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STRENGTHENING THE CLIENT ROLE IN HANDLING PAYMENT-RELATED ISSUES TO INCREASE PROJECT PRODUCTIVITY IN INDONESIA: A DMAIC STUDY CASE

Iyan Nurdiansyah[1], Mahesh Babu Purushothaman[2], Yulham Ferdiansyah Roestam[3]

ABSTRACT

The Dukuh Atas Multifunction Bridge Project in Jakarta, Indonesia, planned to link the newly build public transport infrastructure, LRT Jabodetabek, to the existing modes such as: MRT Dukuh Atas Station, KRL Sudirman Station, Airport Rail Link Station, and Dukuh Atas Bus Rapid Transport. This project got national scale's attention since it targeted to finished prior to LRT Jabedebek launch ceremony which would be attended by the presidential administration. The stakeholders' expectations were intense, and the project faced multiple serious problems that posed a high risk of project failure. The study highlights lessons learned regarding the discontinued flow of funds, which led to poorer performance of the project and how the project team recovered progress through the implementation of lean construction principles from the clients' perspectives. The case study indicates that the implementation of lean construction tools helped bring the project back on track and met the stakeholders' expectations by improving the payment lead time from 68.22 days to 13.47 days. These results demonstrate the benefits of adopting lean construction tools through DMAIC framework to hinder the project from failure.

KEYWORDS

Lean construction, value stream mapping, Gemba, payment, conflict resolution.

INTRODUCTION

The Multifunction Bridge (JPM) Dukuh Atas spans approximately 235 meters and plays a crucial role in enhancing the public transit experience for commuters by connecting the new line of LRT Jabodebek to the existing public transportation in the centre of Jakarta, Indonesia. The bridge was developed by an investment scheme on the public asset consolidated from multiple stakeholders and was considered a fresh breakthrough since it involved zero government budget. The investment return was expected from the commercial activities driven by passenger flow, including retail, advertising, naming rights, and IT services. Nevertheless, the involvement of several stakeholders introduced complexity into the project process, necessitating the prioritisation of diverse concerns, an abundance of tasks, and an extended timeline for achieving conclusions, ultimately becoming a fundamental cause of project failure

1 Project Development Advisor PT. MRT Jakarta, Indonesia, Student of Master Construction Management Auckland University of Technology, NZ. iyan.nurdiansyah22@gmail.com, orcid.org/0009-0002-5486-1722

2 Senior Lecturer, Built Environment Engineering, Auckland University of Technology, NZ, mahesh.babu@aut.ac.nz, orcid.org/0000-0001-5062-272X

3 President Director of PT. Integrasi Transit Jakarta, rferdiansyah@itj-mrtjakarta.co.id

(Arantes & Ferreira, 2021). Due to various problems, the project led to a cash flow problem faced abandonment.

In response to these issues, this study was conducted to highlight the impact of implementing lean construction tools through DMAIC (Define, Measure, Analyse, Improve, and Control) methodology in The Dukuh Atas Multifunction Bridge Project. The purpose was to investigate the following two research questions:

- RQ1: How does strengthening clients' roles in payment-related issues through lean construction principles increase project productivity?
- RQ2: What are the resulting effects (plus and delta) of this strengthening?

Despite the growing interest in lean construction and its potential benefits, there is limited research exploring the client's perspective, especially on payment issues within the DMAIC framework. Although clients are perceived as knowledgeable and engaged in the process, their decision-making is frequently unilateral and driven by short-term financial considerations, resulting in the neglect of collaborative practices (Kuitert et al., 2019). With payment problems on the rise in construction, identifying the determinants of timely payment is a critical step towards improving project outcomes (Peters et al., 2019). To address these challenges, integrating DMAIC cycles with Lean Tools offers a promising approach to waste reduction and productivity improvement (Ferreira et al., 2019). Overall, there is a need for greater awareness and adoption of lean construction principles among clients and practitioners to support sustainable development and to improve payment processes in the construction industry.

LITERATURE REVIEW

THE CLIENT'S ROLE, PAYMENT AND STAKEHOLDER'S ISSUES

The client, while committed to funding and project success (Osuizugbo et al., 2023), often face limitations in controlling project execution (Sitkin et al., 2020). Traditional client practices frequently prioritize self-interest, employing risk transfer strategies that create stakeholder tension and project team disintegration (Tampio et al., 2023). The client's involvement in payment administration and financial oversight plays a crucial role in the pace of construction progress (Shahron et al., 2023) and unfair payment practices have detrimental ripple effects throughout the supply chain. These include mental health issues, stress, reputational damage, and executive turnover (Sohu et al., 2024). The issue of late payments is particularly acute for subcontractors with limited experience and financial instability, despite their crucial role in executing approximately 70% of the work (Haron & Arazmi, 2020). Even with timely client payments, subcontractors remain susceptible to delays due to contractors potentially diverting funds to other projects or for their financial gain (He et al., 2024).

Subcontractors and suppliers are often powerless sufferers of client-contractor conflicts (Sohu et al., 2024). Unresolved project-level disputes frequently escalate into costly legal proceedings, often resulting in liquidation and substantial financial losses (Bektas et al., 2021). Rather than promoting sustainable growth within the construction sector, liquidation and legal action conduct themselves as a win-lose approach and should be considered only a last resort in conflict resolution. Furthermore, it fundamentally contradicts the collaborative principles inherent in lean construction practices (Ørke et al., 2024).

DMAIC CYCLES AND VALUE STREAM MAPPING

The integration of DMAIC methodology with Lean Construction principles has shown benefits in improving construction processes and reducing waste. Studies have demonstrated that combining DMAIC with Lean tools can enhance productivity, reduce cycle times, and minimize defects in various construction-related applications (Ferreira et al., 2019). These

approaches have proven effective in identifying and eliminating non-value-added activities and maintaining continuous improvement in construction projects (Arafeh, 2015).

Value Stream Mapping (VSM) complements the DMAIC framework by providing a robust tool for the 'Measure' and 'Analyse' phases, enabling in-depth analysis of current processes and the identification of areas for improvement. As an example of the potential benefits, Gunduz and Naser (2019) revealed a 30.7% reduction in lead time and a 20.8% decrease in costs in an underground pipeline project. In addition, VSM has been implemented successfully in various construction contexts, such as architectural residential buildings (Lima et al., 2010) and kitchen cabinet assembly (Björnfot et al., 2011) achieving a 34% project duration reduction and 22% value-adding time, respectively. However, construction-specific adjustments are necessary when adapting VSM from manufacturing (Pasqualini & Zawislak, 2005). Despite these challenges, VSM provides a structured approach to implementing lean principles in construction, enabling the identification of inefficiencies and process waste across the value stream, and suggesting improvements for a more streamlined and less disruptive workflow (Lima et al., 2010; Pasqualini & Zawislak, 2005).

METHODOLOGY

The research employs a case study methodology because it is well-suited for exploring practical interventions and illustrating key themes. By using a case study, the research can demonstrate how the DMAIC framework is applied in practice, making the findings more relatable and actionable for stakeholders. According to Särkilahti et al. (2024), case studies are crucial for explaining practical interventions and providing illustrative examples of key themes that can be evaluated in real-world settings. Yin (2018) further emphasizes that case studies are particularly effective for investigating complex phenomena within their real-life contexts, making them ideal for applied research. Despite criticisms regarding scientific rigor and generalizability, case studies are valuable when examining complex activities in great depth (Darke et al., 1998).

According to Bravo et al. (2020), the DMAIC framework is an effective problem-solving approach due to its systematic and integrated structure. Abdelhamid (2003) further emphasizes that the DMAIC framework provides a clear roadmap for addressing complex problems by breaking them down into manageable stages, including:

1. Defining: recognize key stakeholder’s expectations, main problems, and project goals.
2. Measuring: crucial data is obtained to be processed, defining the inputs and outputs.
3. Analysing: statistical analysis is deployed to identify root causes of problems.
4. Improving: countermeasure developed is applied and monitoring the outcomes.
5. Controlling: eliminate reoccurrence of disorder potential and apply adjustments.

The integration of the case study approach with the DMAIC framework provides a robust methodology for the research, including:

- Systematic Approach: The DMAIC framework ensures a structured and logical progression from problem identification to solution implementation (Bravo et al., 2020).
- Data-Driven Decision Making: The emphasis on data collection and analysis ensures that decisions are based on evidence rather than assumptions (Abdelhamid, 2003).
- Practical Relevance: The case study approach ensures that the research findings are grounded in real-world applications, enhancing their relevance and applicability (Särkilahti et al., 2024; Yin, 2018).
- Sustainability: The control stage ensures that improvements are sustained over time, preventing the recurrence of problems (George et al., 2004).

In the case project, the DMAIC framework and Lean tools were not employed during the period from February 2022 to May 2023. The implementation of improvements took place between May 2023 and October 2023. As a project member, the author conducted observations by

participating in meetings, performing site inspections, and documenting findings through daily, weekly, and monthly reports. This hands-on involvement allowed for a comprehensive understanding of the project's progress and outcomes.

RESULT

DEFINE

Managing the stakeholders' expectations is vital due to the project's complexity, where the client's role as the owner of the project needs to be strengthened to create good practice in lean construction project management (Sunder M, 2016). Challenges such as poor stakeholders' management, discontinuing flow of funds, several technical issues and low productivity rate have been identified as key factors contributing to these conditions. In the define phase, a High-Level SIPOC (Supplier, Input, Process, Output, Customer) was elaborated for the JPM Dukuh Atas Project. It was used to define the customer requirements and identify the project goals. Short term goal of this study was to boost the progress of project through financial improvement from the client's perspective since it was the source of the problems. A more strategic goal was to achieve the expected completion date, create value for the involved stakeholders, and hinder project abandonment.

MEASURE

In this phase, the initial condition of the project was mapped from the monthly project reports. Data on invoices released by the contractor and the time taken to process until payment were captured to measure the existing level of the process. Project progress was also recorded to evaluate the correlation between payment disbursement and productivity at the site. Initial conditions are presented in Figure 1, while a summary of average payment lead time, monthly payment disbursement, and monthly work progress were 68.22 days, 3.91%, and 3.90% respectively.

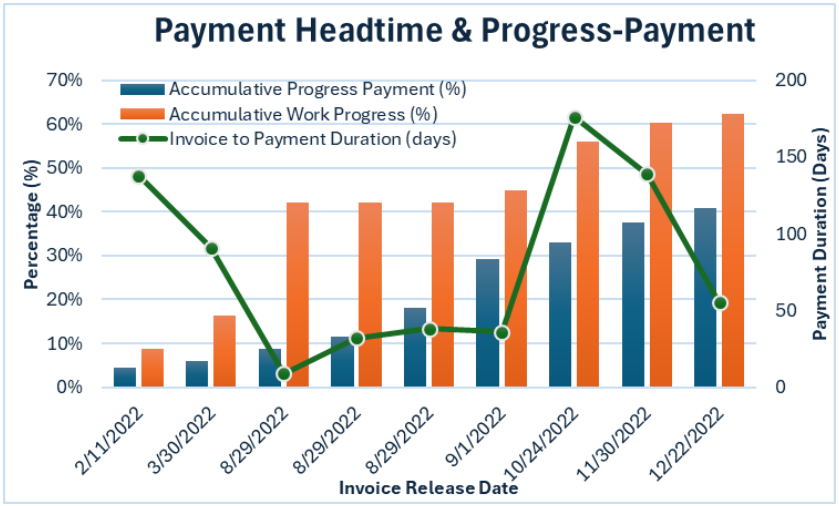

Figure 1: Initial condition of progress payment and work progress

ANALYSE

As illustrated in Figure 2, project funding originated from Shareholders A, B, and C, who formed a consortium based on business case analysis and anticipated return on investment through dividends. This consortium became the client entity, responsible for constructing infrastructure on government assets. This arrangement granted the consortium a concession period and generated rental revenue for the government as the asset owner. The client then engaged a contractor for project delivery, stipulating payment within 45 days of invoice

submission. Payments were processed through the contractor's designated financial institution, which also acted as a project lender to support contractor cash flow.

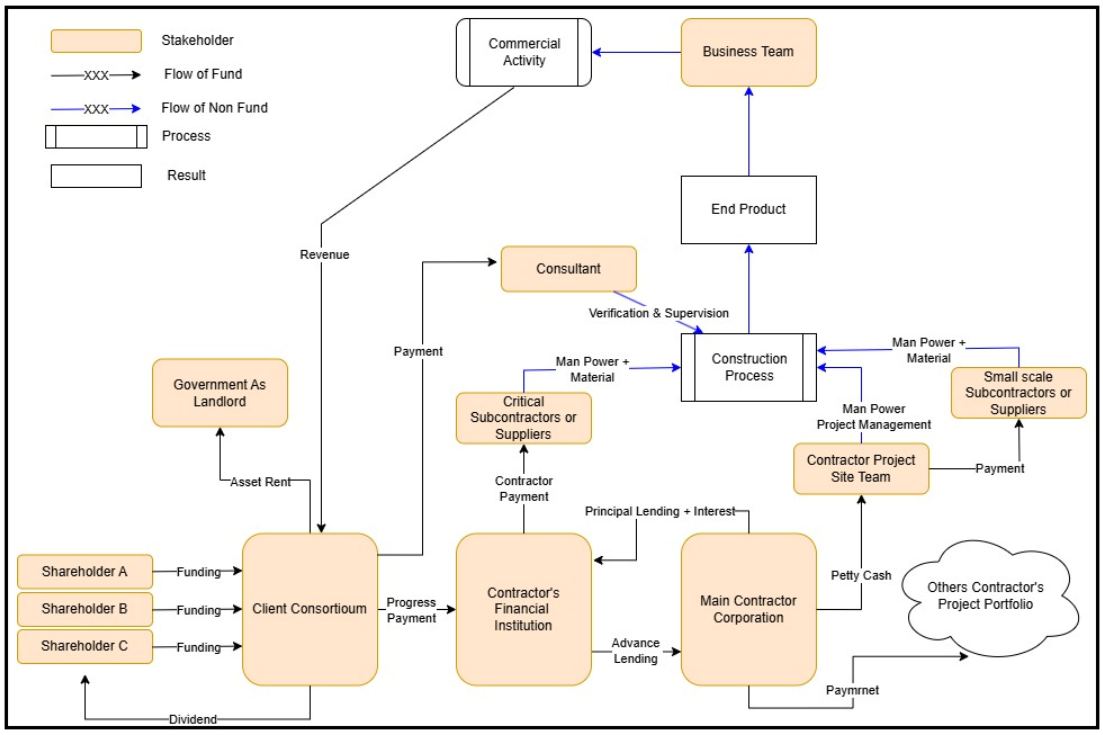

Figure 2 Current project's flow of fund

The contractor faced significant internal financial difficulties, exacerbated by cash flow issues from other projects, which strained relationships with financial institutions due to poor loan repayment performance. This led to the freezing of the contractor's accounts, restricting outgoing payments and causing non-payment to subcontractors and suppliers, thereby escalating conflicts and damaging inter-party relationships. The resulting project delays hindered the commencement of commercial activities, creating cash flow shortages for the client consortium and deteriorating relationships with shareholders and the government, as the asset owner. Ultimately, the project was abandoned due to irreconcilable stakeholder conflicts that reached a critical deadlock. Inefficiencies in the payment process, particularly in budget verification, further hampered progress, with the project failing to meet the agreed 45-day payment timeline and experiencing significant delays, averaging 68.22 days and ranging from 9 to 176 days during peak conflicts. This unpredictability created substantial uncertainty, negatively impacting the project's performance. Additionally, the simultaneous submittal of invoices 3, 4, and 5, closely followed by invoice 6, indicated poor organization in joint inspections, valuation processes, and documentation, leading to queuing delays and a fundamental imbalance between the flow of funds and materials (Chin, 2009). This imbalance caused significant cash flow gaps for contractors, subcontractors, and suppliers, and based on observed productivity levels, the project's projected completion time of 9.63 months was deemed unacceptable by stakeholders, further exacerbating financial distress and conflict sources.

Based on initial data derived from existing project progress reports and the contract, lean construction tools were employed to analyse processes and identify areas for improvement. Value Stream Mapping (VSM) proved instrumental in visually representing the current workflow and soliciting input from key stakeholders regarding challenges and potential solutions (Pasqualini & Zawislak, 2005). To address this issue, the study analyses the existing VSM of the payment process in the project to understand the flow as shown in Figure 3.

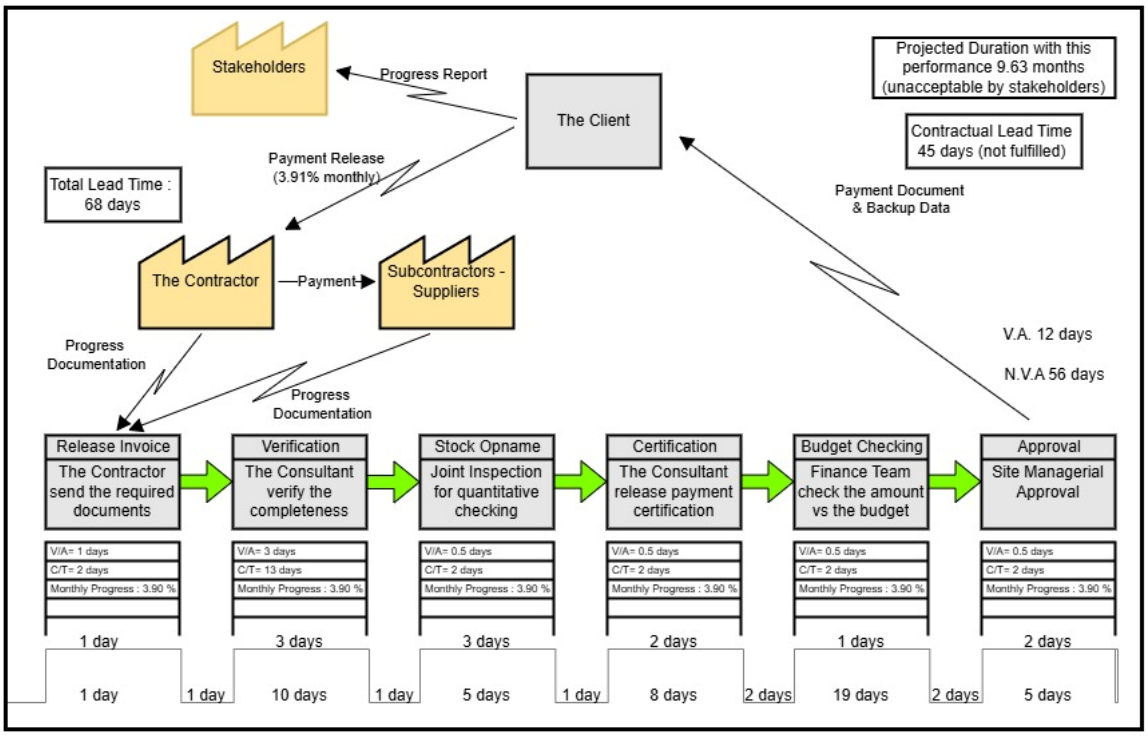

Figure 3 Current state VSM Diagram

IMPROVE

To improve the client consortium's financial situation, all key stakeholders involved gathered to find a solution. In this high-level meeting, all parties agreed to include shareholder D to join and provide the funding. Payment had been made by the consortium after shareholder D join. However, after the payment had been made, the progress did not reach the expected level. The client led several Gemba to be taken place weekly by the project team and monthly involved key stakeholders (Olatunji, 2008). From the Gemba, important findings were found that the contractor had internal problems that put them in a position to be banned by the financial institution. This condition hindered subcontractor payments, preventing the delivery of critical materials. After several meetings and considering the latest conditions, it was decided that conditional direct prepayment from the client would be the solution (Dabirian et al., 2023). To mitigate the risk, this prepayment only activated when the delay reached certain level, agreed by all parties involved, supported by the addendum of contract, and become direct deduction of progress payment. Instead of perceiving this situation as exposing the client to increased risk, the client adopted a proactive approach, viewing it as a chance to strengthen their project role and guide the project back on the right track.

Figure 4 show the process of streamlining the payment process by eliminating non-value-added activities and implementing close monitoring resulted in more timely and less fluctuating payment lead times (Chin, 2009). The contractor implemented a Just-In-Time (JIT) approach to invoice submission, facilitating more manageable processing (Bamana et al., 2017). Another improvement was by held formal and informal meetings with involved project team include subcontractors/suppliers to gain the trust for project completion. The client implemented a distinct separation between the JPM project and subcontractor/supplier disputes arising in the contractor's other projects. This measure was intended to mitigate the influence of external conflicts and facilitate a concentrated effort by all stakeholders to address challenges within the JPM project's scope. The improvement had been conducted was captured by countermeasure development through 5 whys analysis in Table 1.

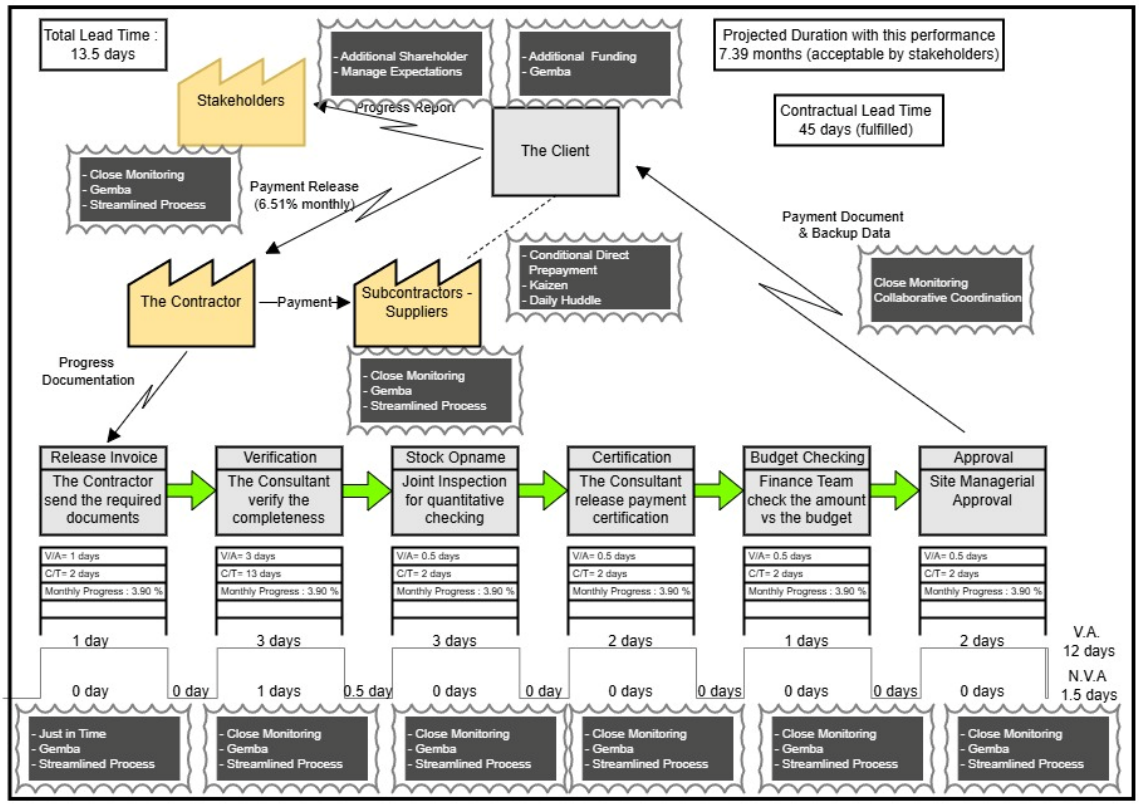

Figure 4 Future state map

Table 1: Countermeasure development

Root Cause	Countermeasure	Strategy
Financial problem of the client	Improve financial condition by adding shareholder D	Conduct high-level meetings and decision-making; deliver due diligence and new shareholder joining procedures; set timelines for funding and approval.
Untimely and fluctuated payment process	Achieve 45 days contractual deadline target	Close monitoring of submission, approval process, and just-in-time payment proposals; enhance communication and collaborative teamwork.
Bad relationship between main contractor and subcontractor-suppliers	The client act as bridge between parties and negotiate process to achieve project target	Formal and informal meetings with involved subcontractors to gain the trust for project completion; Create a bold borderline between their conflict in the contractor's other projects and engage all parties to focus on JPM project.
Payment issues from the contractor to subcontractors-suppliers	Conditional direct prepayment from the client to Subcontractors-Suppliers for critical works/materials	The important finding is that even though timely payment had been made by the client, there was no guarantee that the flow of funds reached subcontractors and suppliers; Since the contractor faced problem with their financial institution, the client needs to convey direct prepayment to subcontractors-suppliers.
Lack of control and stakeholders' management	Gemba (Weekly and monthly through visit)	Gemba was conducted weekly with the project team and monthly involving the key stakeholders.

OUTPUT STATEMENT

Invoice to payment lead time ranges from 9 to 27 days, as shown in Table 2, indicating a faster and less fluctuating payment cycle compared to the pre-improvement average and fulfilling the 45-day contractual requirement. The project also included direct payments from the client to subcontractors and suppliers which varies based on site condition update. It helped the project to rise their productivity.

Table 2: Condition of progress payment and work progress after improvement

Invoice Number	Invoice Date	Accumulative of Progress Payment	Accumulation of Work Progress	Invoice to Payment Duration (days)	Direct Payment to Subcontractors and Suppliers
10	05/02/23	42.95%	64.71%	27	0.00%
11	06/21/23	61.44%	74.30%	12	0.00%
12	07/17/23	69.33%	81.97%	9	6.59%
13	08/24/23	75.68%	91.11%	15	15.66%
14	10/25/23	81.13%	94.52%	16	10.03%

Table 3 provides a clear comparison of key measurements before and after the implementation of lean principles, demonstrating a substantial improvement in payment efficiency. The average payment processing time decreased, from 68.22 days to 13.47 days, a reduction of 54.75 days. Furthermore, the average monthly payment disbursement increased from 3.91% to 6.51%, a gain of 2.59% per month, indicating a more consistent and timely flow of funds into the project. Concurrently, the average monthly work progress, reflecting productivity, also improved, rising from 3.90% to 5.08%, a 1.18% increase per month. This improvement implied a positive correlation between enhanced payment processes and increased project productivity. Finally, the projected time to completion decreased from 9.64 months to 7.39 months, a reduction of 2.24 months.

Table 3: Comparation condition before and after lean & DMAIC improvement

Criteria	Before Approaches	After Approaches	Improvement	Note
Average Process of Payment (days)	68.22	13.47	-54.75	Payment process average shortened 54.75 days
Average % Payment/Month	3.91%	6.51%	2.59%	Payment disbursement increased 2.59%/month
Average % Progress/Progress	3.90%	5.08%	1.18%	Productivity increased 1.18% / month
Projected Required Time (Months)	9.64	7.39	-2.24	Time completion shortened 2.24 months

CONTROL

During this phase, implemented improvements were standardized through formal documentation and revised procedures. Internalization of these changes was facilitated among all team members to ensure a shared understanding. Furthermore, a new fund flow model, designed to promote stronger inter-organizational relationships between the client, the

contractor, and subcontractors/suppliers, was developed for future reference, as presented in Figure 5. The revised fund flow model had accommodated several issues, such as:

1. Conditional direct payments from the client to subcontractors/suppliers in case deadlock happened. This prepayments, according to Dabirian et al. (2023), considered an optimal policy when contractors manage multiple projects and experience internal cash flow constraints.
2. In response to financial limitation, the project stakeholders decided to pursue the gaining of additional equity investment through the acquisition of additional shareholders.
3. Stakeholders' management through close communication and coordination with key stakeholders to manage their expectations and trust to the project. The deliverables of the project are regularly shared and avoid any surprises which can disturb their convenience. This tool addressed the high-level strategic concerns and ensured that on-site implementation follow the established guideline.

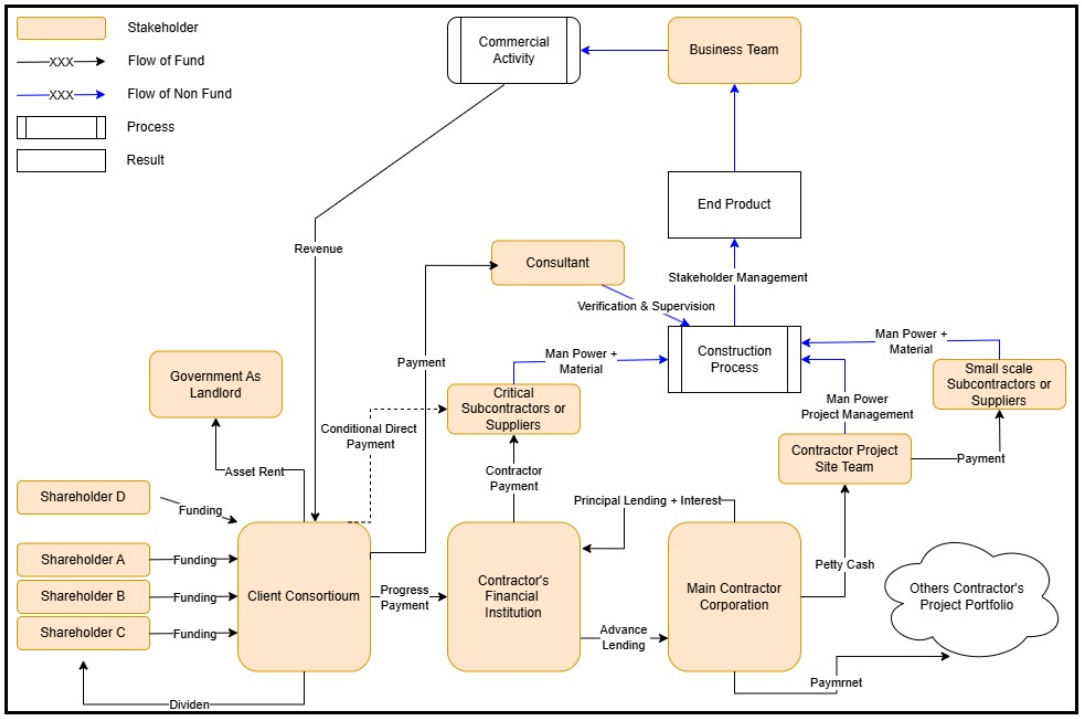

Figure 5 Future project's flow of fund

DISCUSSION

Analysis of the project following the implementation of improvements reveals substantial positive outcomes attributable to the application of lean construction principles and tools. This study highlighted lean construction principles and tools in conflict resolution approach and embrace collaboration in the project. Furthermore, this study encourages the flow of funds in the project to be more balanced by considering a systemic understanding of the role of subcontractors and suppliers as a cohesive unit contributing to overall project success. Ultimately, strengthening the client's role within the project correlated with increased project output and facilitated the resolution of conflicts at the project level, thus preventing legal escalation and its associated drawbacks, including resource expenditure, prolonged processes, potential liquidation, and negative impacts on the national economy and sustainability.

However, the findings also indicate that payments made by the client did not always directly correlate with progress at the site. To address this, the client should ensure that site evaluations are conducted through Gemba (going to the actual site) to uncover the real challenges faced by

the project team (Olatunji, 2008). The insights gathered from the site should be brought into the meeting room within a constructive and collaborative framework to facilitate mutual decision-making. Therefore, despite the streamlined payment process, additional effort from the client is necessary to ensure alignment between payments and project progress.

The findings of this research hold relevance and value for both practitioners and academia. For the construction industry, this study demonstrates that substantial benefits can be achieved through the implementation and utilization of the DMAIC framework and Lean tools in addressing payment-related issues. Furthermore, a mechanism for fund flow from the client to the subcontractors/suppliers, which can be activated in emergency situations, may be incorporated into the standardise contract to mitigate potential deadlocks in the relationship between the contractor and subcontractors/suppliers.

The results of this study are consistent with findings from prior research. For example, case studies have documented improvements such as a 25% reduction in process cycle time for supplier payments (Costa et al., 2013) and identification of non-value-adding steps in construction processes (Daniel et al., 2019). These parallels underscore the effectiveness of DMAIC and Lean methodologies in enhancing operational efficiency and addressing inefficiencies in payment systems.

CONCLUSION

The study highlights the lesson learned from study case regarding payment related issues, conflict resolution and lean construction principles and DMAIC framework application. Addressing payment-related issues using lean construction principles and DMAIC framework application has demonstrated several benefits including: accelerated payment disbursement, reducing financial delays and improving cash flow; increased trust among project team members, fostering a more collaborative work environment and confidence in project completion; mitigation of fluctuations and uncertainties, enhancing project stability; and improved work output and progress, ensuring that project milestones are met efficiently.

The study identified positive outcomes of this approach including strengthened relationships among stakeholders, leading to improved collaboration; addressed concerns of lower-tier stakeholders, ensuring fair treatment and financial security; and enhanced project success by meeting stakeholder expectations. However, the identified challenges should be anticipated, including direct payments to subcontractors and suppliers increased the client’s financial risk exposure; and the potential for opportunistic behaviour by contractors exploiting available support mechanisms.

While the findings of this study provide valuable insights into the benefits and challenges, there are some limitations and areas for improvement. First, the study's focus on a single project may limit the generalisability of the findings. Second, the experimental period is relatively short, which may not capture the long-term or unintended effects of the project. Third, the author's involvement as part of the project team presents a potential source of bias for process analysis.

Future study should examine the client's increased risk due to the strengthened role and establish acceptable risk levels. Strategies to prevent opportunistic behaviour and the misappropriation of support mechanisms should also be explored. Finally, capturing the process from the perspectives of the contractors, suppliers/subcontractors, consultants, shareholders, and the government can enrich future research and provide a comprehensive understanding.

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