

CHALLENGES FOR LAST PLANNER SYSTEM IMPLEMENTATION; SRI LANKAN CONSTRUCTION INDUSTRY PERSPECTIVE

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Abstract: In a rapidly moving world, it is imperative to adopt the latest tools and techniques for the Sri Lankan construction industry to survive in the global market. The Last Planner System (LPS) is one such tool that sets out a proper communication medium and regulates the workflow throughout the construction by individual phase monitoring and remedying the process. Yet, the implementation of LPS is still in the infancy stage in Sri Lanka. Therefore, this research aimed to investigate the potential challenges of implementing LPS within the Sri Lankan construction industry. Nine industry experts were identified by judgemental sampling, and semi-structured interviews were conducted to collect data related to the research under the qualitative approach. Content analysis was used to analyse the data using NVIVO. The research identified 42 challenges pertaining to five LPS stages for the Sri Lankan construction industry. Further, the Master planning and Phase planning stages are crucial as it has many challenges during the implementation compared to other stages. It is recommended to identify the specific challenges concerning each firm's infrastructure for successful LPS implementation in the Sri Lankan construction industry. This research uncovers further areas to identify the strategies to minimize the identified LPS implementation challenges.

Keywords: *Challenges, Construction Industry, Last Planner System, Sri Lanka*

1. Introduction

The present construction industry and projects are facing numerous challenges due to a lack of control over the allocated time, established cost limits, and maintaining the pre-defined quality parameters (El Dimeery et al., 2021). Kendall (2018) stated that insufficient planning, lack of communication, scope creep, unsteady orders, productivity issues, project delays, and ignorance of caution are the major causes of the above failures. According to Banna (2020), to overcome project planning and management issues, practising lean construction methodologies are imperative from the perspective of non-value-adding activities. The Last Planner System (LPS) is one of the lean tools that can be identified as one of the most effective tools to be applied in projects, concerning the project integrity, management, and planning aspects (AlSehaimi et al., 2009; Ballard & Howell, 2010; Hamzeh, 2009). The system mainly complied with five main phases namely, master planning, phase planning, make-ready planning, weekly work planning, and learning (Ballard, 2009). However, according to Perez & Ghosh (2018), the implementation of LPS has not been executed at an adequate level due to the failure of maintaining overall project management strategies due to different challenges. Shehashini, Ranadewa, Mallawarachchi, and De Silva (2021) have stated some general challenges for implementing LPS within the Sri Lankan construction industry. However, less research has been focused on identifying the challenges concerning each phase of LPS to implement LPS within the Sri Lankan construction industry. Hence, this research focuses on investigating the challenges of each phase of LPS for implementation in the Sri Lankan construction industry. This paper initiated by reviewing the literature. Then, research methodologies have been presented. Furthermore, the research findings have discussed the importance and benefits of implementing LPS over the current practices and then the implementation challenges have been identified. Finally, the conclusions and recommendations have been provided.

2. Literature Review

Considering most construction projects' poor risk management, the inefficiency of construction phases and lesser productivity related to resource input can be identified as major issues related to project delivery (Iqbal et al., 2015). According to Hwang (2018), adopting proper risk management strategies, project controlling, and monitoring tools are important to overcome from above-mentioned issues to ensure proper project delivery. According to Xia et al.

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(2018), to integrate risk management and influence over the stakeholders, it is important to manage the risk-based identification of project stakeholders' effect on project performance. Thus, LPS can be suggested as one of the most suitable tools to perform those operations. In the Literature review, an overview of the LPS and challenges for implementing LPS in the construction industry is presented below.

2.1 AN OVERVIEW OF THE LAST PLANNER SYSTEM

LPS was developed by Glenn Ballard and Gregory Howell as a production planning and control system and further assisted in smoothing variations, developing planning foresight, and reducing uncertainty in construction (Patel, 2011). According to Ballard and Howell (2010), LPS consists of five phases. According to Hamzeh (2008), the linkage between the five phases and tasks to be performed within each phase of LPS has been represented concerning the timeline in Figure 1.

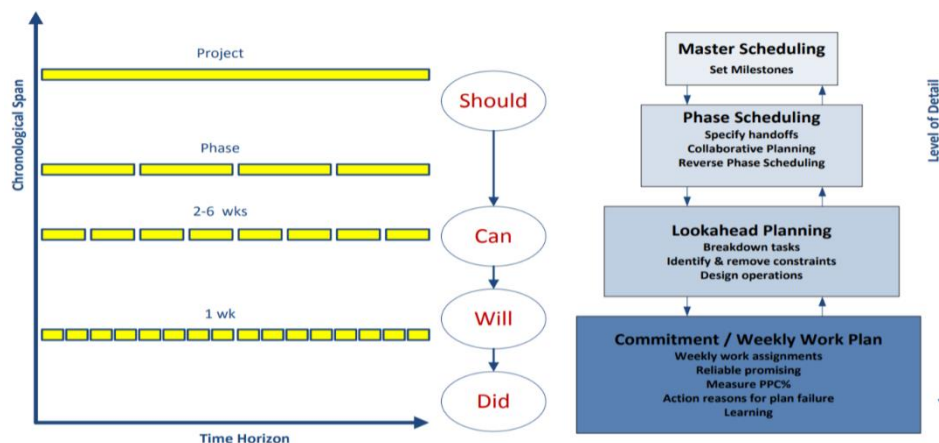


Figure 1- LPS Phases (Source: Hamzeh F.)

Master Planning involves setting up major milestones of the project based on available workload and complexity, and Phase planning further breakdown the Master schedule into several work phases and ensures the individual phase delivery. Make ready planning to identify the potential barriers to project delivery and remedy them before crystallising into major issues. Weekly work planning further refines weekly work and ensures collaboration between the parties. Finally learning phase audits, the performances and feeds the fore coming phases with the experience obtained within the project phases.

2.1.1 Benefits of practising the Last Planner System

Each phase of LPS facilitates the development and improves job satisfaction as the properly established workflow is provide the easiness of understanding the responsibilities and scopes (Hamzeh., 2008). Eventually, LPS-based construction projects have been completed faster and eminently than normal due to the proper structure of LPS (Kalsaas, 2012). According to Brioso (2017), LPS also helps to decrease the number of defects in a construction project by helping to find out the errors that repetition of those errors can be rectified in time. Table 1 represents the benefits of LPS-based construction.

Table 1- Benefits of LPS

Benefits	References														
	2005-2010			2010-2015						2015-2020					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Just-in-Time (JIT) delivery			✓	✓	✓	✓				✓	✓			✓	✓
Improved individual reliability	✓			✓		✓						✓			
Reduce uncertainty	✓			✓									✓		
Foresee work plans				✓				✓			✓	✓	✓		
The lower number of quality issues			✓	✓		✓				✓					
Predicable and smooth workflow				✓	✓	✓									
Lower costs and high productivity	✓	✓		✓	✓		✓			✓					✓
Flexibility if work sequences change.		✓		✓								✓			
Reduced variability in plans	✓	✓		✓							✓		✓	✓	
More coordination	✓		✓	✓	✓				✓					✓	✓
Better communication				✓	✓				✓						✓

1- AlSehaimi et al. (2009), 2- Gonzalez et al. (2009), 3- Koskela et al. (2010), 4- Porwal et al. (2012), 5- Cerveró-Romero et al. (2013), 6- Fernandez-Solis et al. (2013), 7- Fuemana et al. (2013), 8- Dave et al. (2015), 9- Russell et al. (2015), 10- Khanh and Kim (2016), 11- Bhatia et al. (2016), 12- Samad et al. (2017), 13- Torp et al. (2018), 14- Tayeh et al. (2019), 15- Schöttle, et al. (2019)

According to Table 1, many researchers agreed to just-in-time delivery, foreseeing work plans, lower costs, improving productivity, reduced variability in plans and more coordination are key benefits that can be obtained through the successful implementation of LPS.

2.2. CURRENT PRACTICES OF THE LAST PLANNER SYSTEM IN THE CONSTRUCTION INDUSTRY

The LPS is a production control method that is widely used all over the world (Ballard et al. 2009). The LPS of project management and production control is in wide use throughout the world such as in China as LPS causes fewer change orders towards drawings and design, developed coordinated effort within the project team and properly arranged contractual documents (Tayeh, 2018). Current practices can be further discussed in the following sections.

2.2.1 Demand for Last Planner System in the construction industry

The LPS tends to increase the plan’s reliability (Hamzeh, 2008). According to Russell (2015), LPS is a short-term arranging framework that attention to what should and will be possible to do. According to Daniel et al., (2017), LPS has been tested on some construction projects in some countries and it gained positive results. According to some surveys which were done related to LPS, the consequences of this study demonstrate that the assessed all-out season of working with non-value-adding items diminishes as a result of the disposal of waste (Friblick, 2009).

2.2.2 Significance of Last Planner System in the Sri Lankan construction industry

According to Rathnayaka et al. (2020), almost all construction projects have been terminated due to the current epidemic situation as the severe impact on the resource manufacturing and production industry terminations, such as long-term delivery and supply chain of essential construction materials and equipment. Considering such conflicts, lean construction can be viewed as a strategic option for Sri Lanka when considering its cost leadership, differentiation, and focus strategies (Ranadewa et al., 2021; Senaratne et al., 2008). However, many challenges hinder LPS implementation in the construction industry.

2.3. CHALLENGES TO IMPLEMENTING THE LAST PLANNER SYSTEM IN THE CONSTRUCTION INDUSTRY

The challenges for the implementation of LPS can be occurred due to several factors in the industry such as lack of capacities, lesser updating and upgrading about the latest trends and unavailability of resources (Tayeh et al., 2018). Table 2 represents literature on the challenges of implementing LPS within the construction industry.

Table 2- Challenges to implementing the Last Planner System

Challenges	References													
	2005-2010			2010-2020										
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lack of top management support								✓		✓				✓
Absence of incorporation by subcontractors														✓
Less correspondence between gatherings to accomplish collaboration								✓		✓			✓	✓
The weak relationship between suppliers										✓	✓			✓
Lesser workman motivation											✓			✓
Neglected to refresh and meet the program		✓						✓						✓
Absence of characterized jobs and obligations regarding checking execution LPS														✓
Lack of understanding about relationships between the risks in lean implementation	✓												✓	
Lacking prominent responsibility by the executives						✓		✓		✓				✓
Employee’s resistance to change	✓	✓				✓			✓	✓	✓	✓		
Absence of incorporation between subcontractors and supervisors									✓	✓				✓
Frail correspondence, and straightforwardness among members of the creative interaction				✓		✓								
Absence of a mix of the creation chain between the parties of the contract				✓					✓		✓			
Extensive endorsement techniques from the client and top management				✓	✓		✓	✓		✓				
Absence of abilities, preparation, and experience		✓	✓				✓							
Lack of philosophical aspects related to lean culture			✓		✓							✓		
Low comprehension of the process planner to the ideas of the last planner			✓	✓										✓

1- Al-Sudairi (2007), 2- Green et al. (2008), 3- Mossman (2009), 4- Porwal (2010), 5- Guzman et al. (2012), 6- Aomar (2012), 7- Kalsaas (2012), 8- Ogunbiyi (2013), 9- Smart Market Report (2013), 10- Rahman et al. (2013), 11- Jadhav et al. (2014), 12- Shang (2014), 13- Marodin (2015), 14- Tayeh et al. (2018).

According to Table 2, a few research can be identified regarding the challenges of implementing LPS from 2005-2010 compared to 2010-2020. Thus, it can be considered that the construction industry has realized the importance of implementing LPS very recently. All the above barriers to the successful implementation of LPS can be identified as a result of a lack of capacities in the construction industry.

2.3.1. Challenges to implement Last Planner System in the Sri Lankan context

Since Sri Lanka is a developing country, many challenges can be identified as a lack of government support, lack of technical knowledge, lack of government facilities, economic conditions, lack of knowledge of professionals and lack of awareness (Karunarathna et al., 2019). According to Shehashini et al. (2021), another few hindrances are fewer change orders towards design and drawings, further developed coordinated effort inside the project team as well as properly arranged contractual documents. However, less research has been conducted to identify the challenges in each phase of LPS for implementing LPS within the Sri Lankan construction industry. Hence, this study is focused on identifying the potential challenges to implementing LPS within the Sri Lankan construction industry.

3. Research Methodology

First, a comprehensive literature review was carried out to identify the challenges to implementing the LPS in the Sri Lankan construction industry by referring to resources. For the research, a qualitative research approach was used with judgemental sampling for the selection of interviewees. After the selection of interviewees, the required data was collected by conducting 9 semi-structured interviews and data were analysed using the NVIVO application.

Table 3- Respondents for the study

Code	Designation	Subject related Qualifications	Experience	Industry	Key expertise areas
R1	Chartered Civil Engineer	<ul style="list-style-type: none"> Worked as a planning engineer Diploma in Project Management 	10-15	Construction	<ul style="list-style-type: none"> Project management Project monitoring Project controlling
R2	Project Manager	<ul style="list-style-type: none"> Worked as a planning engineer M. Sc. in Project Management 	10-15	Construction	<ul style="list-style-type: none"> Project management Project planning Contract management
R3	Quantity Surveyor	<ul style="list-style-type: none"> M.Sc. in Project Management Diploma in Project Management 	0-5	Construction	<ul style="list-style-type: none"> Project management Project monitoring Project controlling
R4	Civil Engineer	<ul style="list-style-type: none"> Worked as a planning engineer M.Sc. in Project Management Published lean-related articles 	5-10	Construction	
R5	Quantity Surveyor	<ul style="list-style-type: none"> M.Sc. in Project Management 	0-5	Construction	
R6	Contract Manager/ Chartered Quantity Surveyor	<ul style="list-style-type: none"> Worked as a planning engineer M.Sc. in Project Management Diploma in Project Management 	20-25	Construction	<ul style="list-style-type: none"> Project management Project controlling Project monitoring Dispute resolution Contract management
R7	Quantity Surveyor	<ul style="list-style-type: none"> M.Sc. in Project Management 	0-5	Construction	<ul style="list-style-type: none"> Project management
R8	Civil Engineer	<ul style="list-style-type: none"> Worked as a planning engineer 	5-10	Construction	

Code	Designation	Subject related Qualifications	Experience	Industry	Key expertise areas
R9	Quantity Surveyor	<ul style="list-style-type: none"> Diploma in Project Management 	0-5	Construction	<ul style="list-style-type: none"> Project monitoring Project controlling
		<ul style="list-style-type: none"> M.Sc. in Project Management Diploma in Project Management 			

Table 3 represents the sample of the study which is mainly comprised of professionals who have experience with project management, project controlling, and project monitoring. To fulfil the primary objective of the study, it is essential to obtain expert knowledge from professionals who have vast experience in overseas construction projects for remedying the current challenges in the industry and ensuring the successful implementation of LPS. Remedying to challenges further required the practical problems in implementing the LPS and thus the sample contains some dispute specialists. As a whole, the sample comprises specialists who are sufficiently capable of addressing the required specifications of the research topic and fulfilling the requirements of the primary objectives of the research.

4. Research Findings

Under the research findings, comprehensive outcomes are provided based on the outcomes of the interviews under the major objectives of the research namely, an overview of the LPS and challenges to implementing the LPS within the Sri Lankan context.

4.1. REVIEW THE LAST PLANNER SYSTEM FOR THE CONSTRUCTION INDUSTRY

According to the study and information gained from interviewees, the adoption of the LPS in the construction industry is crucial for a country like Sri Lanka. In phase 1, the interviewees were asked to define the importance of implementing LPS, according to the respondent’s point of view responses are recorded and validated with the outcomes identified in the literature review, and the main responses are represented in Figure 2.

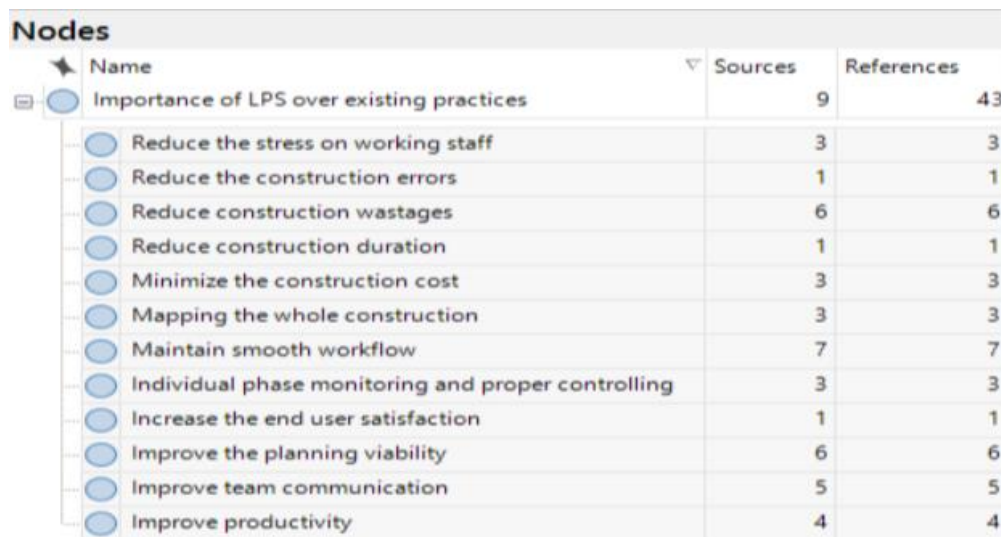


Figure 2- Importance of LPS over existing practices

It helps not only to improve productivity but also reduce wastage and reducing production costs. End-user or customer satisfaction is also an important point in the construction industry. The Last Planner System causes to increase the satisfaction of end customers or end-user. LPS further helps to reduce the time duration of the project and the construction errors. When considering all the points, the adoption and implementation of LPS are very important to the construction industry.

4.2. CHALLENGES FOR LPS IMPLEMENTATION IN THE SRI LANKAN CONSTRUCTION INDUSTRY MEASURES

Table 4 indicates the potential challenges of each LPS phase regarding implementing LPS within the Sri Lankan construction industry as indicated by the experts.

Table 4- Challenges for implementing LPS within the Sri Lankan construction industry

LPS Stage	Challenges	R1	R2	R3	R4	R5	R6	R7	R8	R9
	Unexpected delays	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Non-presence of a planner	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

LPS Stage	Challenges	R1	R2	R3	R4	R5	R6	R7	R8	R9
Master Planning	Difficulties in improving the skills of participants	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Time availability	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Master Planning	Effect of design variations	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Inflexibility	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Higher expenses (For planners etc.)	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Need for knowledge, and additional resources	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Share the knowledge on LPS among the workers and officers.	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Commitment to new systems	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Coordination between team members	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	The discontinuity between spatial planning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Poor controlling practices	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Phase planning	Commitment in crews	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lack of Skills of the planners		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Allocation of responsibilities		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Linkage to the master schedule		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Phase scopes		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Information availability		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Resource availability		<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Uncertainty of constraints		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Costly substitutes		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Issues in the Master schedule breakdown		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Getting ready for the working areas		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Preparing detailed and structured plans		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Lack of training	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Make ready planning	Insufficient resources	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of training, experience, and knowledge	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Determination of planning horizon	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Failure to capture all the corners of the project	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Task breakdown	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of coordination	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Weekly work plan	Planning skills	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Communication	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Resource availability	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of Knowledge and skills in time management	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Failure to gather all the planners at the same time	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Learning	Unavailability of technology	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	Lack of knowledge about metrics	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of concentration	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lack of coordination	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Some common challenges can be identified as unexpected delays, non-presence of skilled planners, coordination between team members, lack of commitment, lack of resources, time availability, and inflexibility of the project proposals. In the literature review, there was a brief explanation of the challenges to be faced when implementing LPS. In an expert interview, the interviewees were questioned about the challenges separately in different stages of LPS. Considering all the challenges under each LPS stage, the root cause can be identified as a lack of capacity in the existing construction industry. Thus, to face the above challenges successfully, it is essential to identify all the potential challenges concerning the relevant capacities. Figure 3 presents a summary of the above findings.

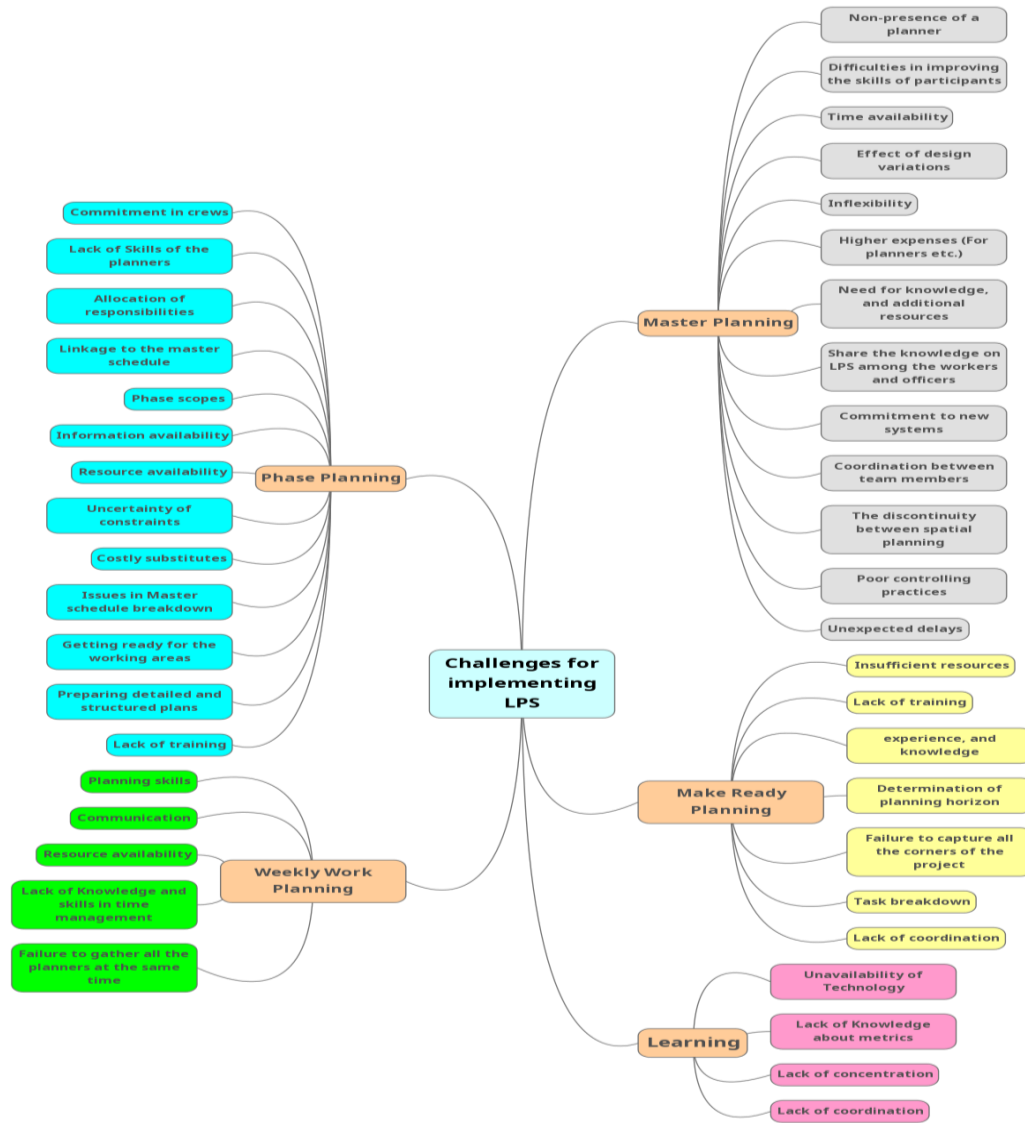


Figure 3- Challenges for implementing LPS

According to Figure 3, there have been 42 challenges identified under each LPS phase while in the literature review, the challenges were identified generally. Regarding the outcomes, there were 26 challenges out of a total of 42 challenges identified for the Master planning and Phase planning phases. Both the Master planning and Phase planning phases consisted of 13 challenges. In the Literature, Al-Sudari (2007), Green et al. (2008), and Jadhav et al. (2014) have identified employee resistance to change as a general challenge and the interviewees also validated it but were not categorized specifically under any LPS phase. Hence, it can be identified as a challenge in all the stages of LPS. According to Tayeh (2018), incorporation, training requirement, collaboration, and workman motivation were identified as major challenges to implementing LPS and under research findings, the respondents recognized those challenges specifically under the phase planning stage. Furthermore, the incompatibility of existing planning methods (Porwal, 2010), and less availability of experienced planners (Mossman, 2009) were also validated through the data collection and categorized under the Phase planning stage. Apart from that, all the other literature findings were validated by the experts and additionally, the determination of planning horizon, the discontinuity between spatial planning, lack of concentration, lack of knowledge about planning metrics such as Work Breakdown Structure (WBS), Percentage Plan Complete (PPC), Task Make Ready (TMR), Task Anticipated (TA) were few important challenges identified only through the data collection.

5. Conclusion

The LPS is globally recognized as one of the most beneficial tools for the construction industry to achieve maximum output with minimum resources as well as with minimum conflicts between the parties. LPS has not only short-term benefits but also long-term benefits. In the meantime, LPS has been implemented in most countries all over the world and benefited through LPS implementation. This research study thoroughly reviewed the adaptability of LPS in the Sri Lankan construction industry. Apart from that, 42 challenges to implementing LPS within the Sri Lankan construction industry have been identified under each phase of LPS through expert interviews. Master planning and Phase planning phases required considerable attention during the LPS implementation stage as it has many challenges to be minimised compared to other phases. Hence, it is recommended to construction organisations be

mindful of these two stages to minimize the challenges during the implementation of LPS and conduct further research to investigate the strategies to minimise the above challenges.

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