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LEAN PUBLIC CONSTRUCTION IN THE PROJECT DEFINITION PHASE: THE CASE OF PERU

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ABSTRACT

Public construction in developing countries is characterized by a lack of quality design information, poor front-end engineering studies, fragmented procurement, and financial obstacles. As a result, projects exhibit major delays, cost overruns, and contract resolution during construction which end up in failed projects. These issues cause dramatic losses in value for end-users and society. Current literature suggests that the main issues in public construction are rooted in the strategic definition, briefing, and concept design. To tackle these problems, the current research will focus on understanding the value-generating principles of public construction at the project definition phase by using the Lean Project Delivery System (LPDS). The methodology in this research is inductive and based on qualitative data. The case of Peru was used as a case representing a developing country. The findings show that the value-generating principles for public construction are end-user consideration, asset functionality, transparency, efficiency, predictability, and efficacy. However, the institutional pressures both enable and constrain public managers' ability to deliver the expected outcomes and value. This represents a great opportunity to deploy lean methods at the beginning of the project to improve transparency, collaboration, and drive innovation. Future studies can develop a lean-enabled framework for public construction and scrutinize the constraints for value generation.

KEYWORDS

Lean construction, LPDS, project definition, public construction.

INTRODUCTION

Construction projects are influenced by country-specific institutional pressures that might drive the management of projects in different directions. Public construction in developing countries faces major challenges to deliver the infrastructure needed to improve citizens' quality of life and reach long-term sustainability targets. For instance, Ezzat (2013) found that the main challenges of construction projects in developing countries are related to engineering issues (e.g., lack of understanding of, and capability to deliver technical requirements), human capital issues (e.g., shortage of quality education and continuous professional development programs), financial issues (e.g..,

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lack of financial resources), and managerial and political issues (e.g., lack of political support, lack of vision from the project's owner).

Very commonly, public construction projects are managed with traditional management methods with a focus on time and cost but overlooking important aspects such as functionality and sustainability (Haddadi et al., 2016). As a result, projects can be delivered on time and within budget, but they do not reach the expected long-term expected outcomes or value (Cooke-Davies, 2002). Previous research has shown that the gap between value generation and project outcomes is commonly attributed to the lack of proper consideration of stakeholders' contributions, the lack of understanding of the influence of the stakeholder's decisions, and the lack of knowledge of the ways to generate value (Tillmann et al., 2013). Moreover, Tillmann et al. (2011) argued that urban regeneration projects in Brazil are influenced by a high dynamic environment due to myriad requirements from multiple stakeholders. Thus, a better approach to managing stakeholders is needed to deliver value. Nonetheless, different actors may have a different meaning for value. Therefore, the problem seems to be rooted in a lack of consensus in determining and/or identifying the value-generating principles that drive expected project performance and outcomes. From a lean perspective, Bølviken et al. (2014) argued that value is about the usefulness, functionality, utility, and benefit of the product. As such, *"Something wanted is wanted by somebody. Value is therefore always value for somebody"*. Bølviken et al. (2014) also argued that in lean construction, the value for the customer is the dominant value perspective. However, public construction is delivered in a complex network of tough regulations, societal expectations, and limited funding. Therefore, this definition suggests that identifying the actors beyond the customer, and their value-generating principles, might provide a better understanding of how to connect value and project outcomes in public projects.

In this context, the Lean Project Delivery System (LPDS) can be applied to facilitate this connection and focus on value generation. Thus, the main objective of this research is to identify the value-generating principles for public construction within the context of developing countries. To analyze the applicability of LPDS, this research will use the Peruvian public construction as a case study. As such, this paper is structured as follows. First, an overview of the Peruvian public construction delivery process, and the major issues facing the sector will be presented. Following, literature about the project definition phase of the LPDS as an enabler of value generation in public construction is discussed. Then, the research method is described. This is followed by the presentation of the results and discussion. Finally, concluding remarks will close this paper.

PERUVIAN PUBLIC CONSTRUCTION

THE DELIVERY PROCESS OF PUBLIC CONSTRUCTION

Peruvian public construction project delivery is determined by the National System of Multiannual Programming and Investment Management (INVIERTE.PE) which is the administrative system responsible for ensuring that public investment meets the criteria of efficiency, effectiveness, sustainability, and transparency for the use of public resources. In other words, it seeks that public investment closes the gaps in infrastructure and access to services in favor of citizens at all levels in all sectors such as water and sanitation, healthcare, and education. The public construction investment cycle has four stages as described below (MEF, 2018):

- Multiannual Investment Programming (PMI): this strategic stage determines the investment portfolio and cost allocation with a focus on closing infrastructure gaps on national, sectoral, and territorial levels.
- Formulation and Evaluation (F&E): this stage formulates the detailed investment proposal to achieve the goals established in the PMI. Here, public managers define service levels, quality standards, social profitability, and sustainability targets.
- Execution: this stage includes the delivery of the design outputs (i.e., drawings and specifications) and the construction of the project based on its design outputs. Likewise, progress and financial monitoring tasks are carried out.
- Operation: this stage includes the operation and maintenance of the built assets and the provision of the services. Here, public managers evaluate whether the expected value was delivered to the beneficiaries or not.

In addition to INVIERTE.PE, public managers must follow the public contracting system enforced by the State Contracting Law (SCL). INVIERTE.PE and SCL both enable and constrain the delivery of public projects in Peru. Previous literature has found many challenges regarding these legal frameworks such as the deliberate fragmentation of project stages, restrictions for using collaborative delivery methods, and lack of responsiveness to uncertain situations (Prado, 2021).

PROBLEMS IN PERUVIAN PUBLIC CONSTRUCTION

According to the latest report published by the Peruvian Audit Office (CGR), national and regional governments, as of July 31, 2018, had 867 projects at standstill for a contracted amount of S/ 16,870'855,767.00 (ca. $4 billion). The main reasons for failed projects were identified as technical deficiencies in both design documents and during construction, contractual non-compliance (39%), overbudgeting (28%) and unreasonable time extensions (15%) (CGR, 2019). Previously, CGR (2014) found that the F&E stage was characterized by poor front-end engineering studies such as soil mechanics or survey reports, as well as inaccurate architectural and structural concept designs. In the Execution stage, the major problem is the long latency of design changes due to poor design coordination.

In addition to the Peruvian government reports, other authors have tried to understand the challenges in the Peruvian public construction. Arnao (2011) stated that the drawbacks of public construction projects are caused by poor management during planning and execution (design and construction), lack of government control, inherent fragmentation of regulated contracting methods, financial obstacles, and incomplete basic engineering studies. Gomez-Sanchez (2015) found that overbudgeting is mainly associated with risks such as poor or incomplete design documents and the non-consideration of other risks such as bad weather conditions, unforeseeable site conditions, excessive bureaucracy in administrative processes, and other unpredictable situations after contract award.

Previous studies have analyzed Lean Construction (LC), Building Information Modelling (BIM) and Virtual Design and Construction (VDC) to improve Peruvian public construction performance. For instance, Prado (2021) described three interrelated challenges during the VDC implementation, namely, legal and contracting issues, culture of the organization and people-related. Similarly, Salinas and Prado (2018) proposed a framework for applying BIM in public construction to integrate design and construction with a focus on the transformation of the delivery process. Moreover, Murguia et al. (2020)

proposed a database structure for capturing lessons learned from facility managers to provide timely input to design and construction teams. Furthermore, Murguia et al. (2021) found cultural-cognitive elements that impact the adoption of BIM, which need to be considered by policymakers who are planning to mandate and control BIM adoption in the public sector. On the other hand, Chuquin et al. (2021) presented case studies for the use of lean design in infrastructure hydraulic projects. However, public organization structure and a lack of trained professionals were the major barriers to successful lean delivery. Huaman-Orosco et al. (2021) reported that one of the most important barriers to LC implementation is the lack of government policies to encourage the use of Lean. As a major player in the industry, the government possesses the power to engage and empower public organizations to deliver value throughout the project lifecycle. Together, these studies suggest that the application of Lean Construction tools and method, together with innovative technologies and processes can support performance improvement in public construction. In this context, the LPDS can be beneficial for providing a framework to determine the value-generating principles at the outset of Peruvian public projects.

LPDS AS AN ENABLER OF VALUE GENERATION

LEAN PROJECT DELIVERY SYSTEM

The LPDS is a delivery system in which the project team helps customers (beneficiaries) to decide what they want. Ballard (2000) described LPDS as a "project-based production system" because it is a temporary production system. LPDS contains five project phases, and each phase contains three project steps, as shown in Figure 1. Each phase is interconnected to the next one through a common step. Thus, each project phase has an impact on the following phase and is influenced by the previous phase.

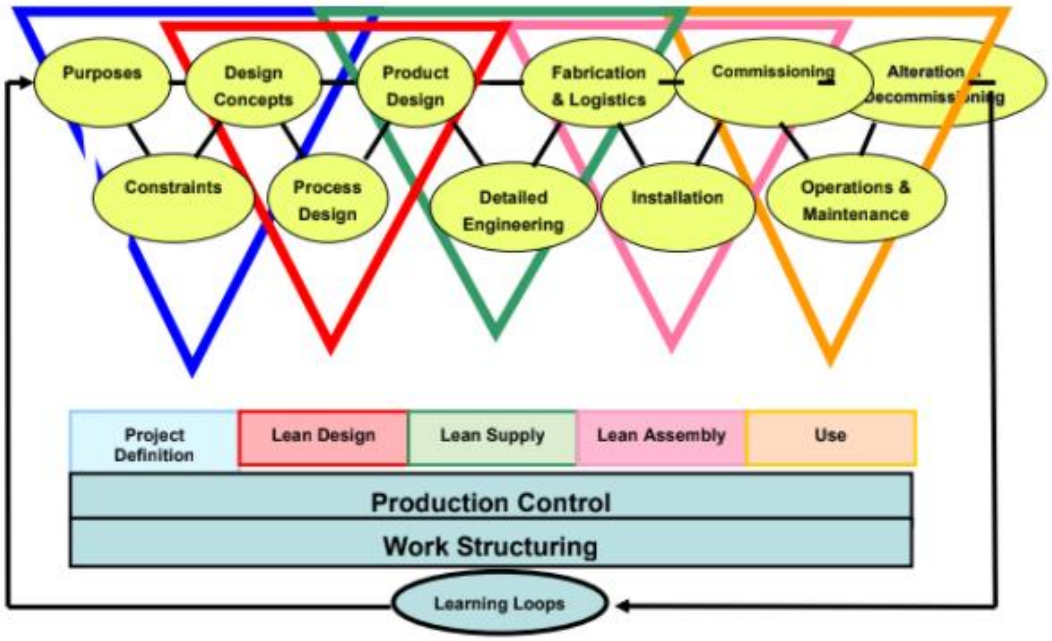

Figure 1: Lean Project Delivery System (Figure 3 in Ballard 2008)

In contrast to traditional project delivery systems, LPDS questions what needs to be done and who is responsible for the task at the very beginning of the project. The following points are key characteristics of LPDS:

- The project is structured and managed as a value-generating process
- Early involvement of downstream stakeholders to plan and design the project steps through cross-functional teams (Ballard, 2000).

As such, decisions, which are made in one phase, affect the other phases. Compared to traditional project delivery (design-bid-build or DBB), LPDS explicitly shows the relations and dependencies between the different phases, which are often ignored, compared to DBB. This research focuses on the LPDS Project Definition phase because many of the problems in public construction projects originate during the F&E stage which contains similar processes to the Project Definition phase.

LPDS PROJECT DEFINITION PHASE

Ballard (2008) presented the Project Definition phase as a process of aligning between Ends, Means and Constraints. Alignment is achieved through a conversation that starts with the customer stating what they want to accomplish (the end), the means (the how) for achieving their ends, and the constraints (location, time, cost) of those means. Defining these three aspects of Project Definition is critical for initiating a project:

- Ends: By understanding what is the final product that the beneficiary wants, we can understand what the purpose of that wanted output is, which then can be described by what are the valuable features of that final product. It is critical to translate from the voice of the customer into the voice of the project members, which then will provide specifications for the wanted product. Both linkages are difficult and critical, linking purposes and values, and linking values and engineering specifications for the project.
- Means: Since in the LPDS projects are described as production systems, it is sometimes necessary to first design how the built asset will be used before designing the facility itself. This idea reflects the need for incorporating criteria for the operation and maintenance stage of the expected product and using it as a trigger for describing the other features of the facility to deliver.
- Constraints: As Ends are more clearly defined and translated into specifications, and as the design-for-use of the facility emerges, constraints are also better defined. What are the customers able and willing to spend to get the means for realizing their purposes? That is the question to ask to find the constraints in projects such as time, geological conditions, or socio-cultural environments.

However, the common practice is that many projects first establish the means, without knowing the purposes of the ends. Tillmann et al. (2013) found that the LPDS can support the pursuit of value in construction projects by establishing favorable conditions for the different participants to collectively generate value. Ballard and Tommelein (2021) provided a variety of uses of LPDS and the Last Planner System with a wide range of lean methods and tools that can improve project performance. Similarly, researchers have found LPDS integration with other technologies. Khanzode et al. (2005) described a strong relationship between VDC as a virtual tool that can improve the implementation of LPDS, specifically using 3D-4D CAD technologies. Nguyen et al. (2008) found that process-based construction cost modeling may be used to assist the stakeholders in resolving a variety of decisions such as evaluating the cost of different design alternatives, establishing the cost impact of design changes and budgeting construction costs.

Previous studies have shown the use of LPDS in public and private construction projects to improve performance, and how technologies can support this delivery system.

However, no study addresses the lack of relationship between value generation and project outcomes in the context of public construction in developing countries. Therefore, the main objective of this research is to fill this research gap by developing a proposal that operationalizes the LPDS with the value-generating principles in the Peruvian public construction to potentially provide a better understanding of what is the value that should be generated.

RESEARCH DESIGN

A qualitative research approach to data collection was deployed to understand the principles that generate value for projects, from the perspective of public managers. Qualitative methods are appropriate when the intention is to understand a phenomenon from the point of view of participants in a particular social and institutional context (Creswell, 2014). Therefore, the research procedure consists of these three steps:

The first step was to collect data about the value-generating principles in Peruvian public construction. The authors selected semi-structured interviews using the critical incident technique (CIT) as the data collection method. By incident is meant any observable human activity that allows inferences to be made. To be critical, the incident must have significance and depict the phenomenon being investigated (Flanagan 1954). CIT enables the possibility to gather critical incidents from interviewees' narratives. Interviews were designed to obtain participants' individual opinions rather than an organizational perspective. Participants were identified through researchers' industry networks and a 'snowball' interview technique was utilized (Lingard et al. 2019). Interview questions were open-ended and project specific. Thus, participants were asked to narrate experiences and discouraged from answering questions in a general way. Questions explored participants' views about (1) their perception of value in the context of expected outcomes in public projects; (2) their perception of the drivers that generate value in projects; and (3) their perception of the constraints to reduce value generation.

The second step was a detailed analysis of the interviews' transcripts to identify the value-generating principles based on the experiences shared by the respondents. Since the interviews were semi-structured, the authors made sure that the experiences related to "value" were related to the benefits provided by the project as opposed to value as the project cost. The third step was to align the value-generating principles found in step 2 with the ends, means, and constraints proposed by the LPDS project definition phase and to propose an alignment matrix for value generation in the early stages of public construction projects.

RESULTS

DEMOGRAPHICS OF THE DATA COLLECTED

The criterion for inclusion was that the participant has had experience as a public manager in construction projects. Eighteen semi-structured interviews (25' on average) were held with public managers with varied backgrounds, as shown in Table 1. Data were recorded and transcribed, and then analysed using NVivo 12. A mixture of deductive and inductive analysis was used as the data analysis method. Nodes were inductively created by the authors to define the value-generating principles. The second round of inductive analysis helped merge nodes into higher-level themes and therefore identify who captures the value.

Table 1: Demographics of interview participants

Variable	Value	Frequency	Percentage
Degree	Architecture	4	22%
	Civil Engineering	14	78%
Years of Experience	5– 10 years	7	39%
	11 – 20 years	7	39%
	More than 20 years	4	22%

VALUE-GENERATING PRINCIPLES IN PERUVIAN PUBLIC CONSTRUCTION

The analysis revealed that public managers perceive that value is generated through the fulfilment of specific principles in three categories: the end-user, the government, and the public manager, as presented in Table 2. Therefore, the value-generating principle generates value for "*someone*". As such, it can be observed a relationship between the recipient of the value and its associated principles.

Table 2: Value-generating principles

Value for who?	Value-generating principles
For the end-user	End-user consideration
	Functionality
For the government	Transparency
	Efficiency
For public managers	Predictability
	Efficacy

Value for the end-user

This is related to the principles that can generate value for the ultimate customers: the end-users or asset beneficiaries. It is also associated with the Operation and Maintenance stage of the project. The value-generating principles for end-users are:

- End-user consideration: enabling a collaborative environment to allow the active participation of the end-users throughout the development of public projects.
- Functionality: considering early in the project the lessons learned and knowledge from the operation and use of facilities.

Value for the government

This is related to the principles that can generate value to be compliant with the laws that govern public projects to ensure competitiveness and accountability. Lack of compliance would have major negative impacts. The government's value-generating principles are:

- Transparency: ensure a transparent exchange of technical and administrative information. Technical information includes achievable schedules, fair quantities and payments, and specifications that meet project needs. Administrative information includes human resources allocation, legal documents, and insurance. Stakeholders are accountable for each process.
- Efficiency: public managers must ensure that the cost-benefit analysis encompasses social and economic benefits for society.

Value for public managers

This is related to the principles that can generate value for the management of the execution stage (design and construction). Public managers value good management practices that comply with the laws and regulations (technical and administrative). However, when public managers face uncertainties, they prefer to avoid decision-making to prevent future sanctions. The value-generating principles for public managers are:

- Predictability: having tools to make accurate time and cost predictions as well as being able to timely identify risks.
- Efficacy: achieving the expected project objectives defined at the beginning of the project and avoiding administrative sanctions.

ALIGNMENT OF PERUVIAN PRINCIPLES AND LPDS PROJECT DEFINITION

Based on the principles that deliver value to each category, Table 3 presents an alignment matrix between the value-generating principles and the ends, means, and constraints of the LPDS project definition phase.

Table 3: Alignment between the principles that generate value in Peruvian public construction and the sections of the LPDS project definition

Principles	Ends	Means	Constraints
End-user consideration	Early involvement of the beneficiaries to capture their needs and values	Understanding the key features of the asset and their functionality from the end-user perspective	Due to specific project conditions, project teams may not be able to involve end-users
Functionality	How the project ought to be operated and its purpose must be known	Lessons learned to meet the expected use of the facility and to allow them to influence project delivery	Lack of involvement of O&M actors due to the traditionally fragmented procurement system (DBB-operate)
Transparency	Maintain transparency of the information throughout the lifecycle to avoid corruption claims	The project delivery should be compliant with the laws for public projects (technical and administrative)	The legal framework and human behavior will frame the environment in which project managers should act
Efficiency	Cost-benefit analysis and an efficiency-driven approach to the use of project resources	The project should meet the need at the lowest “cost” to deliver the expected value	Lack of clearly defined tools to define realistic project costs in early stages
Predictability	Use mechanisms to manage uncertainties or poor information as they impact the project performance	Use of buffers throughout project delivery to predict and manage unforeseen situations	Poor front-end engineering studies, insufficient information, erroneous drawings, and specifications
Efficacy	Establish project objectives (outcomes and performance) by a consensus with relevant stakeholders	Maintaining and meeting objectives throughout project delivery by assigning a skillful project team	Time restrictions lead to poorly defined project objectives and selecting an incompetent project team

The examination of the six value-generating principles in Peruvian public construction and the three steps of the LPDS project definition phase helps to understand the ways public managers can generate value for public construction projects. The ends, means, and constraints were defined for each value-generating principle. For the end-user consideration principle, the ends are related to the involvement of beneficiaries to define the value to be delivered by the built asset, the means are related to key features of the

built asset that will lead to delivering the value already defined, and the constraints are related to the situations when is difficult or impossible to collect the beneficiaries' perspective, such as a wide-range of myriad requirements or changing beneficiaries over time. For the functionality principle, the ends are related to defining how the built asset will be used and operated, the means are related to the inclusion of facility managers' inputs in the project delivery stage, and the constraints are related to the current DBB practice that limits the inclusion of more stakeholders at the beginning of the project.

For the transparency principle, the ends are related to the accountability to be maintained throughout the project, the means are related to the compliance with technical and administrative laws, and the constraints are related to the legal framework in which the project managers must act because of the current regulation. For the efficiency principle, the ends are related to controlling the public expenditure on public projects, the means are related to completing the project at the lowest cost possible while delivering the expected value, and the constraints are related to the lack of tools and methods to define project costs accurately at early stages of the project. For the predictability principle, the ends are related to the be prepared to manage uncertainty, the means are related to the use of buffers to manage uncertainty, and the constraints are related to the poor information in the project that does not allow to prepare for these situations. For the efficacy principle, the ends are related to establishing project objectives collaboratively, the means are related to maintaining these objectives throughout the project delivery, and the constraints are related to time pressures that lead to a poor objective definition.

DISCUSSION

The research findings represent the first attempt to align value-generating principles in public construction with the LPDS. This would provide an opportunity for the use of different lean tools and methods at the beginning of project delivery. In terms of the value for the end-user, an interviewee said that *"the end-user should approve my proposal so they know that later they can maintain it"*. This confirms that end-user consideration is relevant to the project. However, some interviewees pointed out that interrogating end-users might provide unwanted outcomes when the end-user has political influence, such as controlling design decisions that are not aligned with basic design criteria. They might also have the power to add unnecessary risk by reducing the established project timeline. Refurbishment projects are very high risk due to the inexistence of reliable asset information. For example, public managers need to survey existing assets to initiate a project. However, the existing asset management systems are paper-based and lack an agreed process that ensures reliability and consistency across projects. In that sense, the application of BIM for information management would provide the digital platform needed to integrate design information among stakeholders and share lessons learned from facility management systems. However, it is required to implement a robust system to collate lessons learned such as the approach shown in Murguia et al. (2020).

In terms of the value for the government, transparency and cost-efficient decision-making are paramount for public managers. An interviewee pointed out that *"not only the project is important, but also the procedures conducted by audit institutions that are looking for mistakes throughout the project"*. Public managers operate under tough pressure and scrutiny of the Audit Office which is often expressed as "fear" to make wrong decisions, thus, no decisions are made due to the civil and penal consequences. From the lean methods and tools documented by Ballard and Tommelein (2021), the authors of this study argue that Target Value Design, Set-based design, and Choosing by

Advantages can provide a better approach to addressing the project's conceptual design by considering cost implications and improving transparency. The current BIM mandate for public projects in Peru aims to increase transparency in the information and reduce errors across the supply chain, including cost estimators, designers, and contractors. However, there is a capability gap among practitioners, especially designers, that might threaten the expected outcomes of implementing BIM in public construction (Murguia et al., 2021).

In terms of the value for the public managers, predictability and efficacy are project-level value-generating principles during the management of projects. An interviewee said that *"We need predictable engineering documents that provide the right information to develop the project, and if possible, with no defects"*. To achieve improved predictability and efficacy, project managers need to simultaneously manage information and stakeholders. Therefore, lean methods that promote collaboration and knowledge exchange can provide environments to set achievable objectives and better predictions, such as the tools and methods proposed by Ballard and Tommelein (2021) that are used together with LDPS and Last Planner System. Also, the VDC framework can provide a way to focus on project and client objectives in a public organization (Prado, 2021).

By applying the proposed alignment matrix, we can align efforts to reduce the gap between the value generated from the three customers identified (end-users, government, and public managers) perspective and the asset delivered to society. Moreover, the lean tools and methods suggested to use with the alignment matrix can serve as a starting point to produce a lean-enabled framework for operationalizing lean tools and methods in the project definition phase of public projects. This is the baseline for future research.

CONCLUSIONS

This research aimed to identify the value-generating principles for public construction within the context of the project definition phase of the LPDS to provide a potential solution for the research problem: lack of consensus in determining and/or identifying the value-generating principles that drive expected project performance and outcomes. To achieve this aim, an inductive approach was taken, and qualitative data were collected via interviews with a range of managers working in public organizations. Interviewees were asked to narrate experiences about value generation (and loss) during the management of public construction projects and the means to achieve better project outcomes. The findings show that the value-generating principles for public construction extend beyond the end-user perspective. Public projects are deployed within a complex institutional environment that requires the generation of value for the government and the public manager to reduce controversies, cost overruns, corruption, and ultimately resolution of contracts and failed projects that cause profound losses to society. The findings show that the value-generating principles for public construction are end-user consideration, asset functionality, transparency, efficiency, predictability, and efficacy. Furthermore, the LPDS can be extended to consider the specific case of public construction and include the value-generating principles encapsulated in the complex legalistic and managerial context, which led us to propose the alignment matrix that potentially closes the gap of the lack of consensus between project outcomes and value delivered. Further research can develop a framework for Lean Public Construction and scrutinize case studies with the use of Lean tools and methods at the earliest stage of public projects in developing countries to assess performance.

REFERENCES

Arnao, R. (2011). La eficiencia en la gestión pública: "El caso de la gestión de inversión pública local en el Perú" [The efficiency in the public management: "The case study of local public investment in Peru"]. Lima: Serie de investigaciones: Universidad Católica Sedes Sapientae. [In Spanish].

Ballard, G. (2000). Lean Project Delivery System. White Paper 8, *Lean Construction Institute*, 1-7.

Ballard, G. (2008). The Lean Project Delivery System: An Update. *Lean Construction Journal*, 1-19. https://leanconstruction.org/media/docs/lcj/2008/LCJ_08_001.pdf

Ballard, G. (2011) The Target Value Design: Current benchmark (1.0). *Lean Construction Journal*, 79-84, https://leanconstruction.org/media/docs/lcj/2011/LCJ_11_009.pdf

Ballard, G. & Tommelein, I. (2021). 2020 Current Process Benchmark for the Last Planner® System of Project Planning and Control. *Lean Construction Journal*, 53-155, https://leanconstruction.org/uploads/wp/media/docs/lcj/2021/LCJ_21_001.pdf

Bølviken, T., Rooke, J. & Koskela, L. (2014). The Wastes of Production in Construction – a TFV Based Taxonomy. *Proceedings of the 22nd Annual Conference of the International Group for Lean Construction*, 811-822.

Chuquín, F., Chuquín, C. & Saire, R. (2021). Lean Design in Hydraulic Infrastructure – River Defenses and Dikes - A Case Study from Peru. *Proceedings of the 29th Annual Conference of the International Group for Lean Construction*, 584-594. https://doi.org/10.24928/2021/0130

Cooke-Davies, T. (2002). The 'real' success factors on projects, *International Journal of Project Management*, 20(3), 185-190. https://doi.org/10.1016/S0263-7863(01)00067-9

Creswell, J. W. (2014). *Research Design. Qualitative, Quantitative and Mixed methods approaches*. Sage.

Ezzat, A.A. (2013). Challenges of mega construction projects in developing countries. *Organization, technology & management in construction*, 5 (1), 730-746. https://doi.org/10.5592/otmcj.2013.1.10

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin*, 51(4), 327–358.

Gomez-Sanchez (2015). Campaña para lograr proyectos exitosos [Campaign for achieving successful projects]. Lima: Reporte de Ingeniería y servicios tecnológicos S.A.C. [In Spanish].

Haddadi, A., Johansen, A. & Andersen, B. (2016). A Conceptual Framework to Enhance Value Creation in Construction Projects. *Procedia Computer Science*, 100, 565-573. https://doi.org/10.1016/j.procs.2016.09.196

Huaman-Orosco, C. & Erazo-Rondinel, A. A. (2021). An Exploratory Study of the Main Barriers to Lean Construction Implementation in Peru. *Proceedings of the 29th Annual Conference of the International Group for Lean Construction*, 474-483. https://doi.org/10.24928/2021/0173

Khanzode, A., Fischer, M. & Reed, D. (2005). Case Study of the Implementation of the Lean Project Delivery System (LPDS) Using Virtual Building Technologies on a Large Healthcare Project. *Proceedings of the 13th Annual Conference of the International Group for Lean Construction*, 153-160.

Lingard, H., Oswald, D., & Le, T., (2019). Embedding occupational health and safety in the procurement and management of infrastructure projects: institutional logics at play in the context of new public management. *Construction Management and Economics*, 37 (10), 567–583. https://doi.org/10.1080/01446193.2018.1551617

Ministry of Economy and Finance (2018) Supreme Decree 284-2018-EF: Regulation of the National System of Multiannual Programming & Investment Management.

Murguia, D., Felix, K. M. & Guerra, M. A. (2020). An Approach to Capture Design and Construction Lessons Learned From Facility Managers. *Proccedings of the 28th Annual Conference of the International Group for Lean Construction*, 997-1008. https://doi.org/10.24928/2020/0067

Murguia, D., Demian, P. & Soetanto, R. (2021). The role of the industry's cultural-cognitive elements on actors' intention to adopt BIM: an empirical study in Peru. *Engineering, Construction and Architectural Management*, 1-18 https://doi.org/10.1108/ECAM-08-2021-0743

Nguyen, H. V., Tommelein, I. D. & Martin, P. (2018). Process-Based Cost Modeling Framework and Case Study. *Proceedings of the 26th Annual Conference of the International Group for Lean Construction*, 46-57. https://doi.org/10.24928/2018/0523

Peruvian Audit Office (2015). Effectiveness of public investment at the regional and local levels during the period 2009 to 2014. http://doc.contraloria.gob.pe/estudios-especiales/estudio/2016/Estudio_Inversion_Publica.pdf

Peruvian Audit Office (2019). Report of paralyzed public construction projects 2019. https://doc.contraloria.gob.pe/estudios-especiales/documento_trabajo/2019/Reporte_Obras_Paralizadas.pdf

Prado, G. (2021). Challenges of Virtual Design and Construction Implementation in Public Projects. *Proceedings of the 29th Annual Conference of the International Group for Lean Construction*, 413-422. https://doi.org/10.24928/2021/0129

Salinas J. & Prado G. (2019). Building information modeling (BIM) to manage the design and construction phases of Peruvian public projects. *Building and Management*, 3(2), 48-59. http://dx.doi.org/10.20868/bma.2019.2.3923

Tillmann, P., Tzortzopoulos, P., Formoso, C. T. & Ballard, G. (2013). Contributions of Existing Practices to Pursuing Value in Construction Projects. *Proceedings of the 21st Annual Conference of the International Group for Lean Construction*, 359-368. https://www.iglc.net/Papers/Details/955

Tillmann, P., Tzortzopoulos, P., Miron, L.I. & Formoso, C. T. (2011). The Challenges of Managing Stakeholder Requirements in an Urban Regeneration Project. *Proceedings of the 19th Annual Conference of the International Group for Lean Construction*. https://iglc.net/Papers/Details/1141