Integrating ISO 56002:2019 Organizational Context Evaluation with Lean Six Sigma for Cultivating an Innovation Culture in Precast Concrete Companies in Indonesia

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Abstract. Based on Global Innovation Index data, Indonesia's innovation ranking has declined by 2 positions, from 85th in 2019 and 2020 to 87th out of 132 countries in 2021. This places, Indonesia among the lowest in ASEAN-6. This article examines the integration of ISO 56002:2019 Organizational Context Evaluation with Lean Six Sigma which was carried out in the form of quantitative research by analyzing through Structural Equation Model (SEM). This study aims to determine whether the integration between ISO 56002:2019 and Lean Six Sigma is related to Innovation Culture and could cultivate the Innovation Culture of precast concrete companies in Indonesia. The result of this study provides evidence that ISO 56002:2019 and Lean Six Sigma are positively related to Innovation Culture.

1 Introduction

The precast concrete industry in Indonesia is experiencing rapid growth due to increased demand, as evidenced by the inclusion of 41 strategic priority projects in the National Medium-Term Development Plan (RPJMN) 2020 to 2024. These projects include constructing high-rise buildings, industrial areas, coastal development, and various infrastructures. According to the Association of Precast and Prestressed Concrete Companies in Indonesia (AP3I), the production capacity of precast and prestressed concrete in Indonesia has consistently increased from 2017 to 2019, driven by the booming construction sector, particularly in toll road development.

Despite the success in the precast concrete industry, Indonesia's innovation ranking has witnessed a decline of 2 positions according to the Global Innovation Index, dropping to 87th out of 132 countries in 2021. This is attributed to the challenges faced by precast concrete companies, exemplified by a decrease in research and development expenditure in 2021 compared to the previous years due to the greater innovation output in 2020 amid the COVID-19 pandemic. In response to the pandemic, a precast concrete company in Indonesia implemented various strategies, including incorporating business innovation models into Key Performance Indicators (KPIs), structural reforms, establishing learning centers and central laboratories for quality product innovation, and creating operational procedures to realize innovation plans.

Innovation is recognized as a key factor in organizational performance improvement, and contemporary times demand the actualization of an innovative culture for continuous improvement in organizational services. Management of innovation, as suggested by Gaspersz [1], is crucial for developing innovative processes, products, services, organizations, markets, and customers. Leaders play a pivotal role in fostering an innovative culture that encourages creative efforts throughout the organization. The impact of a lack of innovation culture, as noted by experts, can lead to a decline in a country's competitiveness, economic disruption, reduced company performance, diminished consumer appeal, and individual challenges in personal development and broad thinking.

To address these challenges, the development of an innovation culture can be facilitated through the implementation of an innovation management system, such as ISO 56002:2019. However, to systematize innovation, effective integration of technology and innovation management is necessary, aligning with the company's strategic, operational, and commercial mission for competitive advantage [2]. Successful organizations strive to stay at the forefront of competition by applying effective continuous improvement methodologies such as Lean Six Sigma (LSS) [3], a powerful method known for enhancing process performance, customer satisfaction, and bottom-line revenue [4]. Therefore, an evaluation of organizational management based on ISO 56002:2019, integrated with Lean Six Sigma, is crucial for building an innovative culture.

2 Literature Review

2.1 Organizational Context

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In the organizational context, an organization is a process of combining the work that individuals or groups must perform with the necessary talents to efficiently, systematically, positively, and coordinatively channel efforts toward organizational goals. The organizational structure serves as a framework depicting all activities for goal achievement, inter-functional relationships, authority, and responsibilities. The structure comprises various components or work units with four elements: specialization of job activities, standardization of job activities, coordination of job activities, and the overall size of the organization.

Erni [5] further explores the influence of organizational structure on employee satisfaction and performance. Factors such as organizational strategy, scale, technology, and the environment play significant roles in shaping organizational structure. The alignment between organizational strategy and structure is crucial, as changes in strategy may necessitate corresponding adjustments in the organizational structure. The scale of an organization, whether large or small, impacts its structure, with larger organizations requiring delegation of authority and tasks.

Technology and the dynamic environment also influence organizational design, with dynamic environments demanding adaptive structures. The provided text emphasizes the dynamic interplay between organizational elements and external factors, underscoring the importance of context in understanding and shaping organizational structures.

2.2 ISO 56002 Concept

The International Standard for Innovation Management [6], ISO 56002, comprises ten sections with an introductory overview. This preface emphasizes the recognition that an organization's ability to innovate is a key element for sustainable growth, economic continuity, improved well-being, and social development. This emphasizes that organizations can innovate more effectively and efficiently when all necessary activities and interrelated elements are managed as a system. The innovation management system guides organizations in determining their vision, strategy, policies, and innovation objectives, providing support and processes needed to achieve desired outcomes. The document aims to offer guidance on the benefits of implementing innovation assessment, expectations from a good assessment, the implementation process, and the follow-up actions based on the assessment results.

The innovation management system is portrayed as a set of interconnected and interacting elements with the goal of realizing value. It provides a common framework for developing and disseminating innovation capabilities, evaluating performance, and achieving desired outcomes. The significance of innovation extends beyond generating brilliant ideas; it involves creating value and aiding organizations in continual adaptation and growth. The Plan-Do-Check-Act (PDCA) cycle is highlighted as a tool within innovation management for enabling continuous improvement, ensuring that innovation initiatives and processes are well-supported, resources are effectively managed, and opportunities and risks are identified and addressed by the organization. The application of the PDCA cycle to the innovation management system involves planning, execution, monitoring, measurement, and taking actions to enhance the overall performance of the system.

2.3 Lean Six Sigma Concept

Six Sigma is described as a continuous effort to reduce process variation to improve the process's capability in producing error-free products or services, providing value to customers [1]. Lean Six Sigma (LSS) is a combination of lean and Six Sigma, representing a business philosophy and a systematic, systemic approach. The goals of both lean and Six Sigma include identifying and eliminating waste or non-value-added activities, achieving a six sigma process capability level through continuous radical improvement, implementing a pull system for product and information flow, and pursuing excellence by producing only 3.4 defects per million opportunities or operations (3.4 DPMO).

LSS evolved from scientific management and continuous improvement theory, integrating the best elements from a variety of quality approaches. Motorola pioneered Six Sigma in the 1980s, successfully integrating it with lean methodology in the early 2000s [7]. The adoption of LSS has faced challenges in productivity and product cost improvements during the initial stages, leading organizations to tailor Six Sigma tools and methodologies to align with their specific work.

The integration of new quality improvement methodologies, such as LSS, has demonstrated positive effects on employee motivation and the development of a healthier work environment [8]. Organizations have made significant efforts to combine quality improvement methodologies to address industrial-era challenges [9]. Studies and case analyses have shown improved outcomes following LSS implementation [10]. Various researchers have proposed frameworks for successful LSS implementation in manufacturing environments. The definition of "Lean Six Sigma" integration lacks consensus, proposing a grounded theory-based definition.

They believe that LSS is a business operation aimed at maximizing stakeholder value by improving quality, speed, customer satisfaction, and cost, achieved by integrating Lean and Six Sigma tools and principles, we conclude that this is an improvement method. The multifaceted nature of LSS is highlighted, combining Lean's waste elimination and Six Sigma's statistical perspective on identifying and eliminating quality-related issues [9]. From a business perspective, LSS is seen as an integrated process that allows companies to clearly identify customer needs, eliminate non-value-added activities, and reduce variation in production processes.

2.4 Innovation Culture

Innovation is recognized as the key to enhancing organizational performance, and the evolving times demand continuous improvement in the innovation culture within organizations [11]. Generally, innovation involves the conversion of knowledge and technology into social and economic aspects, transforming ideas into marketable products or services, and enhancing production. Organizations that foster creativity and innovation often have greater opportunities for success than passive and reactive ones, especially in the face of rapidly changing external environments. Understanding organizational culture and establishing a culture that aligns with innovation becomes crucial.

As outlined by Dobni [12], the concept of innovation culture is multidimensional, encompassing four dimensions: the intention to innovate, infrastructure to support innovation, operational-level behaviors influencing market orientation and values, and the environment for implementing innovation. Various scholars provide perspectives on the definition of innovation culture within companies. Dombrowski [13] identifies eight collective cultural elements essential to effective innovation strategy and implementation. This includes innovative mission and vision statements, democratic communication, safe spaces, flexibility, collaboration, crossing boundaries, incentives, and leadership. An innovative work culture extends beyond research and development, involving the entire organization in three stages: idea generation, coalition-building, and implementation [14]. Innovation culture is shared values, beliefs, and assumptions within an organization that facilitate product innovation processes, highlighting the importance of a culture that supports employee innovation capacity, risk tolerance, and personal growth. Finally, innovation culture could be defined as an organization's ability to encourage innovation individual responsibility, benefit from opportunities, and support risk-taking [15]. These diverse perspectives collectively contribute to the understanding of innovation culture within organizations.

There are 3 indicators to measure Innovation Culture, as below:

1. Supporting Innovation and Motivating Change
2. Sharing the Vision and Values of Innovation Across the Company
3. Tolerating Failure and Learning from Mistakes

2.5 Integration of Organization Context in ISO 56002 and LSS

The necessity of a robust curriculum, interactive tools, technological exploitation, and documented best practices are needed to enhance Lean Six Sigma (LSS) learning within an organization [16]. Integrating ISO 56002:2019 and Lean Six Sigma involves common indicators, collaboration, and culture, emphasizing the need for a collaborative and culturally aligned approach in implementing both frameworks.

There are 9 indicators in the integration of ISO and LSS in an Organization Context, as below:

1. Lean Knowledge
2. Project Team Training
3. Project Delivery Team Structure
4. Integrated Project Delivery Onboarding and Bootcamp
5. Project Team Target Value Delivery/TVD Training
6. Understand Trends and External Drivers
7. Understand Internal Capabilities and Assets
8. Culture Supports Creativity and Dissemination
9. External and Internal Innovation Collaboration

3 Methodology

In this study, questionnaires with a Likert scale were distributed to 54 respondents who work in the precast concrete field. Furthermore, the results will be analyzed using Structural Equation Modelling. SEM is a statistical technique used to build and test statistical models, usually in the form of cause-and-effect models. SEM is actually a hybrid method that includes factor analysis, path analysis, and confirmatory aspects of regression, and can be considered a special case of SEM [17].

SEM is a multivariate statistical method that combines factor analysis and regression analysis (correlation) and is used to test relationships between variables in a model, such as relationships between indicators and constructs, or relationships between constructs. The following are the indicators in this research:

Table 1. List of Variables and Indicators

Variables	Indicators
X	**Organization Context**
X1	Lean Six Sigma
X1.1	Lean Knowledge
X1.2	Project Team Training
X1.3	Project Delivery Team Structure
X1.4	Integrated Project Delivery Onboarding and Bootcamp
X1.5	Project Team Target Value Delivery/TVD Training
X2	**ISO 56002**
X2.1	Understand Trends and External Drivers
X2.2	Understand Internal Capabilities and Assets
X2.3	Culture Supports Creativity and Dissemination
X2.4	External and Internal Innovation Collaboration
Y	**Innovation Culture**
Y1.1	Supporting Innovation and Motivating Change
Y1.2	Sharing the Vision and Values of Innovation Across the Company

Y1.3	Tolerating Failure and Learning from Mistakes

4 Results and Discussion

After the questionnaire is filled in, the data is processed using SEM (Structural Equation Modeling) to see how the organization context is related to innovation culture. Following is the SEM Conceptual Framework:

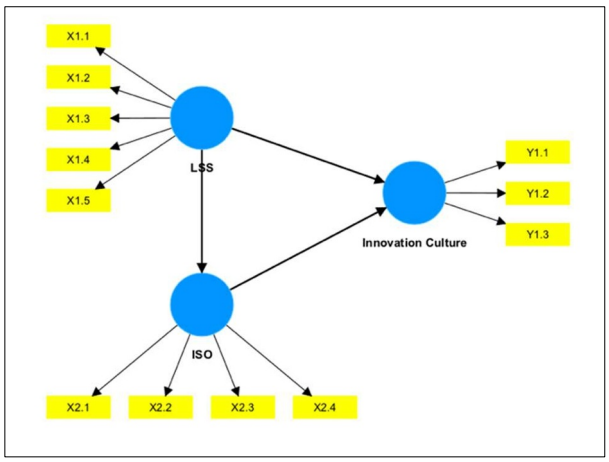

Fig 1. SEM Framework

4.1 Convergent Validity

Convergent validity is seen based on the correlation between the item/indicator scores and the construct scores. An individual reflective measure is said to be high if it correlates more than > 0.70 with the construct you want to measure.

Table 2. Outer Loadings Results

	Outer loadings
X1.1 <- LSS	0.605
X1.2 <- LSS	0.532
X1.3 <- LSS	0.631
X1.4 <- LSS	0.815
X1.5 <- LSS	0.793
X2.1 <- ISO	0.808
X2.2 <- ISO	0.770
X2.3 <- ISO	0.833
X2.4 <- ISO	0.687
Y1.1 <- Innovation Culture	0.844
Y1.2 <- Innovation Culture	0.876
Y1.3 <- Innovation Culture	0.621
X1.1 <- LSS	0.605

Overall, the outer loadings are acceptable for all indicators except for X1.1, X1.2, X1.3, X2.4, and Y1.3. These indicators have outer loadings below the recommended threshold of 0.7, suggesting that they may not measure their respective latent variables well.

4.2 R-Square

In the structural model, we differentiate between exogenous and endogenous constructions. The Structural model reviews the relationship between exogenous and endogenous latent variables or what is called the Inner Model.

Table 3. R-Square Result

	R-square	R-square adjusted
Innovation Culture	0.557	0.549

The R-square value of 0.557 indicates that about 55,7% of the variance in the endogenous latent variable Innovation Culture is explained by the exogenous latent variables. This is considered a moderate level of explained variance. The R-square adjusted value of 0.549, which is slightly lower than the R-square value, further suggests that the model could be improved by adding more exogenous variables or by strengthening the relationships between the exogenous and endogenous variables.

4.3 T-Statistic

T-Statistic is the significance value of a latent variable to its latent variable to answer the research hypothesis. The author used a significance level of 5% in this study, so the threshold for saying it has a significant effect is 1.67. In SmartPLS, if the T-Statistic value is > 1.67 then it has a significant effect. But if the T-Statistic value is <1.67 then it has no significant effect. Hence it can be concluded that all variables have a significant influence.

Table 4. T-Statistic Results

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
ISO -> Innovation Culture	0.514	0.508	0.083	6.219	0.000
LSS -> ISO	0.746	0.758	0.054	13.744	0.000
LSS -> Innovation Culture	0.369	0.375	0.070	5.233	0.000

4.4 Model Fit

Model Fit indicates how good the model is. If the NFI value is closer to 1, it indicates a good model/better suitability.

Table 5. Model Fit Results

	Saturated model	Estimated model
SRMR	0.129	0.129
d_ULS	1.295	1.295
d_G	0.420	0.420
Chi-square	134.257	134.257
NFI	0.572	0.572

Model fit indicates how well the model represents the data. In this case, the NFI value of 0.572 suggests that the model fits the data moderately well. This means that the model is able to explain a significant portion of the variation in the data, but there is still room for improvement.

5 Conclusions

This study has explored the integration of Lean Six Sigma (LSS) and ISO 56002-based organizational context within the context of precast concrete companies in Indonesia. The research methodology involved the distribution of questionnaires to 54 respondents working in the precast concrete field, followed by Structural Equation Modeling (SEM) analysis to investigate the relationship between the leadership system and the cultivation of an innovation culture.

The R-square analysis revealed a moderate level of influence, with a 55,7% explanation of variance for the "Innovation Culture" construct (Y). The T-Statistic results confirmed the significant influence of all variables in the study, aligning with a 5% significance level. Furthermore, the Model Fit assessment, represented by the NFI (Normed Fit Index), indicated a model fit of 57.2%.

In summary, the findings of this study emphasize the importance of integrating LSS and ISO 56002-based organization context in precast concrete companies to promote innovation culture effectively. The 55,7% variance explanation in the "Innovation Culture" construct underscores the impact of organizational context on fostering innovation. These results hold valuable implications for the construction industry in Indonesia, demonstrating the potential for improved business performance, competitive advantage, and a culture of innovation.

This suggests that other factors could contribute to Innovation Culture and that the model could be further enhanced by including these factors. Further, it suggests that the model could be improved by strengthening the relationship between the LSS and ISO latent variables.

Overall, the findings of this study provide evidence that LSS and ISO are positively related to Innovation Culture. However, the model could be further improved by strengthening the variables' relationships and identifying other factors contributing to Innovation Culture. Further research is needed to investigate these relationships and to develop a more comprehensive model of Innovation Culture.

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