Performance of an Infrastructure Project Following the Deployment of a Customized Lean Strategy

Ramez Alchamaa
Dorsch Gruppe–Middle East, Doha, Qatar
ramez.alchamaa@dorsch.com

Hisham M. S. Abushaqra
Public Works Authority (Ashghal), Roads Projects Department, Doha, Qatar
habushaqra@ashghal.gov.qa

Abstract

This paper highlights the benefits of adopting and implementing a tailored lean construction strategy with its dynamic action plans during the construction phase of one of Qatar's recently completed infrastructure projects. The study includes using various enhancement measures and criteria combined with best practices by different project teams from all involved parties. The paper also proves the influence of producing a systematic work process during the project life cycle on overcoming challenges and barriers, in which the critical elements of accomplishment, improvements, and the conditions of satisfaction are adequately outlined and recorded. Through this paper, the lead author claims to achieve one primary goal, which is to name the most crucial barriers that affect the deployment of the Lean Construction concept within the construction industry based on data collected from four infrastructure projects, including the evaluated one in this paper. The required data was collected and collated through questionnaire surveys conducted on 57 professionals following many interactive workshops held by the lead author about the importance of Lean Construction implementation in construction projects. Concurrently, data analysis outcomes were used in the PDCA cycle of continuous improvement. The findings emphasize the importance of leadership engagement in lean deployment processes, and training sessions/workshops, besides rewarding the project team members as a pillar towards an ideal productivity level with the practical usage of resources and delivering the utmost value to the client.

Keywords: Continuous improvement; Lean Construction (LC); Enhanced Contract (EC); Enhancement Check Sheet (ECS) Score; Conditions of Satisfaction (CoS)

1 Introduction

Modern construction projects face frequent burdens related to shorter durations and uncertainty throughout their life cycle (Koskela et al., 2002). The crucial challenge in these current projects lies in the miscoordination of activities and tasks among the project's different teams as the traditional approach for delivery of projects is typically utilized. Given that the implementation of the Lean Construction (LC) principles and tools becomes a recognized approach worldwide to help reduce the uncertainty of activities scheduled in the preliminary plan (initial) schedule at high-level details. The problem seems obvious when new activities or unforeseen changes appear at a particular week of their execution on-site. Then, going ahead in the execution of such activities without properly eliminating the associated constraints might lead to an unreliable workflow that can hinder the overall project progress. In this regard, and as a considerable step forward, the Public Works

Authority (ASHGHAL) has lately adopted the Lean Construction (LC) principles by introducing the Enhanced Contracts in the Construction of infrastructure projects for the first time in the State of Qatar. Adopting this advanced approach in project management has become a strategic intent to enhance communication with stakeholders and residents, safety measure, and the overall appearance of the workplace. As a result, this would speed up the delivery time of projects and improve overcoming challenges the project may face promptly by recognizing and prioritizing them early.

Likewise, by implementing the (LC) principles appropriately, each stage of the construction project is planned for and controlled closely. In addition, holding regular Collaborative Planning sessions in the Project Performance Centre (i.e., The Big Room) would involve as many stakeholders as possible. Using various facilitation techniques to encourage consensus and cooperation is an efficient tool for monitoring the project's performance in all aspects. Furthermore, this implementation provides a more accurate prediction about the work completion schedule considering any emergent constraints and changes in priorities. The project works are also divided into zones and sub-zones for completion according to a zonal delivery plan that intends to minimize the impact of construction works on the residents of the target area or zone (disruption management).

This paper describes a thorough record of the main events of a sensible lean journey for one of the recently completed roads and infrastructure projects. The paper also outlines and evaluates the adopted enhancement measures by the project team, best practices during the life cycle of the cited infrastructure construction project, and the benefits realized through the following sections.

Finally, it is worth noting that the studied project in this paper is governed by the Public Works Authority (ASHGHAL), through the Enhanced Contract (EC) for infrastructure construction projects.

2 Project Overview

The designated project in this paper is a major project of roads and infrastructure construction in residential areas, namely Project A. The project consists of three zones– Zone 0, Zone 1, and Zone 2, with a total area of 117 hectare that covers over 119 residential plots; the scope of work is summarized as follows:

- The construction of drainage networks, including foul sewer, surface water, and groundwater lowering networks. Besides a treated sewerage effluent system (TSE) and portable water network with an approximate length of 33.5 km.
- The construction of a road network with an approximate length of 7.5 km and about 1,112 parking bays. The construction of pedestrian walkways and cycleways within the road corridors with an approximate length of 14.97 km and landscaping a length of 30.36 km.
- The construction of electrical and telecommunications networks.
- The installation of streetlights, traffic signals, and Intelligent Transportation Systems (ITS).

3 Overcoming Challenges and Emergent Barriers

The chronological chart in Figure 1 illustrates a summary of the project's schedule performance from the starting date of Project A in July 2019 till the end of December 2021. A couple of months later, following the start date, particularly in October 2019, the project started suffering from a gradual increment of the reported percentage of variance (delays) as per the original baseline schedule. The

peak point of the reported delays (i.e., a cumulative variance of 37%) occurred in June 2020 due to different events including, but not limited to, COVID-19, where the project has been forced to adapt significant challenges and formulate tailored solutions to mitigate the delays and other impacts caused by COVID-19. In July 2020, the project's leadership, from the Supervision Consultant to the Contractor, built an effective collaborative environment.

In the first place, the formed collaborative environment has targeted overall cultural change and the spread of the collaborative set mindset among team members in the project. The established environment has encouraged the interactive transfer of knowledge in a structured way inside the organization. All voices are heard, and contributions are valued within a safe, open dialogue space focused on asking questions and providing input on various subjects and issues. Furthermore, a recovery plan to minimize the excessive delays was prepared collaboratively between different teams, from the Supervision Consultant to the Contractor, in July 2020. It resulted in the production and implementation of a new revision of the Activity Program as a practical tool for monitoring the performance against planned activities with actual daily rates. It also allocated resources for each activity to ensure a predictable and reliable workflow of on-site construction activities.

Remarkably, the weekly performance of the project started to improve dramatically, with a considerable decrement in delays in the schedule as of August 2020 onwards. The delays began to decrease to an acceptable magnitude of ≤ 5% in February 2021 following the active implementation of the Lean Construction philosophy and tools in the project with the operative engagement of the leadership and teams from different disciplines.

It is worth mentioning that recorded delay in schedule has decreased significantly around the magnitude of ≤ 1% as of June 2021 and maintained to be around this percentage till the end of the year 2021, as demonstrated in Figure 1. This productivity improvement is attributed to the effective collaborative pull production planning and other lean implementation activities with the broad participation of different teams from both the Supervision Consultant and the Contractor associated with an operative implementation of the approved enhancement and lean strategy for the project as of May 2021.

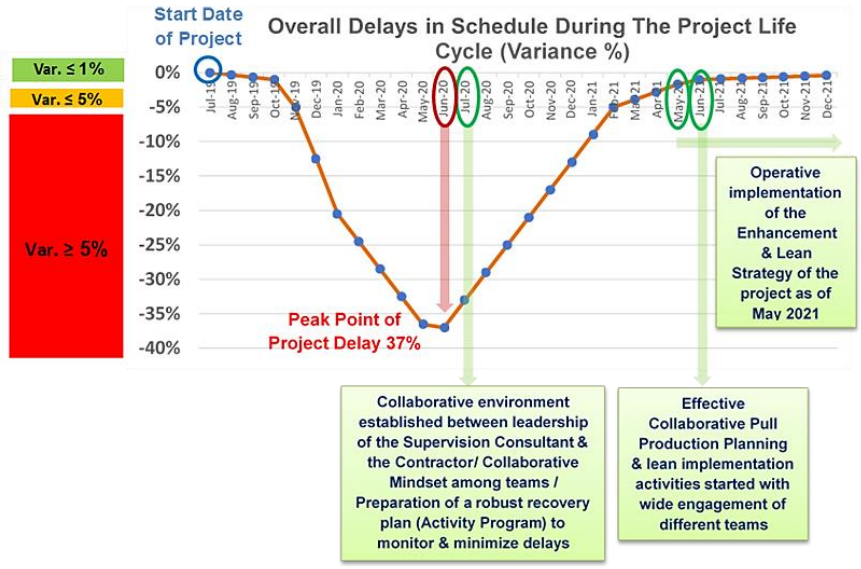
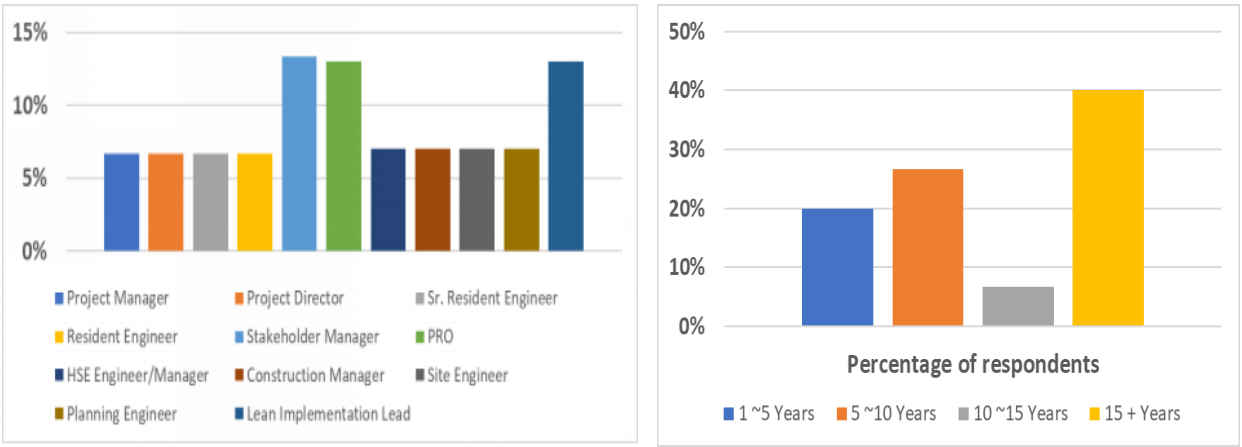


Fig. 1: Major Events in Project Performance

Additionally, the analysis of the chronological chart formed the keystone to conducting a deep-rooted survey to understand the barriers to LC implementation. For this purpose, the lead author has undertaken a series of structured questionnaire surveys to highlight these broadly experienced barriers and challenges in most of the ongoing construction projects to support a successful LC implementation. The cited questionnaire surveys were conducted on a sample of 57 professionals from four infrastructure construction projects, namely Project A, B, C, and D, as primary respondents following several interactive workshops held by the lead author about the importance of Lean Construction principles and implementation in construction projects. As a sample validation, Figure 2 demonstrates the survey respondents' position and total years of experience. According to the



corporation type, the survey respondents represent two parties: The General Contractor (53%) and the Supervision Consultant as representative of the Client (47%).

Fig. 2: Position and Total Years of Experience of Survey Respondents

Based on the gathered information, the lead author performed a descriptive exploratory analysis of the data to extract the most critical and influential barriers, as illustrated in Figure 3. As a result, the significant obstacles defined in this study are the lack of knowledge and understanding of LC due to insufficient training, which is the most effective barrier (45%), followed by the lack of knowledge about the expected benefits of Lean Construction implementation to the construction projects (27%). On the other hand, lack of leadership engagement and collaborative teamwork is a slightly less effective barrier (20%), followed by cultural barriers and attitude to work besides resistance to change by management (8%).

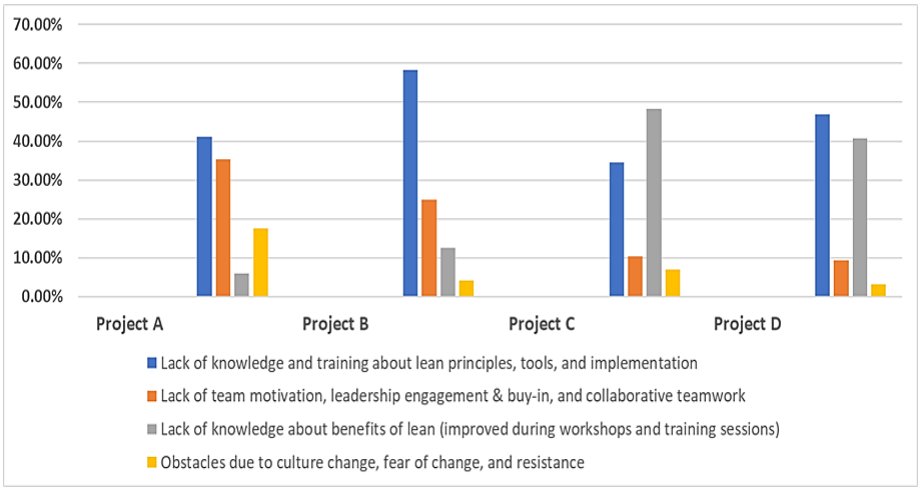


Fig. 3: Summary of the Most Influential Barriers to Lean Construction Implementation

The identified barriers are used for producing a customized enhancement and lean strategy for Project A that aligns with ASHGHAL's pre-set enhancement strategy that targets the enhanced infrastructure projects of 2021. Also, the practical implementation of the LC principles and tools has resulted in improving productivity by eliminating different types of reported wastes of available resources, time, and effort in addition to the repeated observations, minimizing the non-added value activities, and generating the maximum possible amount of value to the client and end-users. The upcoming sections of this paper present all these particulars. The efficient implementation of the approved robust enhancement strategy for Project A during the 2nd Quarter of 2021 has drawn the roadmap to achieve the target productivity, enhanced quality & safety performance, public satisfaction, schedule performance, and early delivery of various project's key stages, and authority satisfaction in alignment with ASHGHAL's pre-set enhancement strategy targets and predefined six categories and criteria for the enhancement process in Enhanced Contract projects (i.e., 1) Project delivery. 2) Site organization and management. 3) Planning and control. 4) HSEQ & KPIs. 5) Public relations and stakeholder management, and 6) Lean construction implementation. These six categories are the major components of the Enhancement Check Sheet (ECS). Hence, the ECS is the monthly evaluation and scoring system with over 100 criteria.

4 The Status of Enhancement & Lean Implementation Before and During the First Quarter of 2021 for Project A

Figure 4 illustrates the status of the Enhancement Check Sheet (ECS) Scores at the end of 2020 and early 2021 before preparing and implementing the Enhancement & Lean Strategy for the Project as of May 2021.

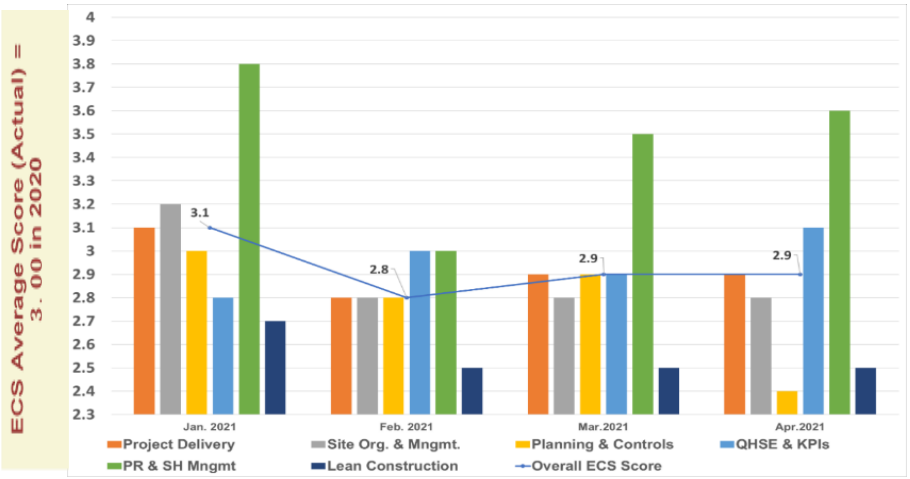


Fig. 4: The Scores of Major Enhancement Categories Before the Implementation of the Enhancement & Lean Strategy For 2021

5 Development of Operative Action Plans for Project A, Based on the Pre-Set Enhancement and Lean Strategy Targets by Ashghal

The continuous improvement (Kaizen) of the ECS categories following the approval and implementation of the enhancement & Lean Strategy for 2021 is demonstrated clearly in Figure 5.

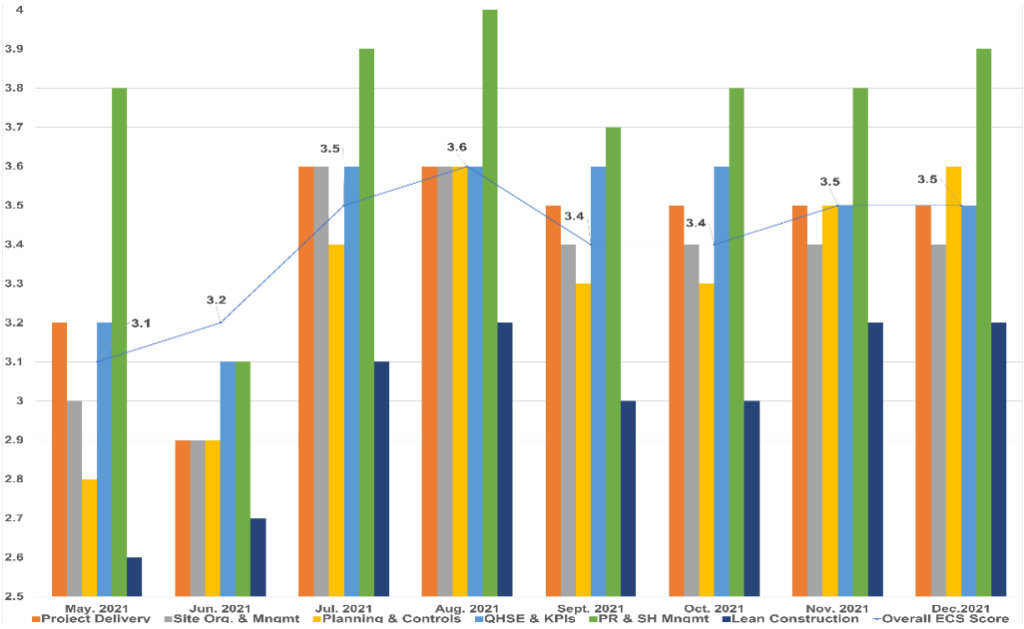


Fig. 5: The Continuous Improvement (Kaizen) of the ECS Categories Following the Implementation of the Approved Enhancement & Lean Strategy for 2021

Table.1 highlights the continuous improvement in the achievement rate of the strategic objectives against the strategic target task as commitments over Q2, Q3, and Q4 of the year 2021.

Table 1: The Enhancement Strategy Performance against the Target Strategic Tasks

(A) Target Strategic Tasks	**Q2 2021**		**Q3 2021**			**Q4 2021**		
	May 21	June 21	July 21	August 21	Sept. 21	Oct. 21	Nov. 21	Dec. 21
	29		40			44		
(B) Achieved strategic objectives	24		37			41		
Achievement rate (B/A) % per quarters during 2021	**89%**		**92%**			**93%**		

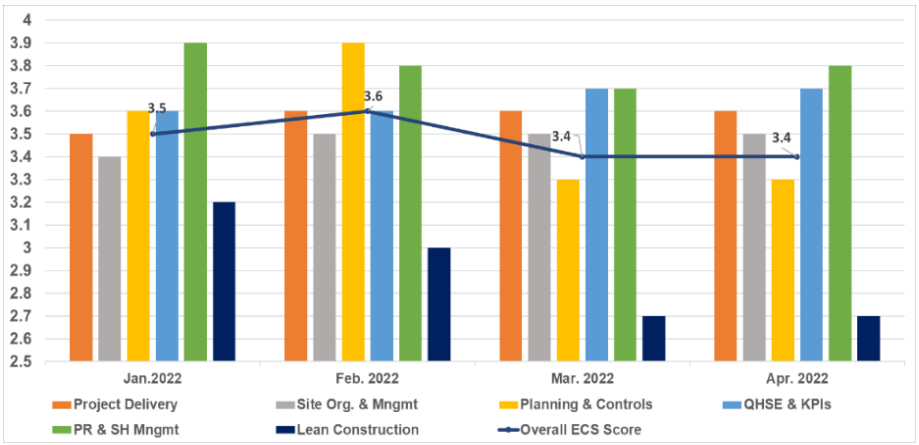


Fig. 6: Status of the ECS Categories During 2022 (January 2022 to April 2022)

Figure 6 displays the status of the ECS categories during the first four months of 2022 until the end of April 2022, when the Project entered the handover and closure phase as the completed tasks are being transferred to the client. The approved enhancement & Lean Strategy for 2021 for Project A

has been completed collaboratively, engaging all team members' inputs and commitments to achieve the targeted strategic tasks from the discipline's representatives in May 2021.

6 The Conditions of Satisfaction for the Ecs Categories During 2021

Table 2 summarizes the ECS categories and their respective conditions of satisfaction (CoS).

Table 2: ECS Categories and Their Respective Conditions of Satisfaction (CoS)

ECS Categories	Conditions of Satisfaction (CoS)
1. Project Delivery	Conduction of regular Collaborative Handing Over sessions with all assigned vital actions.
2 . Site Organization & Management	Site organization, elevated workplace, and proactive resolution of forecasted issues/ bottlenecks collaboratively.
3. Planning & Controls	Use of the actual productivity rate to develop the planning process.
4. HSEQ & KPIs	As a pre-set condition, the observations related to quality, health, safety, and welfare will be reduced by 70% at the end of Q4-2021.
5. Public Relations & Stakeholder Management	Standardize look & feel and achieve ZERO complaints status from the public at the end of Q4-2021 with a reduction in PR complaints by 50% from the previous year.
6. Lean Construction Implementation	The early completion dates of Key Stages due to the successful embedding of lean tools in all Key Stages & challenging pulling sessions of activities.

7 The Adopted PDCA Cycle for Continuous Improvement of ECS Categories and Regular Lean Implementation Activities

Figure 7, Figure 8, and Figure 9 illustrate the improvement of the ECS categories and the regular Lean Implementation Activities (e.g., Gemba walks as stated afterwards) using the PDCA Cycle. All crafted satisfaction conditions and their criteria were met as per the targeted objectives in the Project enhancement strategy for each quarter in 2021. As it is known, conducting the Gemba walk is a great event to allow managers and leaders from the Supervising Consultant and the Contractor to jointly observe the actual work process, engage with other teams and disciplines to gain knowledge about the work process, and explore opportunities for continuous improvement. Figure 7 illustrates the continuous improvement in the number of reported observations from the monthly Gemba walks as of February 2021. The recorded number of observations has decreased dramatically to be limited to 2 observations per month during the 4th quarter of 2021, with a significant improvement in the number of closed observations within ten days from the observations' day. This improvement relates to the satisfactory conditions of the entire ECS categories (see Table 2).

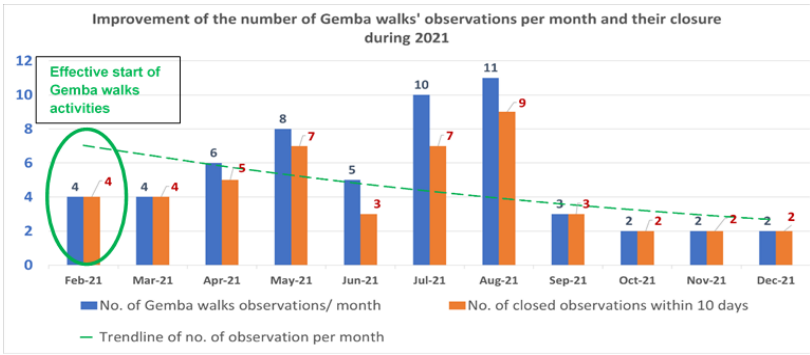


Fig. 7: Continuous Improvement in the Gemba Walks' Observations and their Closure

Likewise, Figure 8 presents the continuous improvement in the number of Public Relation Complaints (PRC) and the overall status of disruption management for Project A following the effective implementation of the enhancement strategy for 2021. Figure 8 reveals that the total number of PRC during 2021 is eight complaints, three of them were reported by the PR team from May 2021 till the end of 2021 (i.e., ZERO complaints status was achieved during Q3 and Q4 of 2021).

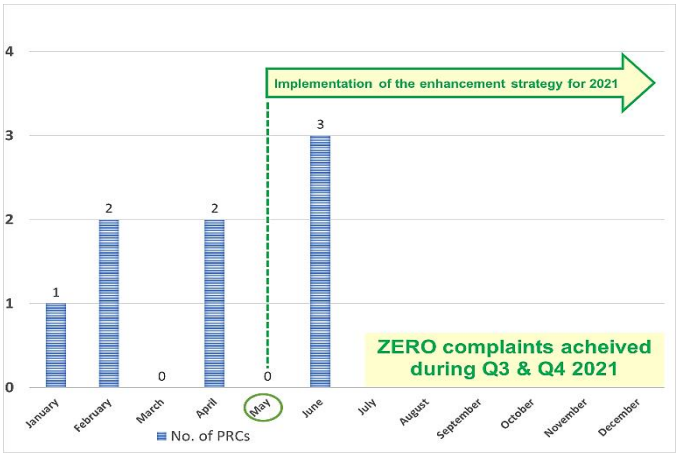


Fig. 8: Continuous Improvement in The Number of PR Complaints During 2021

This recorded status reflects an effective collaboration between various teams in implementing the enhancement strategy that meets the respective CoS for the PR & stakeholder management category (see Table 2). As for the site safety observations, they decreased dramatically during 2021, as illustrated in Figure 9, in which 99 observations were recorded by the respective HSE team early in Jan. 2021.

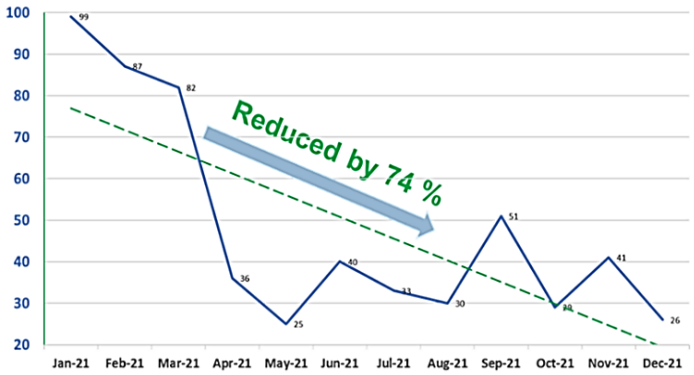


Fig. 9: Continuous Improvement of the Number of Safety Observations During 2021

These observations were eliminated significantly over 2021 quarters to record only 26 observations by the end of 2021 to indicate the outstanding engagement of all teams from various disciplines in the process. A considerable reduction of 74% of the observations is reported during the 4th quarter of 2021; this meets the respective CoS stated in Table 2 for the HSEQ & KPIs category.

8 Leadership Engagement in Lean Deployment, Training Sessions, Workshops, and Recognition (as a Pillar & Key Critical Factor of Continuous Improvement)

Systematic learning and knowledge transfer are proven to have a valuable role in the continuous improvement of this project as they focused on the following perceptions: 1) Empower teams' members with the support of leadership and encourage their collaborations and inputs to the project's

enhancement. Moreover, recognizing and awarding the team members as champions for their outstanding performance every month is proven to be a perfect asset to improve the project's enhancement process. 2) The collected feedback from questionnaire surveys is used to improve the process, have new commitments, and concentrate the teams' efforts on specific areas of improvement as required. 3) Use the monthly assessment of the ECS scores to adjust the strategic tasks that are part of the enhancement strategy of Project A.

9 Conclusion & Recommendations

This paper offered an inside view of a successful lean journey for a designated infrastructure project in the State of Qatar, including a description of the project status and emergent impediments at the initial stage of a selected project under the EC. The study in this paper displays that the leadership and teams' non-adoption of the lean culture is influenced by barriers that are mostly related to people, organizational processes, and other operational aspects. The analysis of these barriers was used to form a solid base for a productive preparation and deployment of a customized LC strategy and its target strategic tasks, remarking that addressing the organizational culture factors in construction was necessary for a successful implementation of practices (Cheung, Wong, & Wu, 2011). The outcome of this study emphasizes the importance of setting good Conditions of Satisfaction and strategic objectives to support LC adoption. In addition, the applied performance evaluation system on LC implementation outcomes of this study utilized the monthly evaluation and scoring system of the (ECS) that has already been stipulated by the Client (ASHGHAL) at an early stage of the construction. The ECS formed a handy tool for closely monitoring the implementation, the success factors, and the crafted CoS for the project. This performance evaluation system proved to help drive change and assess the quarterly performance of the customized action plans. The plans are updated as needed to ensure they are well linked to the CoS and achievable within the pre-determined timeframe for each condition. The cited system also accounts for implementation barriers that should be considered together with the lean-specific factors and CoS (Bassioni, Price, & Hassan, 2005). Lastly, the outcomes of this study can contribute to the further development of effective evaluation systems for future infrastructure projects.

References

Bassioni, H. A., Price, A. D. F., & Hassan, T. M. (2005). Building a Conceptual Framework for Measuring Business Performance in Construction: An Empirical Evaluation. *Construction Management and Economics, 23*(5), 495–507. DOI: 10.1080/0144619042000301401

Cheung, S. O., Wong, P. S. P., & Wu, A. W. Y. (2011). Towards an Organizational Culture Framework in Construction. *International Journal of Project Management, 29*(1), 33-44. DOI: http://dx.doi.org/10.1016/j.ijproman.2010.01.014

Koskela, L. & Howell, G. (2002). The Theory of Project Management: Explanation to Novel Methods, In Proc. 17th Ann. Conf. of the Int'l Group for Lean Construction, Gramado, Brazil, August 6-10.

Cite as: Alchamaa R. & Abushaqra H.M.S., "Performance of an Infrastructure Project Following the Deployment of a Customized Lean Strategy", *The 2nd International Conference on Civil Infrastructure and Construction (CIC 2023)*, Doha, Qatar, 5-8 February 2023, DOI: https://doi.org/10.29117/cic.2023.0018