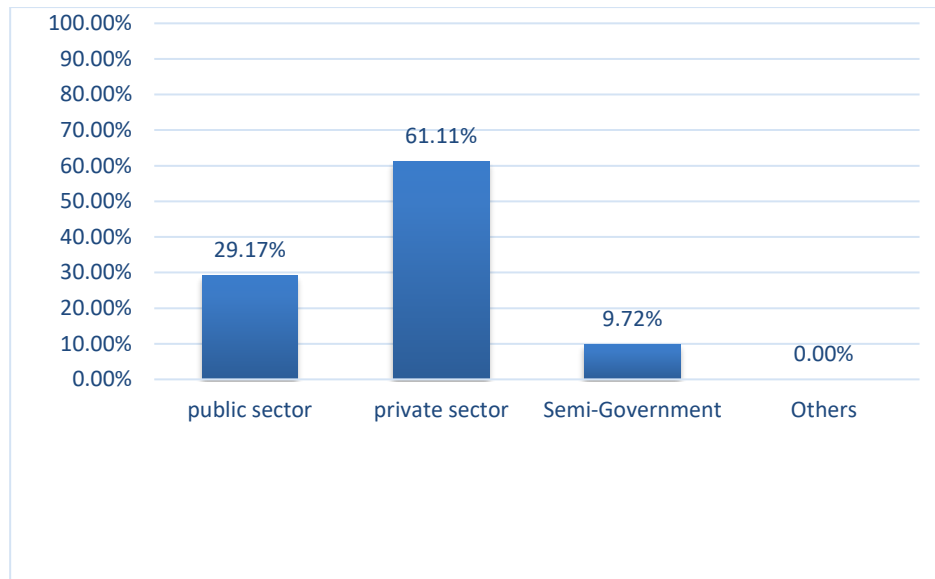


Figure 3. Organization Sector of the respondent

Furthermore, while project and construction management stand out as primary areas of expertise, with 79.17% of respondents indicating proficiency as project/ construction management, figure (4) indicates that there are noticeable gaps in representation across certain job positions. For instance, designers are notably underrepresented, signaling potential disparities in engagement or interest among different professional segments.

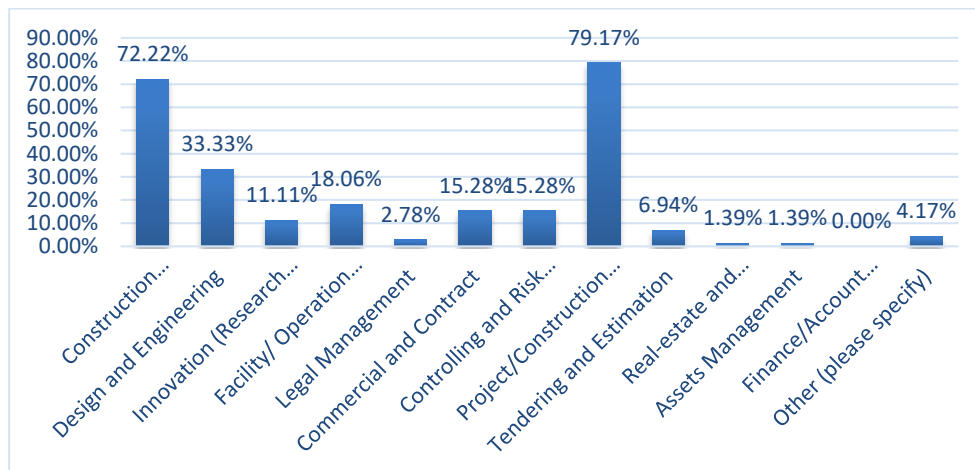


Figure 4. Area of Expertise.

The years of experience of the respondent was collected by the survey in the general section. Respondents with between 11 and 15 years of experience accounted for 23.61 percent of responses; those with between 16 and 20 years of experience and those

more than 25 years of experience came in second and third, respectively. The results of the survey show that participants had wide experience profiles, as shown in Figure (5)

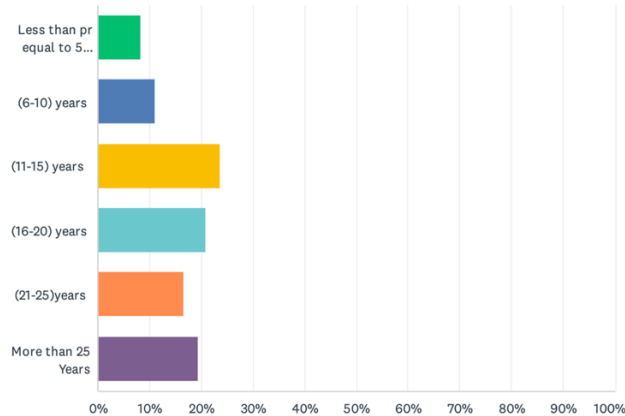


Figure 5. Years of Experience

Examining the barriers to lean implementation, the survey uncovers critical challenges hindering progress in the adoption of lean practices within the Qatari construction industry.

By providing detailed insights into the demographics, expertise, and perspectives of professionals in the Qatari construction industry, this survey offers valuable guidance for stakeholders seeking to promote lean adoption and address implementation barriers effectively. The data-rich findings serve as a foundation for developing targeted strategies to foster a culture of continuous improvement and drive sustainable growth within the industry.

4.2 RII and Rank Analysis

The survey results presented offer a quantitative indication into the challenges and barriers hindering the implementation of lean principles within the construction industry in Qatar. With a structured breakdown of respondent's perceptions, this data

sheds light on the relative importance assigned to various factors impacting lean adoption. These findings serve as a vital tool in understanding the detailed landscape of lean implementation, guiding stakeholders towards targeted strategies for overcoming obstacles and fostering a culture of continuous improvement within the Qatari construction sector

In survey result, data cleaning is considered unnecessary due to small sample size and small percentage of reputational and therefore, its less need to worry about error or bias in analysis.

The survey results obtained from respondents who rated different factors on a scale from 1 to 5, representing varying levels of importance. Each factor is denoted by a code (C1 to C11), and the scale values correspond to the number of respondents who rated each factor at a particular level of importance: "1" indicating "Not Important" and "5" indicating "Extremely Important."

Table 3 Survey Results

scale value	1	2	3	4	5				
code	NI	LI	MI	HI	EI	total	weight	RII	rank
C1	1	2	11	32	26	72	296	0.82222	5
C2	0	2	11	35	24	72	297	0.82500	4
C3	0	5	16	39	12	72	274	0.76111	9
C4	0	1	17	31	23	72	292	0.81111	6
C5	0	0	7	26	39	72	320	0.88889	2
C6	0	0	2	25	45	72	331	0.91944	1
C7	0	2	12	31	27	72	299	0.83056	3
C8	0	1	16	41	14	72	284	0.78889	8
C9	0	3	22	36	11	72	271	0.75278	10
C10	1	6	23	27	15	72	265	0.73611	11
C11	0	1	14	40	17	72	289	0.80278	7

For instance, factor C1 received 1 rating of "1," 2 ratings of "2," 11 ratings of "3," 32 ratings of "4," and 26 ratings of "5." The total number of responses for each factor sums

up to 72, which implies that all respondents provided their ratings for each factor.

Additionally, table (3) includes calculated values such as the total score (total), the weighted score (weight), and the Relative Importance Index (RII). The RII is a metric used to quantify the relative importance of each factor, calculated by dividing the weighted score by the total score.

Finally, the factors are ranked based on their RII values, with lower ranks indicating higher relative importance. For instance, factor C6 has the highest RII value of 0.91944, making it the most important factor according to the respondents, hence receiving rank 1. Conversely, factor C10 has the lowest RII value of 0.73611, indicating the least importance and receiving rank 11.

A comprehensive analysis of the Relative Importance Index (RII) for various factors influencing lean implementation within the construction industry, specifically in Qatar is shown in the table below.

Table 4 RII Analysis

Factor	Likert Scale Point					N	Responses		RII
	NI	LI	MI	HI	EI		Min	Max	
C1	1	2	11	32	26	72	1	5	0.82222
C2	0	2	11	35	24	72	2	5	0.82500
C3	0	5	16	39	12	72	2	5	0.76111
C4	0	1	17	31	23	72	2	5	0.81111
C5	0	0	7	26	39	72	3	5	0.88889
C6	0	0	2	25	45	72	3	5	0.91944
C7	0	2	12	31	27	72	2	5	0.83056
C8	0	1	16	41	14	72	2	5	0.78889
C9	0	3	22	36	11	72	2	5	0.75278
C10	1	6	23	27	15	72	1	5	0.73611
C11	0	1	14	40	17	72	2	5	0.80278

The table presents an analysis of the Relative Importance Index (RII) for factors impacting lean implementation in a specific context, likely within the construction industry in Qatar. Each factor, denoted by codes C1 to C11, is assessed based on Likert

scale points ranging from 1 to 5, where 1 signifies "Not Important" and 5 signifies "Extremely Important."

It is evident that certain factors are perceived as more critical than others. For instance, factors like lack of funds (C1), teamwork challenges (C2), and stakeholder communication issues (C4) display relatively high RII scores, indicating their substantial impact on lean implementation.

Moreover, the distribution of Likert scale responses within each factor reflects the varied perceptions of respondents. Factors such as stress and pressure in deadlines (C3) and adherence to traditional management concepts (C9) received mixed ratings, with some respondents considering them highly important while others rated them lower.

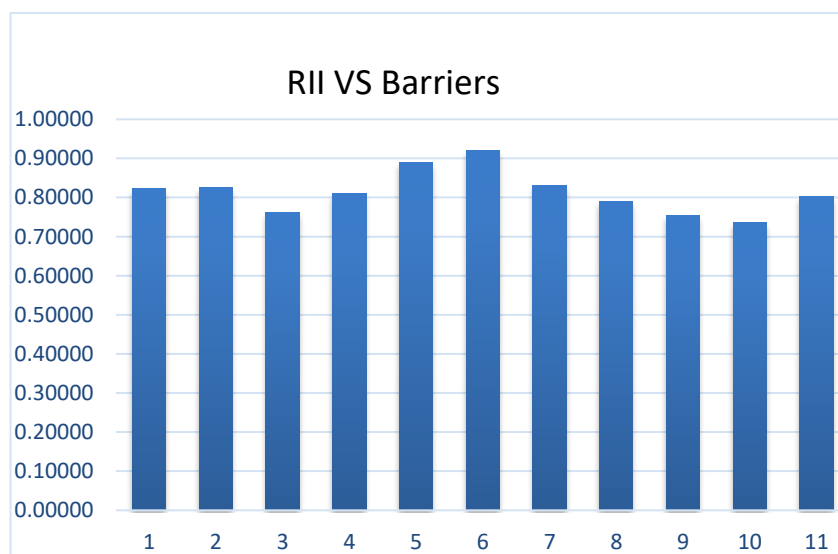


Figure 6. RII Analysis Chart

This analysis serves to quantify the perceived importance of different barriers to lean implementation, providing stakeholders with valuable insights into areas that require prioritized attention. It allows for a more nuanced understanding of the challenges faced in adopting lean practices within the construction industry, facilitating the development of targeted strategies to address these barriers effectively.

4.3 Key Findings

The survey conducted within the construction industry in Qatar reveals several significant findings regarding the perception of lean management principles and the identification of barriers to their implementation. Over 60% of respondents hail from the private sector, indicating a predominant focus on commercial construction activities. Impressively, nearly all participants (97%) exhibit familiarity with lean management principles, suggesting a high level of awareness within the industry. Job positions among respondents vary, with a notable presence of consultants, contractors, and department managers, offering diverse perspectives on lean implementation.

Table 5. Relative Important Indices with Ranking

Code	Factor	RII	Rank	Status
C6	Lack of Top Management commitment and support	0.91944	1	High(H)
C5	Unsupportive organizational culture	0.88889	2	High(H)
C7	Education: Inadequate Training/lack of awareness	0.83056	3	High(H)
C2	Teamwork challenges and divergent goals in Lean	0.82500	4	High(H)
C1	Lack of funds	0.82222	5	High(H)
C4	Stakeholder issues in communication	0.81111	6	High(H)
C11	Inefficiency in resource planning and contract type	0.80278	7	High(H)
C8	Lack of customer-focused and process-based performance measurement systems	0.78889	8	High-Medium(H-M)
C3	Stress and pressure in deadlines	0.76111	9	High-Medium(H-M)
C9	Adherence to traditional management concepts due to time and commercial pressure	0.75278	10	High-Medium(H-M)
C10	Market condition	0.73611	11	High-Medium(H-M)

Analysis of the Relative Importance Index (RII) as shown in table (5) underscores critical barriers to lean adoption, with top priority factors like lack of top management commitment (C6) and unsupportive organizational culture (C5) receiving high RII scores exceeding 0.9 and 0.88 respectively. Other significant barriers include lack of funds (C1) and stakeholder communication challenges (C4), supported by RII scores above 0.8. Conversely, factors such as adherence to traditional management concepts (C9) and market conditions (C10) exhibit relatively lower RII scores, indicating perceived High-Medium Importance. These findings provide valuable insights for industry stakeholders to prioritize efforts in overcoming barriers and fostering a conducive environment for lean implementation within the Qatari construction sector. The analysis also suggests that factors related to management commitment, organizational culture, education/training, teamwork challenges, and lack of funds are of the highest priority. These factors should be addressed with urgency to improve the overall effectiveness and success of the project or organization. Additionally, factors categorized as medium priority still hold significance and require attention but may be addressed with relatively lower urgency compared to high priority factors.

5. Conclusion

In conclusion, the findings from the survey and analysis shed light on the current state of lean implementation within the construction industry in Qatar. The study reveals a high level of familiarity with lean management principles among respondents, indicating a strong foundation for potential adoption. However, critical barriers, such as lack of top management commitment and unsupportive organizational culture, pose significant challenges to effective implementation. Addressing these barriers is crucial

for unlocking the full potential of lean practices and fostering a culture of continuous improvement within the industry.

This study has undertaken a comprehensive exploration of lean implementation dynamics in construction industry, focusing on identifying barriers and exploring strategies for overcoming them. Through a robust review of literature, analysis of survey data, and application of the Relative Importance Index (RII) methodology, valuable insights have been garnered regarding the challenges and opportunities associated with lean adoption in construction projects.

Key barriers identified include the lack of top management commitment and support, unsupportive organizational culture, inadequate training or awareness about lean principles, and challenges related to stakeholder communication and financial constraints. Despite these challenges, the study also highlights several strategies and best practices that can enhance the effectiveness of lean practices in construction projects. These include fostering a culture of continuous improvement, providing comprehensive training and education programs, aligning incentives with lean objectives, and fostering collaboration among project stakeholders. Moreover, leveraging digital technologies and data-driven approaches can enhance decision-making and project performance, facilitating smoother lean implementation processes. Moving forward, the findings of this study offer valuable implications for industry practitioners, project managers, and policymakers seeking to advance lean practices in the construction sector. By addressing the identified barriers and adopting proactive strategies, construction organizations can unlock the full potential of lean principles to drive efficiency, improve project outcomes, and foster sustainable growth. However, recognizing that lean implementation is not a one-size-fits-all solution, careful

customization and adaptation are necessary to suit the unique context and challenges of each construction project.

Therefore, continued research, collaboration, and knowledge sharing are essential to further refining and enhancing lean practices in the construction industry. Ultimately, by overcoming barriers and embracing lean principles, the construction sector can navigate the complexities of modern projects more effectively, delivering greater value to stakeholders and contributing to the overall advancement of the industry.

6. Recommendations

To overcome these challenges and promote lean implementation in the Qatar construction sector, several recommendations can be made:

1. **Top Management Commitment:** Encourage top management to demonstrate strong leadership and commitment to lean principles by actively participating in implementation efforts and providing necessary resources and support.
2. **Organizational Culture:** Foster a supportive organizational culture that values innovation, collaboration, and continuous improvement. This may involve investing in employee training and development programs to increase awareness and understanding of lean concepts.
3. **Stakeholder Communication:** Improve communication channels and processes to facilitate better collaboration and alignment among project stakeholders, thereby addressing issues related to stakeholder communication highlighted in the survey.
4. **Financial Considerations:** Address financial constraints and challenges by exploring opportunities for cost optimization, value engineering, and strategic investment in lean initiatives.
5. **Training and Education:** Invest in comprehensive training and education programs to enhance the skills and capabilities of construction professionals, ensuring they are

equipped with the knowledge and tools needed for successful lean implementation.

6. Benchmarking and Best Practices: Learn from the experiences of other organizations and industries by benchmarking against best practices in lean construction and adopting proven strategies for overcoming implementation barriers.

By prioritizing these recommendations and taking proactive steps to address the identified barriers, the Qatar construction industry can unlock the full potential of lean principles, leading to improved project outcomes, enhanced productivity, and sustainable long-term success.

7. Future Work

1. The survey results could be made more precise and sufficient by using the Analytic Hierarchy Process (AHP) in future work, which would also bring additional depth and clarity. The Analytic Hierarchy Process (AHP) provides a structured approach for decision-making, facilitating comprehensive evaluation and prioritization of barriers affecting the implementation of lean management
2. extending the survey and study on barriers affecting the implementing of lean management in the construction sector beyond Qatar to cover the wider Middle East region which could improve inclusiveness. This expansion would offer a more comprehensive understanding of common challenges and facilitate the development of region-specific strategies for successful lean management implementation in construction sector.

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Appendix 1: Survey QUESTIONNAIRE

Hierarchy of Barriers affecting the lean implementation in the construction industry in Qatar using Relative Importance Index (RII)

Part one: General

Which sector can represent your significant experience?

Mark only one choice

- Public Sector
- Private Sector
- Semi-Government
- Others: _____

Are you familiar with lean management principles?

- Yes No

What job position can represent your significant experience?

Mark only one choice

- Employer/Client
- Contractor
- Consultant
- Designer
- Project Manager/Construction Manager
- Facility Management/Operation
- Finance/Banking
- Developer
- Legal Affairs
- Universities (Research and development)
- Others: _____

What is your position in your current role?

Mark only one choice

- Executive Manager (CEO, CFO, COO, CO)
- Department Manager/Head
- Senior Manager
- Mid Senior Manager
- Standard Level
- Others: _____

What is your area(s) of expertise?

Choose all that are applicable.

- Construction Management
- Design and Engineering
- Innovation (Research and development)
- Facility/Operation management
- Legal Management
- Commercial and Contracts
- Controlling and Risk Management
- Project/Construction Management
- Tendering and estimation
- Real-estate and development
- Assets Management
- Finance/account management
- Others: _____

Which type of projects you are familiar with and reflect your experience?

Choose all that are applicable

- Building Constructions
- Infrastructure (Road, Bridges, Railway...etc.)
- Utilities (Water, Electricity, Drainage, Telecom)
- Oil and Gas
- Sports Facilities
- Urban Planning and Transportation
- Theme Parks and museums
- Information technology (IT)
- Others: _____

What is your total number of years of working experience?

Mark only one choice

- Less than or equal to 5 years
- (6-10) years
- (11-15) years
- (16-20) years
- (21-25) years
- More than 25 years

Part Two: Barriers

What is the importance of the following barriers to implementing lean in the construction industry in Qatar?

1.1 lack of funds

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.2 Teamwork challenges and divergent goals in lean

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.3 Stress and pressure in deadlines

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.4 Stakeholder issues in communication

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.5 Unsupportive organization culture

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.6 Lack of Top management commitment and support

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.7 Education-inadequate training/ lack of awareness

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.8 Lack of customer-focused and process-based performance measurement systems

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.9 Adherence to traditional management concepts due to time and commercial pressure

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.10 Market Condition

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

1.11 inefficiency in resources planning and construction types

Mark only one choice per row

Not Important	Low important	Moderate Important	High Important	Extremely Important
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2 Out of all above barriers which one is most import

3. any other barriers you think.....

