Lean Integrated Project Delivery for Construction Procurement

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The choice of proper procurement methods has an impact on the overall productivity and sustainability of construction projects. The current procurement methods have alerted the construction industry (CI) due to the exacerbating fragmentation among parties and the resulting low level of productivity. Therefore, introducing a new procurement system to eliminate the above challenges is imperative to the CI.

construction procurement | procurement systems | integrated project delivery (IPD) | lean construction | lean integrated project delivery (LIPD)

1. Introduction

The construction industry (CI) is one of the most enormous, dynamic, and complex sectors in the world [1]. In the Sri Lankan (SL) context, the CI is considered to play an essential role as an indicator of economic growth [2]. A product of the CI is considered a success when it is completed within the prescribed time and budget, and with adequate quality [3]. To deliver the products successfully, numerous procurement systems are available [4]. However, conventional construction procurement systems, such as the traditional method and design and build method, are subjected to different types of negative interactions [5]. Ref. [6] found out that to overcome the barriers of conventional procurement methods (i.e., lack of coordination, increased errors and disputes among the parties, and low levels of efficiency and productivity) and to achieve successful project completion, construction projects are required to move towards a new procurement approach. Further, [7] established that, by adopting an integrated approach to the project delivery method, problems with the current procurement systems could be minimised. Therefore, by considering these criteria, a new project delivery approach was introduced to the CI, and it is known as “integrated project delivery” (IPD) [8].

Nowadays, most countries tend to incorporate this novel IPD method into their construction sectors [9]. Thus, even within the SL context, [10] specified the potential application of the IPD system to minimise the existing problems and challenges in the SL CI. Moreover, because of much research related to IPD, [11] suggested that the inclusion of the concept of lean could provide an opportunity to achieve the optimal benefits of IPD. Therefore, to enhance the value of the IPD method, the IPD method was modified by incorporating the lean concept [11], and this concept is commonly known as “lean integrated project delivery” (LIPD). Accordingly, the significant difference between these IPD and LIPD methods is that the LIPD method’s formation is achieved through incorporating the lean concept into the conventional IPD method. However, LIPD’s acceptance as a construction procurement system is still in its infant stage, owing to a lack of direction for experts on how to combine the two well-established ideas of lean concept and IPD [12].

2. Construction Procurement Systems

The CI plays an essential role in the economy of any country [13]. It makes a significant contribution to the national gross domestic product [14]. According to the Asian Countries Report [14], the CI provides job opportunities to millions of people. Further, as construction projects become more complex and advanced, the CI tends to become more specialised [7]. Yet, [7] stated that construction might operate under high pressure to achieve greater efficiency and productivity. Therefore, to achieve the best outcome, the CI needs a suitable and robust construction procurement method as the root of construction projects [13]. Moreover, a crucial decision needs to be made regarding the selection of procurement methods to obtain the desired outcomes for the construction projects [15].

3. Problems in the Construction Industry Due to the Procurement Systems

Due to limited resources and unlimited human needs, the modern CI is more complicated than it has been in the last few decades [16]. There are numerous issues that can be identified in the CI, such as increased errors and disputes among the parties, low levels of efficiency and productivity, and other issues like these [17]. The SL CI also suffers from these problems [14]. Among those problems, the inability to achieve employer satisfaction is the most profound problem [18]. Therefore, for a

construction project to be successful in satisfying the employer, it should achieve the three thresholds of sustainable project management: time, cost, and quality [13].

The foundation of these issues is laid by the current procurement methods (i.e., traditional and design and build procurement systems) of the CI [15]. Therefore, it is essential to select the most suitable and full-strength route for the construction project at an early stage [15]. Ref. [5] found out that to overcome the barriers of conventional procurement methods and to achieve successful project completion, construction projects are required to move towards a new procurement approach. Further, [7] found that, by adopting an integrated approach to the project delivery method, problems with the current procurement system could be minimised [19]. Therefore, by considering these criteria, a new project delivery approach was introduced to the CI, which is known as the IPD [8].

4.Integrated Project Delivery (IPD)

As cited in [20], in 1990, a group of businesspeople created an integrated group that combined engineering, commercial interests, and subsurface considerations. This was successful, and it was named “project alliancing” [21]. As [21] mentioned, this project alliance concept was spectacularly successful and was recognised as the IPD. The American Institute of Architects California Council (AIACC) defined IPD as a project delivery approach that integrates people, systems, business structures, and practices into a specific process that collaboratively harnesses the talents and insights of all participants to optimise project results, increase value to the owner, reduce waste, and maximise efficiency through all phases of design, fabrication, and construction [22].

The goal of this new approach is to create more successful projects by solving the problems of the current CI [23]. Therefore, the IPD approach seeks to improve project outcomes in terms of time taken, cost, and quality, while minimising waste, in the CI [7]. In addition, the major stakeholders work collaboratively as a team to understand each other and get the most out of the construction project [9]. Therefore, all team members try to achieve the project goals rather than their individual goals [24].

As a project delivery approach, the IPD system is highly beneficial to all stakeholders in the CI [25]. Moreover, [11] found that adding the lean concept into the IPD method helps to further increase the value of the IPD. This concept of leanness can be defined as the systematic removal of waste by the organisation from all areas of the value stream [26]. By conforming to this, the IPD system can be modified by incorporating the lean concept.

5. Lean Integrated Project Delivery (LIPD)

As in IPD, the lean concept is a collaborative approach that is focused on increasing efficiency by reducing waste in construction [27]. To get optimum service from the IPD, it is necessary to integrate the lean concept [11]. Ref. [28] called this new integrated procurement method “lean integrated project delivery” (LIPD), which should achieve the ultimate goals of the CI [29].

Ref. [30] explained that LIPD is an alternative and innovative approach to collaborating with the construction project stakeholders. Furthermore, LIPD has evolved from a management approach that focuses on the lean concept in the construction phase to the project delivery phase [31]. Delivering the product with the maximum value and least waste are the fundamental goals of the LIPD system [27]. By combining these two principles, the LIPD method provides more outstanding services to the construction sector than any other method. This is because the IPD method fosters project team collaboration, and the lean concept helps to achieve that. Correspondingly, [27] further explained, “IPD provides a contractual environment through its principles, and lean provides collaborative efficiency for project objectives through lean principles and tools”. As a project delivery method, two milestones can be seen in the LIPD [31]. According to [31], those milestones are the definition of a project-based production system and the definition of a LIPD agreement. As a project-based production system, LIPD is involved in creating innovative design and construction mechanisms for the project. As a definition of an agreement, LIPD is involved in adopting a relational contract [32]. The benefits of LIPD include quality products, a higher production rate [33][34], increased constructability [27], time and cost savings [31], reduced project risk [35], satisfied team members [31], and employer satisfaction [34]. Moreover, one of the primary goals of LIPD is to achieve sustainable construction through economic, social, and environmental sustainability [33]. This objective is achieved by improving the performances of construction projects, especially by reducing construction waste, construction time, and total construction costs, and improving the quality of projects and the environment [13].

Ref. [36] stated that LIPD evaluates all aspects of a project from the beginning to the end to improve the project’s overall performance. Ref. [28] recognised five steps in LIPD: project definition, lean design, lean supply, lean assembly, and lean consumption.

At the project definition stage, a better understanding of the project is essential [37]. Therefore, financial analysis and project risk analysis significantly contribute to fulfilling this requirement [28]. The project definition allows team members to understand the employer's requirements and then act on them [28]. Furthermore, the successful project definition stage comprises needs and values, design criteria, and conceptual design [36].

Then, lean design transfers the conceptual design into a lean process and product design [37]. However, this stage is associated with building output for the project definition phase, which is a deviation from other procurement methods [28]. In the traditional project delivery method, the design team creates the preliminary drawings and then engineers apply relevant design parameters to that framework [38]. Moreover, in the design and build procurement method, a single entity performs the duty of design, but the involvement of the employer is inferior [39]. Therefore, lean design is a significant departure from conventional project delivery methods [36], as the design is produced because of the involvement of all team members [40]. Therefore, the best design output can be expected from the LIPD method [32].

After the lean design, the design is transferred to the lean supply phase [37]. Refs. [37][41] explained the detailed engineering, fabrication, and delivery aspects of lean supply. Moreover, this phase provides a logistical method to reduce inventory and lead time [32][36]. As the fourth stage, lean assembly begins with the delivery of materials and information for their installation [36]. During this stage, project activities are performed at the last responsible moments to minimise change orders for the construction [32]. The final stage, lean usage, refers to the operational and maintenance stage of this LIPD method [28][32].

5.1. Level of LIPD Implementation in the Construction Industry

Even though many studies have enacted a wide range of initiatives to investigate IPD in the US [7][42], Peru [43][44] and Norway [23][43][44], among others, research on LIPD is limited to a few initiatives in the global CI. [28][32][36][38][39] conducted research on LIPD implementation in the US. Ref. [28] said that further study is needed for a better understanding of LIPD practices in various circumstances. [32] distinguished between LIPD and traditional project delivery in the CI. Ref. [32] emphasised the importance of further research on the applicability of LIPD outside of the US. As a result, [39] proposed that design–build contracts can be an effective tool for adopting LIPD in the US, and that LIPD can infiltrate the industry more thoroughly if more owners are able to employ it. Refs. [12][45] created lean integrated project delivery models for road building and highway projects in India, respectively. Furthermore, [46] conducted a LIPD conformance review for Indian CI and found crucial success criteria for effective implementation. Ref. [31] recently conducted a comparative analysis in Chile on integrated project delivery and lean project delivery, emphasising the need to implement LIPD for the CI. Nonetheless, the focus of the above research has given minimum attention towards establishing a technically feasible framework for LIPD implementation.

5.2. Barriers to Implementing LIPD in the Construction Industry

When implementing LIPD in the CI as a new method, it is inevitable to face various barriers [47]. Those barriers (or challenges) are categorised in **Table 1**.

Table 1. Barriers to implementing LIPD in the construction industry.

Barriers/Challenges			References
Organisational Barriers	Financial barriers	High initial investment Inventory cost Compensation structure	[9][48]
	Managerial barriers	Resistance to change Poor awareness Inefficiency in resource planning	[7][49]
	Contractual barriers	Lack of mutual trust among stakeholders Lack of existence of similar IPD contracts Inappropriate contractual strategies	[50][51]
	Educational barriers	Lack of knowledge of IPD and lean Lack of existing training material	[49][51]
	Communication barriers	Poor transmission through all phases of the project Lack of transparency Lack of organisational communication	[48][49]
	Technology barriers	Unwillingness to use new technologies The high financial cost of new software and equipment	[47]
External Barriers	Cultural	Resistance to change	[7][33]

	Barriers/Challenges		References
	barriers	Continuation of individual interests	
	Legal barriers	Unclear responsibilities of the parties A requirement of the new legal framework	[33][51][52]
	Political barriers	Change in the culture of teamwork Lack of government support	[9][49]

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5.3. Strategies to Implement LIPD in the Construction Industry

For a successful LIPD implementation, minimisation of the barriers (in **Table 1**) is essential. Refs. [53][54] stated that enhancing the awareness of LIPD, organising training and workshops, public sector organisation encouragement, and professional motivation can have positive impacts on successful LIPD implementation. Similarly, [8] added that having more employer focus, getting support from IT experts, and arranging proper teamwork are some of the profound strategies that can be applied to the successful LIPD implementation. In addition, the use of good construction management practices also helps to minimise the barriers to LIPD implementation [55]. Ref. [55] further noted that determining the best management team and structure and encouraging team members to solve problems and share knowledge can also be used as critical opportunities for successful LIPD implementation. Accordingly, these are the most appropriate strategies to assist construction professionals in the successful implementation of LIPD. However, these strategies need to be further investigated in the SL CI.

Although attempts have been made by SL research to develop lean frameworks, which include Lean in Large Contractors [56][57] and Lean in SMEs [58][59], the focus on LIPD in such frameworks is insufficient. Therefore, research on LIPD in the SL CI is long overdue. Hence, there is a critical need to investigate the applicability of LIPD to the SL context, and thus to develop a guiding framework for the SL CI.

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