

Impact of Lean Practices and Organisational Culture on Risk Management Knowledge in Chinese Engineering Projects: The Mediating Role of Project Performance

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ARTICLE INFO	ABSTRACT
Received: 18 Aug 2024	The purpose of this paper is to investigate in China's engineering projects the role of project performance as a mediator between lean techniques, organisational culture, and risk management expertise. This work presents a full picture of how operational strategies and risk awareness interact to address the increasing complexity and unpredictability of engineering project settings by means of quantitative data analysis combined with qualitative case studies. Structured questionnaires were sent to engineers, project managers, and quality assurance staff of many Chinese engineering firms to gather quantitative data. A statistically study conducted using structural equation modelling shows that lean approaches including continuous improvement, waste minimisation, and stakeholder involvement show favourably effect risk management knowledge. Strong corporate culture supporting cooperation, communication, and shared responsibility is raising awareness of risk and therefore reducing tactics. The importance of project performance in transforming organisational values and practices into effective knowledge application is underlined by the fact that project performance moderates the relationship between risk management knowledge and lean practices and organisational culture. One may evaluate project performance using cost efficiency, time management, and quality outputs. Semi-structured interviews yielded qualitative data that helped to balance the quantitative results and offer a more whole picture of how engineering teams implement lean concepts and cultural norms to actual projects. This extensive study highlights the need of engineering firms developing a culture of support and operational excellence to gain long-term risk management capacity. The results should be used as a road map for Chinese project managers, lawmakers, and corporate leaders to build more robust project processes in the engineering industry of the country. Keywords: lean practices, organisational culture, project performance, risk management knowledge, Chinese engineering projects.
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1. INTRODUCTION

Particularly in fast growing countries like China's, the capacity to properly control risk has become a crucial success element in modern engineering project management scene. Financial, technical, operational, and environmental uncertainties are just a few of the many kinds of risk engineering projects China might encounter given their scale, resource intensity, and time sensitivity. Thus, if we are to guarantee ongoing project success and organisational sustainability, it is essential to understand what makes project teams more competent about risk management. Lean methods have evolved into a useful tool for project management contexts aiming to increase productivity, reduce waste, and promote a growth mind-set depending on the Toyota Production System. Lean concepts not only simplify processes and reduce duplication but also help an organisation respond better to risk. Moreover significantly affecting employee conduct, communication, and company management of risks and problems is organisational culture. Strong, honest, and cooperative culture will aid significantly in the ability to recognise dangers, share knowledge about them, and respond collectively to new difficulties. About engineering projects in China, little is known about how lean techniques and organisational culture combine to affect understanding of risk management. Project performance which spans time, money, quality, and stakeholder satisfaction offers yet another level of complexity that requires mediation by research. One operational technique is project performance; cultural values may therefore be transformed into a real risk control instrument.

This study made thorough research of these links by combining qualitative insights obtained from in-depth interviews with quantitative data received from surveys using a mixed-methods methodology. This approach seeks to fully grasp how project success influences the relationships among lean tactics, organisational culture, and knowledge of risk management. The results of this study have pragmatic consequences for engineering companies, governments, and project managers in China's dynamic infrastructure and construction industries trying to improve project performance and create solid, statistically based risk management systems (Shen, 2023).

2. BACKGROUND OF THE STUDY

Company culture, effective communication management, and a well-defined project scope are three factors that may make or break a construction project. This research seeks to understand how project manager competences moderate this relationship. Since this research is trying to understand how the project manager's abilities influence the relationship, these concepts are provided in the following paragraphs from a theoretical perspective. There are risks associated with China's recent leadership in massive engineering and infrastructure projects, and those risks include those pertaining to money, operations, the environment, and organisational structures. So, these days, no project can be considered complete without first implementing a solid risk management strategy. Organisational policies, attitudes, and performance outcomes are all relevant, but the technological components of risk management are crucial. More and more, engineering projects are using lean principles. In the end, these ideas boost responsiveness and output by emphasising efficiency, cutting down on waste, and constantly improving. Equally significant in shaping risk teams' perspectives and reactions is an organization's corporate culture, which is itself shaped by its values, practices, and leadership style. Although these effects are known to have a significant impact, little is known about how Lean methods and culture shape the perception of risk management. Stakeholders' risk awareness and reactivity are mediated by project performance (Chen et al., 2023).

Both the operational methods and the cultural dynamics contribute to the project's performance. Using integrated management approaches in challenging project environments may improve risk resilience and performance. By using this approach, this research hopes to provide light on China's engineering goals. In 1990, the term "lean" was first used to describe the Toyota model, which had long been the centre of attention around the "transference" concept. This thesis argued that non-Japanese companies may gain an advantage by adopting the same mental models as Japanese companies, given that management encounters the same problems in all sectors, including manufacturing. Lean management is both a theory and a method for management that may help you reduce waste, streamline processes, and encourage continuous improvement across your whole organisation. The importance of a lean culture in driving the ongoing development of internal operations to their maximum efficiency is understood by all employees. Lean methodology promotes cross-departmental and cross-level collaboration among employees to reduce internal waste and provide consumers with the best product on the market (Hong et al., 2019).

3. PURPOSE OF THE RESEARCH

The purpose of this study is to apply lean methodology to engineering projects in China in order to better understand project performance and risk management. This paper aims to talk about how lean approach could help us understand risk management in Chinese engineering projects. The secondary goal of the research is to find out how lean approaches affect the perspectives of experts and teams on risk management. This study aims to determine how much of an impact lean approaches have on the completion rate of engineering projects in China. Cost management, quality outputs, stakeholder satisfaction, and time efficiency are some of the other performance measures that will be studied to see how lean impacts them. The research aims to answer these issues by providing evidence that lean approaches improve engineering project management in China by raising awareness of risks and improving project performance.

4. LITERATURE REVIEW

If engineering projects in China are to be successful, good risk management is very crucial. Common knowledge is that these projects might be fairly enormous in scale, complicated, and time-sensitive. Lean techniques, business culture, and completed projects combine to provide fewer information on risk management. This literature review investigates how two related elements—organizational culture, which determines common ideas and behaviours, and lean practices, which highlight efficiency and the waste elimination—interact with project performance to impact risk

management strategies. Increasing numbers of engineering projects are using lean concepts—which aim to improve quality while reducing costs and boosting output. Though a lot of evidence supports their worth, it is debatable whether or not they enable us to better control risk. Seen as a collection of ideas, values, and beliefs, an organization's culture might significantly affect risk perception and handling. One environment better adapted to control risks is one which promotes a culture of awareness, proactive planning, and continuous education. Project performance thereby moderates the connection; this is defined here as the degree of aim accomplishment for a project. Control of risks would benefit from more universal acceptance of lean ideas and improved use of them by successful enterprises. Projects failing expectations may not be able to afford risk management strategies or lean methods. The real data supporting certain correlations was investigated in this literature review to aid to fill in some knowledge gaps in our understanding of risk control in Chinese engineering projects. Interactions among lean methodology, business culture, and project outcomes took front stage. Organisations that have a solid grasp of these dynamics might improve project performance, create a risk-aware culture, and use lean methodologies more wisely (Emrouznejad et al., 2023).

5. RESEARCH QUESTIONS

- 5.1 What effect does lean methodology have on the comprehension of risk management in engineering projects in China?
- 5.2 To what extent do lean practices affect project performance in Chinese engineering projects?

6. RESEARCH METHODOLOGY

6.1 Research Methodology: As part of their cross-sectional inquiry, the researchers monitored the participants for four months to compile their data. Implementing the cross-sectional design required fast and cost-effective data collection at a particular point in time. The study was conducted by a wide variety of groups in China. Due to time constraints and limited resources, the researcher opted for a quantitative approach. The survey was administered to all respondents using a random selection method. After that, 500 samples were collected using Rao Soft to estimate a sample size. A researcher would read the survey questions aloud to those who are unable to read or write, and then they would record their exact responses on the survey form. This method would be useful for people who are confined to wheelchairs or who are unable to read and write. As people waited to fill out their questionnaires, the researcher would brief them about the study and answer any questions they may have. On rare occasions, we require that you complete and return our surveys all at once.

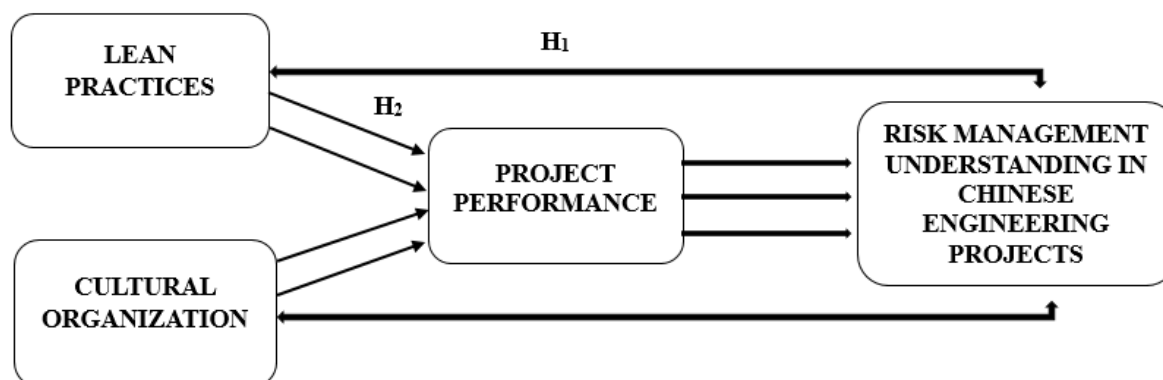
6.2 Sampling: To collect information for the study, survey methods were used. The sample size was found to be 600 using Rao-soft software. Out of 775 questionnaires, 662 were returned, and 13 were rejected because they were not filled out completely. The study included a total of 649 questionnaires, with 257 women and 392 men participating.

6.3 Data and measurement: Questionnaires served as the main means of data collection for the investigation. There were two sections to the survey: (A) General demographic information and (B) Online and non-online channel factor replies on a 5-point Likert scale. The majority of the secondary data was culled from online databases and other secondary sources.

6.4 Statistical Software: MS-Excel and SPSS 25 will be used for Statistical analysis.

6.5 Statistical tools: Descriptive analysis was used to comprehend the fundamental characteristics of the data. Validity will be assessed by factor analysis.

7. CONCEPTUAL FRAMEWORK



8. RESULT

Factor Analysis

One common usage of Factor Analysis (FA) is to check the underlying component structure of a group of measurement items. There is a belief that factors that are not immediately apparent impact the scores of the observable variables. A strategy that relies on models is the accuracy analysis (FA) method. Building causal pathways that link observable events, hidden causes, and measurement errors is the main focus of this work.

One way to determine whether data is suitable for factor analysis is to use the Kaiser-Meyer-Olkin (KMO) Method. We check whether the sample is enough for the whole model and for each individual variable. The statistics provide a numerical representation of the potential shared variance across several variables. Factor analysis works better with data that has smaller percentages.

The output of KMO is an integer between 0 and 1. A sufficient sample size is defined as a KMO value between 0.8 and 1.

In the event that the KMO falls below 0.6, indicating insufficient sampling, corrective measures must be implemented. Make an informed decision; 0.5 is used by certain writers for this purpose, hence the range is 0.5 to 0.6.

The high partial correlations relative to the overall correlations are indicated by a KMO near to 0. To reiterate, significant correlations significantly impede component analysis.

According to Kaiser, the following are the acceptable limits:

Declining from 0.050 to 0.059.

- Below-average by 0.60 to 0.69

Middle school typical range: range: 0.70-0.79.

With a quality point score ranging from 0.80 to 0.89.

Everything from 0.90 to 1.00 is really mind-blowing.

Table: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.955
Bartlett's Test of Sphericity	Approx. Chi-Square	3252.968
	df	190
	Sig.	.000

Applying Bartlett's Test of Sphericity provided further confirmation of the correlation matrices' overall significance. For Kaiser-Meyer-Olkin sampling, an adequate value is 0.955. The researchers discovered a p-value of 0.00 by using Bartlett's sphericity test. The correlation matrix was shown to not be a correlation matrix by a significant test result from Bartlett's sphericity test.

TEST FOR HYPOTHESIS

❖ INDEPENDENT VARIABLE

• Lean practices

Lean procedures are a methodical process for using waste reduction or elimination to increase value in the operations of an entity. Lean is a method of doing things that attempts to progressively make operations more efficient and better at what they do. The Toyota Production System was fundamental in driving development. Lean techniques aim to maximise resources, streamline procedures, eliminate non-value-adding activities, and assure timely project delivery in the engineering and building industries. Lean approach is predicated on just-in-time production, value stream mapping, and staff involvement in problem resolution. These kinds of approaches that support openness, cooperation, and flexibility help to lower the frequency of reactive risk management while nevertheless increasing production. When used properly, lean methodology may help teams communicate better and simplify proactive decision-making while also lowering the likelihood of budget and scheduling overruns. Lean ideas are thought to help technical efforts create strong systems that actively manage uncertainty and still satisfy long-term performance requirements (Lyu et al., 2020).

❖ MEDIATING VARIABLE

• Project performance

Project performance is the degree of success of a project within time, money, scope, and quality limitations. Examining the project's performance will assist one to determine if it met stakeholders' expectations and aims. Project performance is particularly crucial for engineering systems operational success as China's fast economic expansion and vast infrastructure need for it. Conventional performance evaluations follow the "iron triangle" of maintaining under budget, achieving deadlines, and completing the project to standards. Modern evaluations, however, include team performance, resource usage, innovation, environmental compliance, safety and stakeholder satisfaction. Completing a project successfully exposes conscientious preparation, adaptable leadership, and good judgement. The success of the project depends on lean approach, business culture, and risk management. Inadequate performance may make stakeholders angry, thereby influencing quality, cost overruns, and delays. Project

performance assessments would benefit the engineering and construction sectors as they provide necessary data for success, planning, and development (Zhou et al., 2024).

❖ DEPENDENT VARIABLE

• Risk management understanding in Chinese engineering projects

One must be somewhat educated about risk management—that is, aware of any hazards, evaluate their degree, establish strategies to lower them, and watch their development if one wants to correctly accomplish engineering projects. China boasts many engineering projects in large-scale infrastructure, sophisticated stakeholder networks, and strict regulatory systems; hence, risk management knowledge is highly crucial for the success of any project. It tackles project teams' capacity for active management of risks including design faults, cost overruns, delays, and compliance problems. Organisational learning, training, experience, and easily accessible data on hazards help to develop knowledge like this. Fast urbanisation and policy-driven projects, in many areas including major effect on risk management knowledge, have shaped engineering projects in China. This information enables teams to satisfy government requirements, handle local issues, and change with the times with regard for project surroundings. It also promotes knowledge-based strategy to lower project risk, resilience, and improved cooperation (Ullah, 2021).

▪ Relationship between lean practices and risk management understanding in Chinese engineering projects

Lean methods and risk management experience clearly relate in the context of engineering projects in China that provide efficiency, quality, and timely delivery great relevance. Lean ideas provide operational responsiveness and clarity by means of strategies of value development, standardisation, continuous improvement, and waste reduction. Teams operating in an open and honest project environment might then detect, assess, and control dangers. Lean methods reduce inefficiencies and so boost cross-functional collaboration, thereby enhancing communication and information flow and hence the availability and value of knowledge about hazards. Lean approaches would allow engineering teams working on projects in China benefit from their quite high degrees of complexity, fast development, predictability, and responsiveness. Lean promotes a learning culture and an attitude of continuous awareness by helping to give a thorough knowledge of project risks and quick adoption of steps to reduce them (Villanueva, 2024).

On the basis of the above discussion, the researcher formulated the following hypothesis, which was analyse the relationship between lean practices and risk management understanding in Chinese engineering projects.

“H₀: There is no significant relationship between lean practices and risk management understanding in Chinese engineering projects.”

“H₁: There is a significant relationship between lean practices and risk management understanding in Chinese engineering projects.”

Table 2: H₁ ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	74506.320	242	4382.725	259.935	.000
Within Groups	1382.590	406	16.861		
Total	75888.910	648			

In this study, the result is significant. The value of F is 259.935, which reaches significance with a p-value of .000 (which is less than the .05 alpha level). This means the ***“H₁: There is a significant relationship between lean practices and risk management understanding in Chinese engineering projects.”*** is accepted and the null hypothesis is rejected.

▪ Relation between lean practices and project performance

Lean ideas immediately and favourably affect project performance especially in engineering projects because efficiency, cost control, and on-time delivery are so highly appreciated. Lean techniques stress the removal of waste, simplicity of operations, and encouragement of constant improvement, thereby boosting workflow efficiency, resource utilisation, and quality control. These methods will enable project teams to maintain their high degrees of output within budgetary and scheduling constraints. Lean procedures are essential for the success of engineering projects in China as they allow quick decision-making, minimise obstacles, and encourage team responsibility—all of which help to remove bottlenecks and, thus, provide outstanding performance results. Lean not only improves reactivity to new problems and helps to match project goals but also encourages interdisciplinary collaboration and active engagement of stakeholders. Lean adoption obviously affects better general project performance as projects implemented in accordance with lean ideas often demonstrate lower costs, better customer satisfaction, and fewer delays (Voegtlin, 2020).

On the basis of the above discussion, the researcher formulated the following hypothesis, which was analysed the Relation between lean practices and project performance.

“H₀₂: There is no significant relationship between lean practices and project performance.”

“H₂: There is a significant relationship between lean practices and project performance.”

Table 3. H₃ ANOVA Test

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	75114.754	115	3576.893	360.390	.000
Within Groups	774.156	533	9.925		
Total	75888.910	648			

In this study, the result is significant. The value of F is 360.390, which reaches significance with a p-value of .000 (which is less than the .05 alpha level). This means the ***“H₂: There is a significant relationship between lean practices and project performance”*** is accepted and the null hypothesis is rejected.

9. DISCUSSION

This paper claims that lean approaches greatly affect project performance as well as risk management knowledge in Chinese engineering projects. Lean approaches have shown to help engineering teams find, evaluate, and minimise risks: waste reduction, continuous development, and process standardising. These methods promote responsibility, improve communication, and help to raise shared risk awareness by means of a more orderly and transparent workplace. Lean techniques also help to improve project performance by means of more productivity, less delays, assurance of better quality and cost control. Particularly, the findings reveal the mediation function of project performance, thus lean approaches not only directly affect knowledge of risk management but also indirectly by better project implementation. This mediating effect implies that lean techniques offer a framework for more simultaneous understanding of hazards and better informed decision-making even while they improve performance results. These ideas especially help in the framework of Chinese engineering projects, where legal constraints, great complexity, and fast development are typical. To build strong and risk-aware project configurations, they underline the need of matching operational strategies with project performance goals. By proving that lean techniques could be a risk-awareness and performance-enhancing tool in engineering environments, the study adds to the increasing body of knowledge. It also emphasises the need of engineering companies in China investing not only in lean training but also in performance monitoring systems able to mix operational practices with strategic risk management. These

results highlight generally the transforming power of lean thinking in engineering project management and offer a useful structure for companies trying to increase their risk capacity and project outputs by means of operational excellence.

10. CONCLUSION

This paper shows that lean techniques significantly improve risk management knowledge and project performance in Chinese engineering projects. Lean approaches support ongoing development, waste reduction, and efficiency enhancement, so enabling projects to reach operational success and concurrently foster a culture sensitive to risk. The studies underline the mediating function of project performance to build even more a link between lean methods and knowledge of risk management. Usually, projects with high performance approach risk from a more proactive, self-conscious standpoint. These results amply demonstrate how lean techniques have to be included into project management systems given China's dynamic and advanced engineering scene. Applying the results of this study will help engineering firms and project managers to develop improved, more knowledge-based, and more effective project systems. Future studies should investigate other mediating factors and extend them to several spheres or sectors so raising the relevance of this study on a worldwide level.

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