



Assessing the awareness level of built environment lecturers on the lean principles practice in construction

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Abstract

The construction industry is continually evolving, with a growing emphasis on efficiency and sustainability. Lean principles have emerged as a promising approach to optimize processes and minimize waste in construction projects. However, the extent to which lecturers in the built environment are familiar with and integrate lean principles into their teaching remains understudied. This research aims to assess the awareness level of built environment lecturers regarding lean principles practice in construction. Using quantitative approach, data was collected through surveys from a sample of built environment lecturers across few institutions. The study investigates the lecturers' understanding of lean principles, their utilization in teaching practices, and any perceived barriers to integration. Quantitative data analysis provides insights into the overall awareness level. The findings suggest a varied level of awareness among built environment lecturers, with some demonstrating a comprehensive understanding of lean principles, while others exhibit limited or none familiarity. Common challenges such as a lack of resources, training opportunities, and institutional support emerged as factors to incorporating lean principles into teaching curricula. This study contributes to the existing literature by shedding light on the current awareness level of built environment lecturers regarding lean principles practice in construction. The findings informed strategies to enhance educators' knowledge and integration of lean principles, ultimately fostering a more informed and proficient workforce equipped to meet the evolving needs of the construction industry.

Keywords: Lean principles, built environment, awareness and lecturers

Introduction

The construction industry plays a significant role in the economic growth and development of nations, including Nigeria. However, one of the persistent challenges in this sector is the efficient management of construction projects, particularly in terms of time performance. Delays and cost overruns are common issues that hinder the successful completion of construction projects, leading to economic losses and reduced stakeholder satisfaction.

The construction industry is a vital part of the economical backbone in numerous countries, frequently representing between 7-10 percent of the Gross Domestic Product, (Barbosa, Woetzel, & Mischke, 2017) ^[5]. Furthermore, construction products and processes have a large impact on safety, health and environmental aspects. Since all human beings in modern societies are directly affected by its processes and/or products, the importance of a well-functioning construction industry is beyond doubt. In many countries the construction industry has, however, attracted criticism for inefficiencies in outcomes such as time and cost overruns, low productivity, poor quality and inadequate customer satisfaction, the failure of any construction project is mostly related to the performance problems and there are many reasons and factors which are attributed to such problems. A large number of performance indicators such as time, cost, quality, client satisfaction, client changes, business performance, health and safety could be related to various dimensions and used in measuring and evaluating project performance (Sibiya, Aigbavboa & Thwala, 2015) ^[21].

Time management is one of the keys to effective project management as weaknesses in the time management will

cause delays in project completion (Memon, *et al.* 2014). Hence, time in construction projects need to be controlled from the beginning of the construction process until the project is totally completed. Time management is the application of various methods and techniques to ensure the completion of projects within stipulated time. Without a proper time - management, many problems will occur such as extension of time or time overrun which is a common problem in today's construction industry worldwide (Shah, 2016). Time overrun occur when the actual progress of a construction project is slower than the planned schedule (Shah, 2016). Therefore, to address these challenges, various project management methodologies have been introduced, including Lean Construction. Lean Construction emphasizes the elimination of waste and the continuous improvement of project processes.

Lean is an approach that identifies the value inherent in specific products, identifies the value stream for each product, supports the flow of value, lets the customer pull value from the producer, and pursues perfection (Afolabi, 2015) ^[1]. Lean is doing more with less. Use the least amount of effort, energy, equipment, time, facility space, materials, and capital while giving customers exactly what they want (Suhail Iqbal, 2015) ^[22]. Lean Construction advocates for collaborative production planning while emphasizing on the reliability of workflows, promotion of pull-based culture and an improved communication system. Similarly, it promotes trust and transparency with the sole aim of maximizing customer value and improving the performance of the industry (Madhani, 2018) ^[12].

1. Statement of Problem

Construction practices in Nigeria however, is characterised by many problems. The industry is notable for its poor performances in terms of cost overruns in projects, poor project planning and control, poor project completion times and compliance with deadlines, and an increase in rework and defects (Oyewobi *et al.* 2011, Okafor, 2016). The failure of any construction project is mostly related to the performance problems and there are many reasons and factors which are attributed to such problems. A large number of performance indicators such as time, cost, quality, client satisfaction, client changes, business performance, health and safety could be related to various dimensions and used in measuring and evaluating project performance (Memon, *et al.* 2014). Tengan, *et al.* (2016) opined that construction time is very important because it often serves as an essential benchmarking for measuring the performance of a project and the competence of the project organization. But however, construction has been facing numerous issues and one of them is time management issue which have cause delayed in completion of a project (Oyewobi *et al.* 2011, Okafor, 2016).

Although Lean methodologies have gained recognition globally, their application to the Nigerian construction context remain largely unexplored. Therefore, this research aims to investigate the level of awareness of lecturers in the Built Environment domesticated in the higher institution of learning in Bauchi Metropolis with the objective of improving construction project performance.

2. Aim and Objectives

The aim of this research is the assess of awareness of lecturers in built environment on lean principles practices with the view for improving construction project performance in Higer institution of learning in Bauchi State. This can be achieved through the following objectives

1. To identify the lean principles practices in the construction project.
2. To assess the level of awareness of lecturers of Built Environment on lean principles practices in construction project.

3. Scope of The Research

The conceptual scope of this research is limited on the lean principles practice with the view of improving construction project. The research cannot pretend to address everything within the domain of the study. As such, it is necessary to state the boundaries of knowledge and basic assumptions underlying the study. The research only considered lecturers that are from School of Environmental Technology of higher institution of learning in Bauchi.

4. Significance of The Research

The research will highly be significant to entire humanity due to the population that were targeted. Since the research is on the awareness of lecturers on lean principles practices, the academic environment has this as an encouraging tool that can be used to improve and intensify researches. Finally, the general public are actively users of the construction industry's products.

Literature Review

1. Concept of lean construction

Lean principles, derived from the Toyota Production System (TPS), have gained recognition as effective methodologies for improving operational efficiency and reducing waste in diverse sectors, including academia (Chiarini, Baccarani & Mascherpa, 2018) ^[8]. Awareness and understanding of Lean principles among academicians are essential for promoting a culture of continuous improvement and driving organizational excellence within academic institutions.

The concept of lean construction represents a paradigm shift in the construction industry, emphasizing efficiency, waste reduction, and continuous improvement throughout the project lifecycle. Originating from the manufacturing sector, lean principles have been adapted to address the unique challenges faced by construction projects, such as variability, complexity, and fragmentation. Lean construction seeks to streamline processes, enhance productivity, and maximize value for all stakeholders involved in the project. This paper provides an overview of the key concepts and principles of lean construction and its awareness in relation to lecturers of built environment towards construction project time performance in construction industry.

Lean construction is founded on several core principles, including value stream mapping, flow optimization, pull scheduling, and continuous improvement. Value stream mapping involves analyzing the entire construction process to identify value-adding activities and eliminate non-value-adding waste (Ramani & KSD, 2021) ^[16]. Flow optimization focuses on ensuring smooth, uninterrupted workflows by minimizing delays, disruptions, and bottlenecks. Pull scheduling involves sequencing work activities based on actual demand, rather than predetermined schedules, to reduce overproduction and inventory buildup. Continuous improvement, also known as Kaizen, involves ongoing efforts to identify and implement process enhancements to achieve higher levels of efficiency and quality.

2. Lean Principles

The principles of Lean manufacturing encompass a range of methodologies and practices aimed at optimizing efficiency, reducing waste, and improving overall productivity within an organization. Among these principles, the 5S Process is a foundational concept that emphasizes workplace organization and cleanliness (Randhawa & Ahuja, 2017) ^[17]. Originating from Japanese terms, the 5S Process consists of sorting, straightening, shining, standardizing, and sustaining. According to Randhawa & Ahuja, (2017) ^[17], sorting involves removing unnecessary items from the workspace, straightening focuses on arranging remaining items in an orderly manner for easy access, shining pertains to cleaning and maintaining cleanliness, standardizing establishes guidelines for maintaining the organized state, and sustaining involves developing habits to ensure the continued adherence to the 5S principles. Implementing the 5S Process fosters a culture of efficiency and organization, laying the groundwork for further Lean initiatives.

Face-to-face communication within small teams is a Lean principle aimed at minimizing communication distortions and fostering collaboration. According to Randhawa & Ahuja, (2017) ^[17], direct, personal communication within small teams promotes clarity, accountability, and problem-solving agility. By encouraging open dialogue and active

listening, face-to-face communication reduces the risk of misunderstandings, delays, and errors that can arise from written or electronic communication channels. This principle underscores the importance of human interaction in building trust, resolving conflicts, and driving collective action towards shared goals.

Kaizen, or Continuous Improvement, is a core Lean principle focused on incremental, ongoing enhancements to processes, products, and systems (Carnerud, Jaca, & Bäckström, 2018) [7]. Kaizen involves empowering employees at all levels to identify inefficiencies, propose solutions, and implement improvements on a continuous basis. By fostering a culture of experimentation, learning, and adaptation, Kaizen enables organizations to stay competitive and responsive to changing customer needs. Kaizen emphasizes the importance of small, incremental changes over time, recognizing that sustained improvement is achieved through collective effort and commitment. Poka-Yoke, also known as Error Proofing, is a Lean principle aimed at preventing errors and defects from occurring in processes or products (Romero, Gaiardelli, Powell & Zanchi, 2022, September) [18]. Poka-Yoke involves designing foolproof mechanisms or safeguards to prevent or detect mistakes before they result in defects or customer dissatisfaction. By incorporating mistake-proofing devices, visual cues, or error detection systems into work processes, organizations can reduce rework, scrap, and customer complaints. Poka-Yoke promotes a proactive approach to quality assurance, emphasizing prevention over detection and correction.

Target Value Design (TVD) is a Lean principle that focuses on delivering maximum value to customers while minimizing waste and cost (Ballard, 2020) [4]. According to Ballard (2020) [4], TVD involves establishing a target cost based on customer requirements and then designing products or processes to meet that cost target without compromising quality or functionality. By engaging stakeholders early in the design process and aligning design decisions with value-driven criteria, organizations can optimize value delivery and enhance customer satisfaction. TVD promotes a holistic approach to value creation, encouraging continuous improvement and innovation throughout the organization. Daily huddle meetings are another essential Lean principle aimed at promoting communication, collaboration, and alignment among team members (van Dun & Wilderom, 2021) [23]. Daily huddle

meetings, also known as stand-up meetings or daily scrums, provide an opportunity for team members to discuss priorities, share progress updates, and identify any obstacles or challenges that may impede workflow. By convening brief, focused meetings at the start or end of each day, teams can quickly address issues, coordinate activities, and maintain momentum towards achieving project goals. Daily huddles foster a sense of urgency, accountability, and teamwork, driving continuous improvement and problem-solving within the organization.

Concurrent engineering works in alignment with Lean principles by emphasizing collaboration and integration across different stages of product development (Ebrahimi, 2011) [9]. Concurrent Engineering involves the simultaneous design, development, and manufacturing of products to streamline processes and reduce time to market. By involving cross-functional teams early in the product development process, concurrent engineering facilitates communication, reduces rework, and enables faster decision-making. This approach aligns with Lean principles by eliminating silos, minimizing handoffs, and optimizing workflow efficiency throughout the product lifecycle.

Value analysis is a lean principle focused on identifying and eliminating non-value-added activities or processes within an organization (Ahmad, Amin & Mustafa, 2022) [2]. Value analysis involves systematically examining every aspect of a process or product to determine its contribution to customer value. By distinguishing between value-added, non-value-added, and necessary non-value-added activities, organizations can prioritize improvement efforts and allocate resources more efficiently. Value analysis fosters a culture of continuous improvement, encouraging teams to challenge existing practices and seek innovative solutions to enhance value delivery. Kanban, often referred to as pull materials throughout value streaming, is a Lean principle that emphasizes demand-driven production and inventory management (Zeng, Ye, Liu & König, 2023) [24]. Kanban involves visualizing workflow, limiting work in progress, and replenishing materials based on customer demand. By using visual cues such as Kanban cards or boards, organizations can optimize production flow, minimize waste, and respond quickly to changes in customer requirements. Kanban promotes flexibility, efficiency, and just-in-time delivery, enabling organizations to adapt to fluctuating demand and market conditions effectively.

Table 1: Lean Principles

S/N	Lean Principles
1	The 5S Process (sorting, straightening, shining, standardizing and sustaining)
2	Face-to-face communication within small teams in order to minimize communication distortions and problems
3	Kaizen (Continuous Improvement)
4	Poka-Yoke (Error Proofing)
5	Target Value Design (TVD)
6	Daily huddle meetings
7	Concurrent engineering works
8	Value analysis
9	Kanban (pull materials throughout value streaming)
10	Standardized Work

Finally, Standardized Work is a fundamental Lean principle that involves documenting and continuously improving best practices to achieve consistency and efficiency in processes. According to Bragança, & Costa (2015) [6], standardized

work establishes clear guidelines for performing tasks, specifying the sequence of steps, cycle times, and quality standards. By standardizing work processes, organizations can eliminate variability, reduce errors, and improve

productivity. Standardized work serves as a foundation for continuous improvement efforts such as Kaizen, enabling organizations to systematically identify and implement enhancements to achieve higher levels of performance.

3. Factors of lean awareness

Assessing the level of awareness of lean principles and practices among lecturers in the Built Environment discipline involves considering several factors to ensure a comprehensive evaluation. These factors encompass various aspects of knowledge, understanding, training, and application of lean concepts within the context of construction education. These are the key factors to consider when assessing the level of awareness of lean among lecturers

- 1. Understanding of Lean Principles:** Evaluate lecturers' understanding of fundamental lean principles such as waste reduction, value stream mapping, continuous improvement, and respect for people. Assess their ability to explain these principles and apply them to construction project scenarios, demonstrating a deep comprehension of lean philosophy.
- 2. Familiarity with Lean Tools and Techniques:** Assess lecturers' familiarity with lean tools and techniques commonly used in construction projects, such as Last Planner System, pull planning, 5S, Kaizen events, and visual management. Understanding their proficiency in utilizing these tools to enhance project efficiency and quality is essential.
- 3. Integration into Curriculum:** Consider the extent to which lean principles are integrated into the curriculum of Built Environment programs. Evaluate the presence of lean-related courses, modules, or topics within the curriculum and assess the depth of coverage and emphasis on lean concepts in course materials and teaching methodologies.
- 4. Professional Development and Training:** Assess whether lecturers have received formal training, certifications, or professional development opportunities related to lean construction. Consider participation in workshops, seminars, conferences, or industry partnerships aimed at enhancing understanding and application of lean principles in construction education.

- 5. Research and Scholarship:** Evaluate lecturers' engagement in research and scholarship related to lean construction. Assess the extent to which they contribute to advancing knowledge and understanding of lean principles through publications, conference presentations, and collaborative research projects within the Built Environment discipline.
- 6. Application in Teaching and Practice:** Examine lecturers' ability to incorporate lean principles and practices into their teaching methodologies and practical exercises. Assess the integration of real-world case studies, industry examples, and experiential learning opportunities that emphasize lean principles and their application in construction projects.
- 7. Industry Experience and Engagement:** Consider lecturers' industry experience and engagement with construction practitioners and organizations. Evaluate their ability to bring real-world insights and industry perspectives into the classroom, fostering a deeper understanding of lean principles and their relevance to professional practice.
- 8. Awareness of Lean Culture and Mindset:** Assess lecturers' awareness of the cultural aspects of lean, including collaboration, teamwork, continuous improvement, and customer focus. Evaluate their ability to instill a lean mindset among students, emphasizing the importance of lean principles beyond tools and techniques.
- 9. Feedback and Evaluation:** Gather feedback from students, peers, and industry stakeholders regarding lecturers' effectiveness in teaching lean principles and practices. Assess perceptions of lecturers' knowledge, communication skills, and ability to inspire enthusiasm and interest in lean construction among students.
- 10. Commitment to Continuous Learning and Improvement:** Consider lecturers' commitment to continuous learning and improvement in the field of lean construction. Assess their willingness to adapt to emerging trends, incorporate feedback, and pursue opportunities for professional growth and development in lean education.

Table 2: Factors of Lean Awareness

Factors of Lean Awareness by Lecturers	Sources
Understanding of Lean Principles	Narayanamurthy, Gurumurthy & Chockalingam, (2017) ^[13]
Familiarity with Lean Tools and Techniques	Klein, Tonetto, Avila & Moreira, (2021) ^[11]
Integration into Curriculum	Pusca & Northwood, (2016) ^[15] .
Professional Development and Training	Jahan & Doggett, (2015) ^[10] .
Research and Scholarship	Jahan & Doggett, (2015) ^[10] .
Application in Teaching and Practice	Pusca & Northwood, (2016) ^[15] ; Klein, Tonetto, Avila & Moreira, (2021) ^[11]
Industry Experience and Engagement	Pusca & Northwood, (2016) ^[15]
Feedback and Evaluation	Jahan & Doggett, (2015) ^[10] ; Narayanamurthy, Gurumurthy & Chockalingam, (2017) ^[13]
Commitment to Continuous Learning and Improvement	Klein, Tonetto, Avila & Moreira, (2021) ^[11]
Awareness of Lean Culture and Mindset	Narayanamurthy, Gurumurthy & Chockalingam, (2017) ^[13]

Research Methodology

The study operational approach is strongly influenced by the research quantitative method using survey strategy chosen, as numerical data was collected and analysed. The study population comprised of 34 lecturers in the school of environmental technology. These respondents were chosen because of their involvement in the academic activities in the built environment. Questionnaires were distributed to all the staff.

A consistent questionnaire exposes each respondent to the same set of questions. This study applied a structured questionnaire in lean principles and its awareness within the lecturers of school of environmental technology for improving construction project time performance in construction industry. Statistical Package for Social Science (SPSS, version 26) was used for statistical analysis of the data collected from the questionnaire survey. The data was analysed based on the type of research questions. All the research questions were analysed using descriptive analysis.

Results and Discussion

The data is normally distributed, hence, acceptable for the analyses. It indicated that the data did not skew too much to the right or left, which can distress the mean and the results for inference. The data distribution ranges from .001 to -1.226 which is within the satisfactory range of +/-2. The result of the overall Cronbach’s alpha for the questionnaire is presented in Table 2. It is indicating that, Lean Principles (LP) with 0.886, and the awareness is 0.796 respectively.

This means that the questionnaire as a whole is reliable and acceptable to carry out analysis.

Table 3 shows the current level of Lean Principles’ implementation in achieving construction project time performance based on five-point likert scale. The result revealed that 5S Process (Sorting, Straightening, Shining, Standardizing and Sustaining) with mean score of 3.41, ranked 1st, Daily huddle meetings with mean score of 3.31, ranked 2nd, concurrent engineering works with mean score of 3.31, ranked 3rd, Target Value Design (TVD) with mean value of 3.31, ranked 4th, Face-to-face communication within small teams in order to minimize communication distortions and problems with mean value of 3.29, ranked 5th. Furthermore, Value analysis with mean vales of 3.26, ranked 6th, kanban (pull materials throughout value streaming) with the mean value of 3.25, ranked 7th and Standardized work with mean value of 3.24, ranked 8th, kaizen (continuous improvement) with the mean value of 3.24, ranked 9th, and finally Poka-Yoke (Error proofing) with the mean value of 3.23, ranked 10th.

In the discussion of the results, the 5S Process has the highest mean score of 3.41, indicating that it is the most effective lean principle in achieving construction project time performance in the study area. The 5S process focuses on organizing the workplace through sorting, straightening, shining, standardizing, and sustaining. Its moderately high mean score suggests that its implementation positively impacts project time performance and it is the opinion of (Nguyen & Watanabe, 2017).

Table 3: Result on Lean Principles

Lean Principles	Mean	Standard Deviation	Ranking
The 5S Process (sorting, straightening, shining, standardizing and sustaining)	3.41	.961	1
Daily huddle meetings	3.31	.906	2
Concurrent engineering works	3.31	.906	3
Target Value Design (TVD)	3.31	.955	4
Face-to-face communication within small teams in order to minimize communication distortions and problems	3.29	.860	5
Value analysis	3.26	.935	6
Kanban (pull materials throughout value streaming)	3.25	.997	7
Standardized Work	3.24	1.022	8
Kaizen (Continuous Improvement)	3.24	1.031	9
Poka-Yoke (Error Proofing)	3.23	.874	10

A daily huddle meeting has a mean score of 3.31 and is ranked second. Daily huddle meetings involve short team meetings to discuss progress, challenges, and coordinate work. The relatively high mean score suggests that the meetings have a positive impact on project time performance. This opinion is as similar to the opinion of (Ngacho & Das, 2014) [14]. Concurrent engineering works also has a mean score of 3.31 and is ranked third. Concurrent engineering emphasizes the collaboration and simultaneous involvement of multiple disciplines in the project, which can lead to reduced project durations. Its similar mean score to daily huddle meetings indicates its effectiveness in improving time performance and was supported also by (Ngacho & Das, 2014) [14]. In a nutshell, the result indicate generally that it is moderate. This is clearly showing that there is need for improvement in the lean principles’ implementation.

Table 4 explains the level of awareness of lecturers on the Lean Principles’ implementation in achieving construction project time performance based on five-point likert scale. The result indicated that Research and Scholarship with mean score of 3.40, ranked 1st, Awareness of Lean Culture and Mindset with mean score of 3.37, ranked 2nd, Application of Teaching Practice with mean score of 3.35, ranked 3rd, Industry Experience and Engagement with mean value of 3.33, ranked 4th, Feedback and Evaluation with mean value of 3.29, ranked 5th. Furthermore, Commitment to Continuous Learning and Improvement with mean vales of 3.27, ranked 6th, Understanding of Lean Principles with the mean value of 3.25, ranked 7th and Familiarity with Lean Tools and Techniques with mean value of 3.24, ranked 8th, Integration and Curriculum with the mean value of 3.22, ranked 9th, and finally Professional Development and Training with the mean value of 3.21, ranked 10th.

Table 4: Results

Factors of Lean Awareness by Lecturers	Mean	Standard Deviation	Ranking
Research and Scholarship	3.40	.961	1
Awareness of Lean Culture and Mindset	3.37	.906	2
Application in Teaching and Practice	3.35	.906	3
Industry Experience and Engagement	3.33	.955	4
Feedback and Evaluation	3.29	.860	5
Commitment to Continuous Learning and Improvement	3.27	.935	6
Understanding of Lean Principles	3.25	.997	7
Familiarity with Lean Tools and Techniques	3.24	1.022	8
Integration into Curriculum	3.22	1.031	9
Professional Development and Training	3.21	.874	10

The results of our study indicate a generally positive trend in various aspects of Research and Scholarship, Awareness of Lean Culture and Mindset, Application in Teaching and Practice, Industry Experience and Engagement, Feedback and Evaluation, Commitment to Continuous Learning and Improvement, Understanding of Lean Principles, Familiarity with Lean Tools and Techniques, Integration into Curriculum, and Professional Development and Training.

In terms of Research and Scholarship, participants demonstrated a strong understanding and engagement ($M = 3.40$, $SD = .961$), aligning with previous literature highlighting the importance of research in the field. This finding is consistent with the work of Jahan & Doggett, (2015) ^[10] which emphasized the significance of scholarly activities in advancing knowledge and practice within Lean environments.

Furthermore, the results suggest a notable awareness of Lean culture and mindset ($M = 3.37$, $SD = .906$), indicating participants' recognition of the philosophical underpinnings of Lean methodologies. This echoes the findings of Narayanamurthy, Gurumurthy & Chockalingam, (2017) ^[13], who stressed the critical role of cultivating a Lean mindset for successful Lean implementation.

Moreover, the high scores in Application in Teaching and Practice ($M = 3.35$, $SD = .906$) and Integration into Curriculum ($M = 3.22$, $SD = 1.031$) suggest a strong emphasis on incorporating Lean principles into both educational settings and professional practice. These findings resonate with the recommendations of Klein, Tonetto, Avila & Moreira, (2021) ^[11], advocating for the integration of Lean concepts across educational curricula to foster a culture of continuous improvement.

Additionally, participants demonstrated a solid understanding of Lean principles ($M = 3.25$, $SD = .997$) and familiarity with Lean tools and techniques ($M = 3.24$, $SD = 1.022$). These results are consistent with the findings of Narayanamurthy, *et al.* (2017) ^[13], who emphasized the importance of equipping practitioners with the necessary knowledge and skills to effectively apply Lean methodologies.

However, it is worth noting that areas such as Feedback and Evaluation ($M = 3.29$, $SD = .860$) and Professional Development and Training ($M = 3.21$, $SD = .874$) received slightly lower scores compared to other dimensions. This suggests a potential area for improvement in terms of providing structured feedback mechanisms and enhancing opportunities for professional growth within Lean contexts.

In a nutshell, the findings of this study underscore the importance of ongoing efforts to promote research, education, and practical application of Lean principles,

while also highlighting areas where further attention and development may be warranted.

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