BENTHAM OPEN

CrossMark

The Open Construction and Building Technology Journal

Content list available at: www.benthamopen.com/TOBCTJ/

DOI: 10.2174/1874836801812010389, 2018, *12*, 389-403

RESEARCH ARTICLE

Success Factors and Barriers of Last Planner System Implementation in the Gaza Strip Construction Industry

Bassam A. Tayeh[1,*], Khalid Al Hallaq[1], Abdulla H. Al Faqawi[1], Wesam S. Alaloul[2] and Soo Y. Kim[3]

[1]*Civil Engineering Department, Faculty of Engineering, Islamic University of Gaza, Gaza, Palestine*
[2]*Department of Civil and Environmental Engineering, Universiti Teknologi PETRONAS, Bandar Seri Iskandar, 32610 Tronoh, Perak, Malaysia*
[3]*Department of Civil Engineering, Pukyong National University, 45 Yongso-ro, Nam-gu, Busan, 48513, South Korea*

Received: July 21, 2018 Revised: September 12, 2018 Accepted: November 25, 2018

Abstract:

Background:

Plan unreliability is a serious issue in the construction industry. Since the industry is fragmented and every project is unique, time overrun is a chronic problem. In this context, Last Planner Concept (LPC) has been considered as a valuable approach for the management of the construction process.

Objective:

This study contributes to a better knowledge of the lean construction and last planner concept, and therefore the efficiency of their implementation. The aim of this paper is to determine the main factors supporting the applicability of Last Planner Concept (LPC) and to determine its challenges/barriers in the Gaza Strip construction industry.

Methods:

At first, all the relevant literature was systematically reviewed. At this stage, 17 critical success factors and 18 barriers for LPC were identified. After that, a survey was conducted through a questionnaire to collect the data from 98 contractors. A Likert scale data were analyzed to rank the success factors and the barriers using Relative Importance Index (RII).

Results and Conclusion:

The results showed that “Close relationship with subcontractors" and "Top management support” are the main factors that affect the successful application of LPC. Moreover, “lack of skills, training, and experience” and “lack of the training program for the managers” were deliberated as the key obstructs of the LPC implementation. It is recommended to choose the subcontractor based on his previous expertise and competence such as workers, tools, and machinery. The subcontractor should support all parties to address the project problems to make the right decisions for project objectives achievement.

Keywords: Barriers, Construction industry, Gaza strip, Last planner, Success factors, Likert scale data.

1. INTRODUCTION

The construction industry is influenced by a number of issues, which necessity to be explained and addressed [1]. The chronic problems of construction projects poor performance are low productivity, risk, defective design, inferior

* Address correspondence to this author at the Civil Engineering Department, Faculty of Engineering, Islamic University of Gaza, Gaza, Palestine; Tel: +972-82644400; Fax: +972-82644800; E-mail:btayeh@iugaza.edu.ps

working conditions, and insufficient quality *etc.* [2, 3]. Unfortunately, these chronic problems have created a large wastes volume, which the owner, in reality, is paying as a part of the project budget [4]. The construction industry is known to be one of the largest environmental polluters, physical waste producers, and energy consumers throughout its lifecycle. Because of these challenges in the built environment, including issues relating to rapidly growing populations and anthropogenic climate changes, there is an important need in proceeding the industry towards sustainable development. Therefore, lean construction approach was transformed from the car manufacturing industry into the construction industry to reduce the waste and optimize the resources. Lean construction is a mixture of operational research and practical development in design and construction with an adjustment of lean manufacturing philosophies and practices to the end-to-end design and construction procedure. Dissimilar manufacturing industry, the construction industry is a project-based production procedure. Lean construction is worried about the alignment and holistic pursuit of concurrent and continuous enhancements in all measurements of the built and natural environment: design, construction, repairs, retrieving and reprocessing [5]. One of the lean construction tools is Last Planer Concept (LPC), which usually applied to cover the project planning and scheduling procedure. Therefore, this proves to be a perfect method in dealing with waste minimization and efficiency improvement by the analysis of the per cent of planned complete. The important role of the last planner concept is to replace optimistic planning with realistic planning by assessing the performance of workers based on their capability to reliably achieve their promises. The aim of the last planner is to pull the tasks by reverse phase scheduling through team planning that optimize the project resources.

The construction sector in Gaza strip had a major development and significant growth in the aftermath of 1994, after the Palestinian Authority establishment [6]. It suffers from several problems such as overruns in time and budget, low productivity, insufficient coordination, poor quality, and high accident rates *etc.* [7, 8]. [9] stated that the industry needs major attempts at growing awareness of the modern management approaches among its stakeholders. Educating the operators of the construction industry is vital to consolidate the quality culture and wastes reduction. It also needs a proper national campaign to capitalize on its strengths and the potential improvement opportunity [10]. The industry can be motorized by initiative programs that include firm technical assistance, access to finance access to technology, workforce development, and policy and regulatory reform [11].

This paper investigates the LPC success factors and barriers in Gaza Strip construction industry. The results draw the roadmap for this concept proper implementation in order to address the poor performance problem in Gaza strip construction industry.

2. LITERATURE REVIEW

lean thinking concepts have evolved and were successfully implemented by Toyota Motor Company since the 1950s. The system has two main concepts: Just in Time flow (JIT) and Autonomation (smooth mechanization). Implementing lean concepts means applying tools and techniques throughout the stages of a project lifecycle in order to minimize waste and enhance productivity. A hypothetical foundation is given through the transformation flow-value aspect and further aspects of management theory and complexity theory. Apparently, however, adopting lean concepts need an essential adjustment of classical structures in terms of both organisation and behaviour.

2.1. Principle of the Last Planner Concept

The Last Planner Concept (LPC) is an applied technique in which construction executives and crew leaders cooperate with each other to arrange work plans. The outcome work plans will be executed with a high level of reliability, therefore enhancing work constancy and expectedness [12]. In other words, the LPC means works to fulfilment “Coordination by the Plan” [13, 14]. This concept was established by Ballard and Howell as a production planning and control scheme to help in levelling changes in construction workflow, emerging scheduling foresight, and decreasing ambiguity in construction processes [15]

Porwal [16] explained that the main principles of the LPC are: Identify activities are planned with more details to accomplish the work; Identify plans cooperatively with those who are to execute them; Identify and eliminate restrictions on planned activities as a crew; Create and secure consistent promises; and take future lessons from failures to prevent future reoccurrence. While, the functions of LPC are: “Cooperative planning; Making Ready by constraints identification and removal, Task breakdown, Operations design. Releasing; Obligation; and Learning”.

The functions of the LPC also consist of the productive section and workflow management and affecting quality tasks. Moreover, the purpose of the LPC is to make the work simpler to understand the root causes of the issues, and to take suitable decisions concerning action needed during the construction process in order to bring the project back to the

baseline; thereby enhance the performance [17].

The LPC consists of many effective techniques such as improved visualization, 5S procedure, regular huddle meeting, first run study, fail-safe for quality, value stream mapping afford working planning to optimize the cost and time by maintaining the intense pressure for construction on every task [18]. The LPC is a methodology designed to minimize plan failures and to avoid unnecessary execution failures [19, 20] stated that LPC provides all of the following: A work scheme of what must be done, An organization map- who- does- what, An agreement among parts of work - when to start and when to finish, A strategic plan- when we need to prepare materials, trade teams, drawings *etc*., A device for workflow monitoring, and A basis for control progress. The LPC consists of five fundamental integrated components [21], as shown in Table **1**:

Table 1. Fundamental integrated components of LPC.

Components	Description	Purpose
Master Plan	This stage is used to achieve an over-all plan and recognizes the Work Breakdown Structure (WBS) for all the work packages of the project showing the hierarchy of the activities level by level, the duration for tasks and sequences [22]. It covers main milestones, where the date is decided by applying the pull procedure from next milestones.	▪ Validate the practicality of finishing the work within the offered time. ▪ Present a completing scheme which can function as a main coordinating tool, and ▪ Decide at what time long lead items will be required.
Phase Planning	This stage is used to divide the master plan into different stages to improve further detailed and information work plans and supply objectives that could be deliberated as targets by the project manager.	▪ Shape work plan features in the best achievable details and rate for satisfying project objectives within the power of the organization in time.
Look Ahead Planning	This stage is used to focus management awareness on what is assumed to occur concurrently in the future and to motivate actions in the current time that required future. It represents a transitional phase of planning. This timetable covers key work elements that should be accomplished to achieve the milestone times in the main pull schedule.	▪ Mapping manpower and other resources with workflow, ▪ Harvest a backlog of tasks for frontline crew superintendent screened for design and finishing of the predefined work, ▪ Assemble interdependent tasks together, thus the work statement planned for entire procedure jointly by multiple trades.
Weekly Work Plan (WWP)	This stage concern is to make production tasks cooperative arrangement for the succeeding day or week thru weekly meetings. The WWP meeting includes the weekly plans, safety concerns, quality issue, resources, construction techniques, and any posable problems.	▪ Recognize real actions and check their feasibility earlier to task execution so as to shield construction units from ambiguity. ▪ Optimize the use of the construction unit's capability and recognize individual's differences based on the timetable loads.
Percent Plan Completed (PPC)	In this stage, the project planning is improved by continual valuation and knowledge from breakdown. The PPC is the degree of the proportion of potentials made that are provided on time. The PPC can be computed as the number of tasks that are finished as planned divided by the total number of planned tasks, and it is shown as a percentage.	▪ Assist in the incessant enhancement of the construction project as efforts are made to avoid the reoccurrence of issues. ▪ Determine the reasons for the non-achievement of tasks immediately during analysing PPC.

2.2. Critical Success Factors (CSFs) for Implementation LPC

There is a substantial body of literature concerning the use of LPS for various construction projects. The majority of this literature is in the form of case studies from academic and industrial backgrounds. Case studies report the use of LPS in different project settings (building construction, heavy civil construction, *etc*.), in different parts of the world, and for different project phases (definition, design, pre-design, and construction). In particular, some of them discussed the CSFs for LPC implementation. Table **2** shows a summarized list of the key factors supporting the implementation of LPC in the construction industry from previous studies:

The critical factors for successful implementation LPC are the commitment to planning and coordination between the project parties. The collected factors showed that the LPC achieve more successful planning and control than the traditional approach through the involvement of all stakeholders e.g. sub-contractors and suppliers [25].

Table 2. Factors to support the implementation of LPC.

No.	Critical Success Factors (CSFs)	References
1.	Top management support	[23]
2.	Commitment to promises	
3.	Involvement of all stakeholders	
4.	Communication between parties to achieve team work	
5.	Robust relationship with suppliers	
6.	Push employees to create change	
7.	Coordination and cooperation between parties	
8.	Manage resistance to change	
9.	Definition of roles and responsibilities	[24]
10.	Involvement of project manager	
11.	Increased support and monitoring of management and Sub directorate	
12.	Failed to update and meet the program daily	
13.	Lack of defined roles and responsibilities for monitoring implementation LPC	
14.	The project does not have all the subcontractors, which forces perform the implementation of LPC through several stages	
15.	Lacking greater commitment by management on the implementation	
16.	There was a lack of integration of subcontractors	
17.	Managers lacked participation	

2.3. Challenges Faced During the Implementation of LPC

Porwal, *et al.* [26] explained that the LPC challenges fall into two categories: The first category is "challenges faced during the implementation phase" as follows: "(1) Lack of training, (2) Lack of leadership/failure of management commitment or organizational climate, (3) Organizational inertia & resistance to change, (4) Stakeholder support, (5) Contracting and legal issues/contractual structure, and (6) Partial implementation of LPC & late implementation of LPC". The second category is "challenges faced during the use of LPC" as follows "(1) Lack of human capital & Lack of understanding of new system; difficulty making quality assignments/human capital–skills and experience, (2) Lack of commitment to use LPC & attitude toward new system, (3) Bad team chemistry & lack of collaboration, (4) Empowerment of field management or lengthy approval procedure from client and top management, and (5) Physical integration". Dave, *et al.* [27] said that the barriers emerge through direct observation from organizations practicing LPC. There are several recurrent problems, which can be categorized, as follows: "(1) Inability to effectively deploy collaborative aspects, (2) Partial deployment of LPC, (3) Reduced importance of robust phase and master plans, (4) Missing continuous improvement, and (5) Missing the links between detailed and high level plans [28]. explained that the barriers during implementation of LPC are: (1) Misuse of information generated during implementation of LPC, (2) Lack of time and training, (3) Lack of self-criticism, (4) Inadequate administration, (5) Inadequate communication, (6) Inadequate management support, (7) Lack of commitment, (8) Lack of integration of all area, (9) Standards not full suitable, (10) Difficult relationships, and (11) Lack of involvement".

At the same time, the barriers during the implementation of LPC discussed in construction projects within another context are: "(1) Lengthy approval procedure from client and top management, (2) Involvement of so many parties joined the project, especially subcontractors and suppliers, (3) Low understanding of the process planner to the concepts of last planner, (4) Weak communication and transparency among participants of the production process, (5) Lack of integration of the production chain between client, consultant, contractor and supplier, (6) Inadequate administration of the necessary information to generate a "learning cycle" and to take corrective actions, (7) Low implementation of advanced technology in construction, (8) Language and cultural issues when performing a project, (9) Shortage of the training course for the directors when planning and controlling a project, and (10) Over-commitment to the work which can be done in a look ahead plan" [23, 29 - 31]. Table **3** shows summarized lists for the challenges when implementing LPC in the construction industry from previous studies:

Table 3. Challenges faced during the implementation of LPC.

Challenges	Ballard [32]	Garza and Leong [33]	Alarcón and Diethelm [34]	Alarcón, *et al.* [35]	Fiallo and Revelo [17]	Kim and Jang [36]	Koskenvesa and Koskela [37]	Salem, *et al.* [38]	Arbulu and Soto [39]	Ansell, *et al.* [40]	Ballard, *et al.* [41]	Jang, *et al.* [42]	Novaes, *et al.* [43]	Kim, *et al.* [44]	Sterzi, *et al.* [45]	Alarcón, *et al.* [29]	AlSehaimi, *et al.* [23]	Hamzeh, *et al.* [46]	Jara, *et al.* [47]	Liu and Ballard [48]
Organizational inertia or resistance to change or "This is how I've always done it" attitude.		√		√	√		√	√		√	√	√			√		√			
Lack of commitment to LPC implementation or negative attitude towards new systems.	√	√	√					√	√		√	√					√			√
Lack of human capital: Lack of understanding of new system.	√					√			√			√	√	√				√	√	√
Difficulty in making quality assignments, or lack of skills, training, and experience.	√			√		√	√	√			√							√	√	
Lack of leadership or failure of management commitment.	√	√	√	√					√		√									√
Shortage of stakeholder support.	√	√						√					√							
Lack of empowerment of field management or lengthy approval procedure from client and top management.												√					√			√
Poor use of information generated during implementation of LPC.	√											√				√				
Contracting and legal issues or structure.	√	√																		
Partial or late implementation of LPC.			√	√													√			√
Bad team chemistry or lack of collaboration.											√									
Bad work ethics and cultural issues.																	√			
Short-term vision.				√													√			
Misinterpretation of PPC indicator.		√		√																
Extra resources or More paper work or Extra staff or more meeting or additional time.				√				√	√											
Lack of physical integration of all the stakeholders.									√											√
Inadequate administration.				√													√			
Parallel implementation with other improvement programs.				√																

3. METHODOLOGY

In this paper, a questionnaire survey was conducted to gather the opinions, views, and attitudes of the participants. The questionnaire is the most widely applied method for data collection for both descriptive and inferential surveys. Furthermore, the questionnaire is a fast and simple technique of data collection and more precise when beginning exploring and analyzing the collected data [49].

The targeted population was the construction companies which have valid registration in the Palestinian Contractors Union (PCU) in Gaza Strip and categorized by the national classification committee to have active membership in the PCU until the February 2017. The number of contractors has been recorded and classified according to the work field was 246 companies. For this research target group, there are totally 189 contractors classified under building category only with grades first, second and third classes. The companies under categories fourth and fifth classes were excluded because of the lack of workable and management expertise.

3.1. Sample Size and Characteristics

[50] said that sampling is generally executed by recognizing the relative significance of every segment in population and utilizing such weighting to classify them. In order to decide the sample size; the following statistical formula was utilized:

$$SS = \frac{Z^2 \times P \times (1 - P)}{C^2}$$

Where:

SS: The size of sample.

Z: Z value (for example: when confidence interval 95%, Z value =1.96).

P: Percentage picking a choice, expressed as decimal, (0.50 applied for sample size required).

C: Maximum estimation error (0.08).

$$SS = \frac{(1.96)^2 \times 0.5 \times (1 - 0.5)}{(0.08)^2} = 150$$

Correction for finite population is:

$$SS(new) = \frac{\text{SS}}{1 + (\frac{\text{SS} - 1}{\text{Population}})}$$

$$SSnew = \frac{150}{1 + (\frac{149}{189})} = 83.89 \approx 84$$

The result illustrates that the minimum number of the questionnaires required to be collected is 84, which represent 44.44% of the target group. This research has distributed 110 questionnaires randomly and then received 98 valid responses with 89.01% response rate.

3.2. Questionnaire Design and Contents

After making a review of all studies that focus on LPC especially in the construction industry, the questionnaire was prepared to satisfy the research objectives. The questionnaire contained a covering letter that explains the study purpose, the way of filling the questionnaire, the study goal and the confidentiality of the information for encouraging high response, as shown in Appendix A. Sections in the questionnaire were arranged as following: (i) General information about the participant, (ii) Profile of company, (iii) Evaluating key factors (success factors) for applicability of LPC, (iv) Evaluating challenges and barriers of LPC.

The Relative Importance Index (RII) method has been extensively applied in construction management studies for determining attitudes with regards to surveyed factors. Numerous studies [10, 51 - 58] have used the RII in their analysis. The participants were requested to assess the identified interface problems on a five-point Likert scale between "1" for the strongly disagree and "5" for the strongly agree. Based on the survey response, RII was calculated using the following equation:

$$\text{Relative Importance Index} = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Where, W is the weighting specified to every factor by the participant between 1 and 5, n1 = number of participants for strongly disagree, n2 = number of participants for disagree, n3 = number of participants for neutral, n4 = number of participants for agree, n5 = number of participants for strongly agree, A is the highest weight (5 in this study) and N is the total number of samples.

4. RESULTS AND DISCUSSION

4.1. Respondents and Companies Profile

Table **4** presents the representation of three (3) questions about the respondents; Respondent educational level, Job Title, and Work experience in the construction sector (Years). It is shown that (13) 13.27% of them have educational level diploma, (66) 67.35% of the respondents have educational level bachelors and (19) 19.39% of the respondents have educational level master. This indicates that the willingness of most of the graduates after graduation go to work directly to get workable expertise.

Table 4. Respondents information.

General Information	Categories	Frequency	Percentage%
Respondent educational level	Diploma	13	13.27
	Bachelors	66	67.35
	Master	19	19.39
Job Title	Head/Board Member	23	23.47
	Projects Manager	29	29.59
	Project Manager	24	24.49
	Site Engineer	13	13.27
	Office Engineer	9	9.18
Work Experience (Years)	Less than 5 years	31	31.63
	5- Less than 10years	24	24.49
	10- Less than 15years	21	21.43
	More than 15 years	22	22.45

Regarding the job title results, it is shown that (23) 23.47% of the respondents are head/board member, (29) 29.59% of them are projects manager, (24) 24.49% of them are project manager, (13) 13.27% of them are site engineer and (9) 9.18% of them are office engineer. This indicates that the projects manager is the most persons who face all the crises and he is most of the times available in the sites. For the work experience, it is shown that (31) 31.63% of the respondents have experience less than 5 years, (24) 24.49% of the respondents have experience from 5 years to less than 10 years, (21) 21.43% of the respondents have experience from10 years to less than 15 years, and (22) 22.45% of the respondents have experience more than 15 years. This indicates that the individuals who have experience less than 5 years are the most vigor at work and who don't demand high fees wherefore the contractors mostly required them.

For the companies' profile, Table **5** shows the results of the questions about the company age (years), company size (according to the number of permanent employees), Capital of the company, and Number of completed projects worked in during last five years. The results confirm more that 60.020% (59) from the sample have company age more than 15 years. This indicates reliable results.

Table 5. Company information.

General Information	Categories	Frequency	Percentage%
Company Age (Years)	Less than 5 years	0	—
	5- Less than 10years	11	11.22
	10- Less than 15years	28	28.57
	More than 15 years	59	60.20
Company size (according to the number of permanent employees)	(1-4) very small	2	2.04
	(5-19) small	61	62.24
	(20-49) medium	26	26.53
	(>50) large	9	9.18
Capital of the company	Less than $100,000	15	15.31
	$ 100,000-$250,000	21	21.43
Number of completed projects worked in during last five years	1-5 projects	11	11.22
	6-10 projects	21	21.43
	11-15 projects	43	43.88
	More than 15 projects	23	23.47

However, in term of company size, it is shown that (2) 2.04% of surveyed companies is very small companies, (61) 62.24% of them small companies, (26) 26.53% from the surveyed sample is medium companies, and (9) 9.18% of them is large companies. This indicates the companies at Gaza strip have few permanent employees while the majorities have non-permanent employee.

Regarding the Capital of the company, it is shown that (15) 15.31% from the sample have capital Less than $100,000, (21) 21.43% from the sample have capital from $ 100,000 to $250,000, (27) 27.55% from the sample have capital from $251,000 to $500,000 and (35) 35.71% from the sample have capital more than $ 500,000. This indicates that the size of Gaza strip construction projects is comparatively small.

Regarding the company work volume, it is shown that (11) 11.22% from the companies sample have number of completed projects worked in during last five years from 1 to 5 projects, (21) 21.43% from the companies sample have number of completed projects worked in during last five years from 6 to 10 projects, (43) 43.88% from the companies sample have number of completed projects worked in during last five years from 11 to 15 projects and (23) 23.47% from the companies sample have number of completed projects worked in during last five years more than 15 projects. This indicates that the projects which have been started in the same period were high, and the number of projects is small in comparison to the number of companies in the Gaza. But the companies in the market cannot have more than one project in the same time because of the shortage of capitals.

4.2. Evaluating the Key Factors Supporting for Success the LPC

The mean, RII, and t-test were calculated for each factor as presented in Table **6**. Based on Table **6** results, it is shown that “close relationship with subcontractors” factor is ranked in the first position with a mean of 4.05, RII of 81.02% and P-value of 0.00. This result explains that implementing LPC require high cooperation and robust relationship between the subcontractors and the top management. The obtained results agreed with [24] who highlighted that coordination issues with subcontractors may cause interface issues in sequences of activities and delay in the completing the tasks on time.

Table 6. The statistical outcomes of key success factors supporting LPC implementation.

No.	Factor	Mean	Std.	RII %	T-test	P-value	Rank
1	Top management support	4.03	1.247	80.612	8.180	0.000	2
2	nvolvement of all stakeholders	3.28	1.299	65.51	2.100	0.000	15
3	Coordination and cooperation between staffs to achieve team work	3.94	1.283	78.776	7.244	0.000	3
4	Close relationship with suppliers	3.58	1.354	71.633	4.252	0.000	10
5	Motivate employees to make change	2.84	1.518	56.735	-1.065	0.000	16
6	Manage resistance of managers to change planner system	3.47	1.548	69.388	3.002	0.000	11
7	Definition of roles and responsibilities	3.30	1.487	65.918	1.970	0.000	13
8	Involvement of management staffs	3.45	1.194	68.98	3.723	0.000	12

(Table 6) contd.....

No.	Factor	Mean	Std.	RII %	T-test	P-value	Rank
9	Increased support and monitoring of management for Subordinates	3.70	1.408	74.082	4.949	0.000	8
10	Update the program daily	3.76	1.393	75.102	5.368	0.000	7
11	Accuracy and flexibility in planning	3.81	1.39	76.122	5.743	0.000	5
12	Greater commitment by management on the implementation of development system promises	3.65	1.244	73.061	5.195	0.000	9
13	Close relationship with subcontractors	4.05	1.097	81.02	9.484	0.000	1
14	Willingness to learn and train	2.82	1.515	56.327	-1.200	0.000	17
15	Sufficient knowledge to start the project	3.81	1.198	76.122	6.659	0.000	5
16	Sufficient knowledge for scheduling and planning	3.83	1.227	76.531	6.668	0.000	4
17	Sufficient knowledge for controlling system	3.30	1.487	65.918	1.970	0.000	13

Critical value of t at df "97" and significance level 0.05 equal 1.99

Also based on Table **6**, it is presented that "top management support " factor scored the second order with a mean of 4.03, RII of 80.61% and P-value of 0.00. This result indicates that implementing LPC require support and commitment of top management. The achieved outcomes agreed with [23] who highlighted that the presence of complete support and obligation from top management is necessary. "Coordination and cooperation between staffs to achieve teamwork" factor scored the third order with a mean of 3.94, RII of 78.77% and P-value of 0.00. This result shows that huge cooperation and robust relationship between the staffs themselves and the top management is necessary. The effective team building will support the LPC and achieve satisfactory performance indicators. The obtained outcomes in the same line with [23] who highlighted that the existence of coordination and cooperation between staffs helps to achieve team work and leads to the success of the project. "Motivate employees to make a change" and "willingness to learn and train" do not have high influence on the implementation of LPC. The first factor is ranked in the position 16 with a mean of 2.84, RII of 56.73% and P-value of 0.00 while the second factor is ranked in the last important position with a mean of 2.82, RII of 56.32% and P-value of 0.00. These results confirm that implementing LPC still needs massive attempts to change the mentality and culture of the parties operating in Gaza Strip construction industry. The results do not match with [23] who found that "motivate employees to make a change" is important factor to implement LPC and do not match with [24] who found that "willingness to learn and train" will be useful to implement LPC. This may relate to unwillingness to self-development through learning and training and may relate to resistance to change.

The overall results show that the average mean is equal to 3.56, RII is equal to 71.28% which is larger than " 60%", the value of t-test is equivalent to 4.372 which is larger than the critical value of 1.99, and the p-value equal 0.000 which is less than 0.05. These indicate that key factors for applicability of LPC are significant at the level of 0.05.

4.3. Evaluating the Challenges/Barriers of LPC

Table **7** shows that "lack of skills, training, and experience" and "lack of the training program for the managers" related to the challenges/barriers of LPC implementation are ranked in the first position with a mean of 4.13, RII of 82.65% and P-value of 0.00. Actually, this is a critical fact in the Gaza Strip since any training for the managers and staffs (subordinates and labours) needs extra resources (cost and time) while the contractors are not ready to overcome this barrier.

Table 7. The statistical results of key challenges /barriers of LPC implementation.

No.	Factor	Mean	Std.	RII %	T-test	P-value	Rank
1	Resistance of managers to change planner system	3.82	1.221	76.327	6.617	0.000	12
2	Failure of management commitment to LPC implementation	4.05	1.134	81.020	9.175	0.000	7
3	Lack of human capital	3.16	1.544	63.265	1.046	0.000	16
4	Lack of understanding of new system	3.71	1.339	74.286	5.280	0.000	13
5	Lack of skills, training, and experience	4.13	1.090	82.653	10.286	0.000	1
6	Non-supportive organizational climate	3.83	1.308	76.531	6.254	0.000	11
7	Lack of stakeholder support	3.91	1.236	78.163	7.274	0.000	10
8	Lengthy approval procedure from client and top management	4.11	1.064	82.245	10.351	0.000	3
9	Misuse of information generated during implementation of LPC	4.11	0.962	82.245	11.446	0.000	3
10	Partial or late implementation of LPC	3.94	1.208	78.776	7.691	0.000	9
11	Unavailability of coordinate and cooperation between parties	3.96	1.183	79.184	8.024	0.000	8
12	Short-term vision	3.03	1.516	60.612	0.200	0.000	18
13	Misinterpretation of PPC indicator	3.32	1.517	66.327	2.064	0.000	14

(Table 7) contd.....

No.	Factor	Mean	Std.	RII %	T-test	P-value	Rank
14	Involvement of many parties joined the project, especially subcontractors and suppliers	3.23	1.491	64.694	1.558	0.000	15
15	Weak communication among participants of the production process	3.13	1.597	62.653	0.822	0.000	17
16	Lack of integration between client, consultant, contractor and supplier	4.06	1.073	81.224	9.793	0.000	6
17	Lack of implementation of advanced technology in construction	4.07	1.077	81.429	9.849	0.000	5
18	Lack of the training program for the managers	4.13	0.970	82.653	11.559	0.000	1

The majority of the respondents believe that they can invest better in construction process itself instead of training the staff. These outcomes agreed with [59] who highlighted that any company needed training programs for staffs and highlight the importance of skill development and human capital in using LPC. Also according to Table **7**, it is shown that "lengthy approval procedure from the client and top management" and "misuse of information generated during implementation of LPC" are categorized in the third rank with a mean of 4.11, RII of 82.24% and P-value of 0.00. Actually, long-lasting endorsement process from the client and highest management is one of the utmost fumes obstacles in arrangement and monitoring construction projects in the Gaza Strip. Therefore, if any delay occurs during construction stage the owner should be in charge of damages instigated by this interruption. In addition, misuse of information generated during implementation of LPC would affect the corrective actions to improve the accomplishment rate. These two barriers were introduced by [59, 60].

Critical value of t at df "97" and significance level 0.05 equal 1.99

Moreover, the respondents did not strongly believe that implementing LPC needs "short-term vision". The result means that the managers and staffs do not allow visualizing issues with sufficient time to take the correct decisions. This barrier is in the last position with a mean of 3.03, RII of 60.61% and P-value of 0.00.

The overall results show that the average mean is equal to 3.76, RII is equal to 75.23% which is larger than 60%, the value of t-test is equivalent to 6.361 which is larger than the critical value of 1.99, and the p-value is equivalent to 0.000 which is less than 0.05. These mean that the challenges/barriers to LPC implementation are significant at the level of 0.05.

CONCLUSION

LPC is one of the lean construction approaches. In this research, a questionnaire survey was implemented to identify the key factors supporting the applicability LPC and to determine its challenges/barriers in the Gaza Strip construction industry. The main results of the study show that: Close relationship with subcontractors, top management support and coordination and cooperation between staffs to achieve teamwork were the key factors of LPC implementation. The high cooperation and robust relationship between the subcontractors, staffs and the top management should be exerted to enhance and develop the LPC implementation. On the other hand, lack of skills, training, and experience, lack of the training program for the managers, lengthy approval procedure from the client and top management, and misuse of information generated during implementation of LPC were the main challenges /barriers of LPC implementation. The intensive training for all parties is necessary in order to enhance and develop the LPC implementation.

It is recommended that contractors ought to comprehend their accountability to Choose the subcontractor based on his previous expertise and competence in light of workers, tools, and equipment as these elements safeguard the obligation of the subcontractor in finalizing the works according to the time schedule. In addition to supporting all parties in the project for the short-term vision to visualize issues with sufficient time to take the correct decisions and achieve the project objectives.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

Declared none.

APPENDIX A: A SAMPLE QUESTIONNAIRE

First of all, I would like to thank you for your value time and effort that will be consumed in this questionnaire filling. This questionnaire aims to study the ability of applying the "Last Planner System" in construction companies placed in Gaza, which it's a philosophy of projects management through monitoring and tracking all activities in the project to avoid any failure at implementation phase and minimizing (time/cost) project. In addition to spot the lights on Key Factors of last planner system success in Gaza strip. And to investigate tools and techniques for last planner system that affect in construction projects in Gaza. And study benefits through implementation Last Planner System. Finally, to study the challenges and barriers of LPS applicability.

Content of Questionnaire:

- **Section One:** General information about the responding person
- **Section Two:** Profile of company
- **Section Three:** Evaluating Key Factors (Success Factors) for applicability of LPS.
- **Section Four:** Evaluating the Tools and Techniques used in LPS.
- **Section Five:** Evaluating Benefits through implementation LPS.
- **Section Six:** Evaluating Challenges and barriers of LPS.

Thank you for your cooperation

● Section One: General Information

1. Respondent Educational Level

Diploma	Bachelors	Master	Doctorial	Others

2. Job Title

Head/Board Member	Projects Manager	Project Manager	Site Engineer	Office Engineer
Others, please explain				

3. Work Experience in the Construction Sector (Years)

Less than 5 years	5- Less than 10years	10- Less than 15years	More than 15 years

● Section Two: Profile of Company

1. Company Age (Years)

Less than 5 years	5- Less than 10years	10- Less than 15years	More than 15 years

2. Company Size

(1-4) very small	(5-19) small	(20-49) medium	(>50) large

3. Capital of the Company

Less than $100,000	$ 100,000-$250,000	$251,000-$500,000	More than $ 500,000

4. Average Value of Projects Executed per Year

Less than 1 Million	1 Million - Less than 5 Millions	5 Millions - Less than 10 Millions	More than 10 Millions

5. Classification under Palestinian Contractors Union(PCU) Category

Building			
1st (A)	**1st** (B)	**2nd**	**3rd**

6. Number of Completed Projects Worked in During Last Five Years

1-5 projects	6-10 projects	11-15 projects	More than 15 projects

● Section Three: Key Factors of Last Planner System Success

Please tick (X) opposite the appropriate item

	Key Factors of Last Planner System Success	Level of Implementation				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1	Top management support					
2	Involvement of all stakeholders					
3	Coordination and cooperation between staffs to achieve team work					
4	Robust relationship with suppliers					
5	Push employees to create change					
6	Manage resistance of managers to change planner system					
7	Definition of roles and responsibilities					
8	Involvement of management staffs					
9	Increased support and monitoring of management for Subordinates					
10	Update the program daily					
11	Accuracy and flexibility in planning					
12	Greater commitment by management on the implementation of development system promises					
13	Close relationship with subcontractors					
14	Willingness to learn and train					
15	Sufficient knowledge to start the project					
16	Sufficient knowledge for scheduling and planning					
17	Sufficient knowledge for controlling system					

● Section Four: Challenges /barriers to implement Last Planner System

	Challenges /barriers to implement Last Planner System	Level of Importance				
		Very high	High	Medium	Low	Very Low
1	Resistance of managers to change planner system					
2	Failure of management commitment to LPS implementation					
3	Shortage of human capital					
4	Shortage of recognize of new system					
5	Lack of skills, training, and experience					
6	Non-supportive company environment					
7	Shortage of stakeholder support					
8	Elongate acceptance steps from top management					
9	Misuse of output data generated during implementation of LPS					
10	Partial or late implementation of LPS					
11	Unavailability of coordinate and cooperation between parties					
12	Short-term vision					
13	Misinterpretation of PPC indicator					
14	Participation of many parties joined the project, principally subcontractors and suppliers					
15	Shortage of communication amongst participants of the production process					
16	Shortage of integration among client, consultant, contractor and supplier					
17	Shortage of application of advanced technology in construction					
18	Shortage of the training course for the directors					

REFERENCES

[1] P.E. Love, G.D. Holt, and H. Li, "Triangulation in construction management research", *Eng. Construct. Architect. Manag.,* vol. 9, pp. 294-303, 2002.

[2] L. Koskela, "Lean production in construction", In: *Automation and robotics in construction X: Proceedings of the 10th International Symposium on Automation and Robotics in Construction (ISARC),* 1993, p. 47.Houston, Texas, USA

[3] M.S. Abdullah, W.S. Alaloul, M.S. Liew, and B.S. Mohammed, "Delays and cost overruns causes during construction of palm oil refinery projects", *MATEC Web of Conferences,* p. 02004, 2018.
[http://dx.doi.org/10.1051/matecconf/201820302004]

[4] H.D. Khanh, and S.Y. Kim, "Identifying causes for waste factors in high-rise building projects: A survey in Vietnam", *KSCE J. Civ. Eng.,* vol. 18, pp. 865-874, 2014.
[http://dx.doi.org/10.1007/s12205-014-1327-z]

[5] W.S. Alaloul, M.S. Liew, and N. Zawawi, "Coordination process in construction projects management", In: *Engineering Challenges for Sustainable Future,* vol. 149. ROUTLEDGE in association with GSE Research: Kuala Lumpur, Malaysia, 2016, pp. 149-153.

[6] N. El- Sawalhi, *"Project management practices public owners and contractors"*, MSc thesis*,* The Islamic University of Gaza–Palestine, 2002.

[7] A. Yahia, *"Time schedule preparation by predicting production rate using simulation"*, M.Sc. thesis*,* The Islamic University of Gaza-Palestine, 2004.

[8] W.S. Alaloul, M.S. Liew, and N.A.W.A. Zawawi, "Identification of coordination factors affecting building projects performance", *Alexand. Eng. J.,* vol. 55, pp. 2689-2698, 2016.
[http://dx.doi.org/10.1016/j.aej.2016.06.010]

[9] M. Abu Ismaiel, *"The applicability of lean construction in the gaza strip construction industry"*, M.Sc. thesis*,* The Islamic University of Gaza-Palestine, 2013.

[10] B.A. Tayeh, K. Al Hallaq, W.S. Alaloul, and A.R. Kuhail, "Factors affecting the success of construction projects in Gaza Strip", *Open Civil Eng. J.,* vol. 12, pp. 301-305, 2018.

[11] W.S. Alaloul, M.S. Liew, and N.A.B. Zawawi, "A framework for coordination process into construction projects", In: *MATEC Web of Conferences,* 2016, p. 00079.
[http://dx.doi.org/10.1051/matecconf/20166600079]

[12] B.T. Kalsaas, "The last planner system style of planning: Its basis in learning theory", *J. Eng. Proj. Produc. Manage.,* vol. 2, p. 88, 2012.
[http://dx.doi.org/10.32738/JEPPM.201207.0005]

[13] B.T. Kalsaas, and R. Sacks, "Conceptualization of interdependency and coordination between construction tasks", *19th Annual Conference of the International Group for Lean Construction,* 2011.

[14] W.S. Alaloul, M.S. Liew, and N.A.W.A. Zawawi, "The characteristics of coordination process in construction projects", In: *Technology Management and Emerging Technologies (ISTMET), 2015 International Symposium on,* 2015, pp. 159-164.IEEE: Langkawai Island, Malaysia
[http://dx.doi.org/10.1109/ISTMET.2015.7359021]

[15] M.J. Rajprasad, and S. Saminu, "A study and application of lean construction techniques using last planner concept in residential building", *Int. J. Eng. Dev. Res,* 2014.

[16] V. Porwal, *Last planner system-Areas of application and implementation challenges.,* Texas A&M University, 2010.

[17] M. Fiallo, and V. Revelo, "Applying the last planner control system to a construction project: A case study in Quito, Ecuador", *Proceedings of the 10th Annual conference of the International Group for Lean Construction,* 2002.

[18] A.S. Munje, and D.S. Patil, "Comparative study of last planner system over traditional construction processes", *Current Tren. Tech. Sci.,* vol. 3, pp. 308-311, 2014.

[19] S. Skinnarland, and S. Yndesdal, "The last planner system as a driver for knowledge creation", In: *Proceedings for the 20th Annual Conference of the International Group,* Lean Construction Montezume Publishing: San Diego, CA, 2012, p. 1190.

[20] S. Bertelsen, "Lean Construction: Where are we and how to proceed", *Lean Construct. J.,* vol. 1, pp. 46-69, 2004.

[21] L. Koskela, R. Stratton, and A. Koskenvesa, "Last planner and critical chain in construction management: Comparative analysis", In: *Proceedings of the 18th Annual Conference of the International Group for Lean Construction,* 2010, pp. 538-547.

[22] S.A.M. Hussain, B.V. Krishna, and V.R. Kumar, "Application and analysis of last planner system in the construction industry", *Int. J. of Res. Eng. Tech.,* vol. 2, pp. 33-44, 2014.

[23] A.O. AlSehaimi, P. Tzortzopoulos, and L. Koskela, "Last planner system: Experiences from pilot implementation in the Middle East", In: *17th Annual Conference of the International Group for Lean Construction IGLC 17,* 2009.Taipei, Taiwan

[24] F. Cerveró-Romero, P. Napolitano, E. Reyes, and L. Teran, "Last Planner System® and Lean approach process®: experiences from implementation in Mexico", In: *21st Annual Conference of the International Group for Lean Construction, IGLC,* 2013, pp. 709-718.Mexico

[25] W.S. Alaloul, M.S. Liew, N.A. Wan Zawawi, B.S. Mohammed, and M. Adamu, "An artificial neural networks (ann) model for evaluating construction project performance based on coordination factors", *Cogent Eng.,* vol. 5, pp. 1-18, 2018.

[http://dx.doi.org/10.1080/23311916.2018.1507657]

[26] V. Porwal, J. Fernandez-Solis, S. Lavy, and Z.K. Rybkowski, "Last planner system implementation challenges", In: *Proceedings of the 18th Annual Conference International Group for Lean Construction, IGLC,* 2010, pp. 548-54.Israel.

[27] B. Dave, J-P. Hämäläinen, and L. Koskela, "Exploring the recurrent problems in the last planner implementation on construction projects", In: *Proceedings of the Indian Lean Construction Conference (ILCC 2015),* 2015.India.

[28] D.A. Brady, P. Tzortzopoulos, and J. Rooke, "An examination of the barriers to last planner implementation", In: *19th Annual Conference for Lean Construction,* 2011.

[29] L.F. Alarcón, S. Diethelm, O. Rojo, and R. Calderón, "Assessing the impacts of implementing lean construction", *Rev. Ing. Constr.,* vol. 23, pp. 26-33, 2008.

[30] S.B. Mohan, and S. Iyer, "Effectiveness of lean principles in construction", In: *13th International Group for Lean Construction Conference: Proceedings,* 2005, p. 421.International Group on Lean Construction: Sydney.

[31] W.S. Alaloul, M.S. Liew, and N.A.W. Zawawi, "Communication, coordination and cooperation in construction projects: Business environment and human behaviours", In: *IOP Conference Series: Mat. Sci. Eng.,* IOP Publishing Ltd: Bristol, United Kingdom, 2017, p. 012003.
[http://dx.doi.org/10.1088/1757-899X/291/1/012003]

[32] H.G. Ballard, *The last planner system of production control.,* The University of Birmingham: Birmingham, 2000.

[33] J.M. Garza, and M-W. Leong, "Last planner technique: A case study", In: *Construction congress VI: Building together for a better tomorrow in an increasingly complex world,* 2000, pp. 680-689.
[http://dx.doi.org/10.1061/40475(278)73]

[34] L.F. Alarcón, and S. Diethelm, "Organizing to introduce lean practices in construction companies", *Rev. Ing. Constr.,* vol. 17, pp. 54-59, 2001.

[35] L.F. Alarcón, S. Diethelm, and O. Rojo, "Collaborative implementation of lean planning systems in chilean construction companies", In: *Tenth Annual Conference of the International Group for Lean Construction (IGLC-10),* 2002, pp. 1-11.Brazil

[36] Y-W. Kim, and J-W. Jang, "Case study: An application of last planner to heavy civil construction in Korea", In: *13th International Group for Lean Construction Conference: Proceedings,* 2005, p. 405.

[37] A. Koskenvesa, and L. Koskela, "Introducing last planner-finnish experiences", In: *Proceedings of 11th Joint CIB International Symposium-Combining Forces,* 2005, pp. 95-107.

[38] O. Salem, J. Solomon, A. Genaidy, and M. Luegring, "Site implementation and assessment of lean construction techniques", *Lean Construct. J.,* vol. 2, pp. 1-21, 2005.

[39] R. Arbulu, and J. Soto, "A design case study: Integrated product and process management", In: *Proceedings 14th Annual Conf. of the Int. Group for Lean Construction (IGLC-14),* 2006.

[40] M. Ansell, M. Holmes, R. Evans, C. Pasquire, and A. Price, "Lean construction trial on a highways maintenance project", In: *Proceeding IGLC-15: Fifteenth annual conference of the international group for lean construction,* 2007.

[41] G. Ballard, Y. Kim, J. Jang, and M. Liu, *Roadmap for lean implementation at the project level.,* The Construction Industry Institute: Austin, Texas, USA, 2007.

[42] J.W. Jang, Y-W. Kim, C.J. Park, and W.S. Jang, "Importance of partners in a challenging lean journey", In: *Proceedings 15th Annual Conf. of the Int. Group for Lean Construction (IGLC-15),* 2007.

[43] M.D.V. Novaes, L.F.M. Heineck, C.A. Mourão, S.L. Kemmer, and T.D.C. Alves, "Medium-term planning: Contributions based on field application", In: *Proceedings 15th Annual Conf. of the Int. Group for Lean Construction,* 2007.

[44] Y-W. Kim, C. Park, and G. Ballard, "A case study on rebar supply chain management by GS E&C", In: *Proceedings 15th Annual Conf. of the Int. Group for Lean Construction (IGLC-15),* 2007.

[45] M.P. Sterzi, E.L. Isatto, and C.T. Formoso, "Integrating strategic project supply chain members in production planning and control", In: *Proceedings 15th Annual Conf. of the Int. Group for Lean Construction (IGLC-15),* 2007.

[46] F.R. Hamzeh, G. Ballard, and I.D. Tommelein, "Is the Last Planner System applicable to design?-A case study", In: *Proceedings 17th Annual Conf. of the Int. Group for Lean Construction (IGLC-17),* 2009.

[47] C. Jara, L.F. Alarcón, and C. Mourgues, "Accelerating interactions in project design through extreme collaboration and commitment management-A case study", In: *Proceedings 17th Annual Conf. of the Int. Group for Lean Construction (IGLC-17),* 2009.

[48] M. Liu, and G. Ballard, "Factors affecting work flow reliability-A case study", In: *Proceedings 17th Annual Conf. of the Int. Group for Lean Construction (IGLC-17),* 2009.

[49] W.S. Alaloul, M.S. Liew, W. Zawawi, and N. Amila, "Delphi technique procedures: A new perspective in construction management research", *Appl. Mech. Mater.,* vol. 802, pp. 661-667, 2015.
[http://dx.doi.org/10.4028/www.scientific.net/AMM.802.661]

[50] R.F. Fellows, and A.M. Liu, *Research methods for construction.,* John Wiley & Sons: Hoboken, New Jersey, USA, 1997.

[51] A.A. Enshassi, F.M. Arain, and B.A. Tayeh, "Subcontractor prequalification practices in palestine", *Int. J. Construct. Manage.,* vol. 10, pp. 45-74, 2010.
[http://dx.doi.org/10.1080/15623599.2010.10773154]

[52] K. El-Hallaq, and B.A. Tayeh, "Strategic planning in construction companies in Gaza strip", *J. Eng. Res. Techn.,* vol. 2, pp. 167-174, 2016.

[53] A.A. Enshassi, F. Arain, and B.A. Tayeh, "Major causes of problems between contractors and subcontractors in the Gaza Strip", *J. Financ. Manage. Property Construct.,* vol. 17, pp. 92-112, 2012.
[http://dx.doi.org/10.1108/13664381211211064]

[54] B.A. Tayeh, K. Al Hallaq, and F.A. Sabha, "Effects of faulty design phase on school buildings maintenance in Gaza strip", *Americ. J. Sustainable. Eng. Arch.,* vol. 4, pp. 199-210, 2016.

[55] O.A. Tayeh, K. El-Hallaq, and B.A. Tayeh, "Importance of organizational culture for Gaza strip construction companies", *Int. J. Eng. Manage. Res.,* vol. 8, pp. 35-39, 2018.

[56] O.A. Tayeh, K. El-Hallaq, and B.A. Tayeh, "The organizational culture of Gaza strip construction companies", *Int. J. Eng. Manage. Res.,* vol. 8, pp. 40-64, 2018.

[57] B.A. Tayeh, K. AL Hallaq, F.A. Sabha, and M. O. Yusuf, "Effects of construction phase errors on maintenance of school buildings in Gaza Strip", *Int. J. Manage., Inform. Techno. Eng. (BEST: IJMITE),* vol. 5, pp. 21-34, 2017.

[58] M.A. Albhaisi, B.A. Tayeh, and K. El-Hallaq, "Factors causing variation orders in construction projects in gaza strip (Case Study: Qatar Projects)", *Int. J. Eng. Manage. Res.,* vol. 6, pp. 262-270, 2016.

[59] J.L. Fernandez-Solis, V. Porwal, S. Lavy, A. Shafaat, Z.K. Rybkowski, K. Son, and N. Lagoo, "Survey of motivations, benefits, and implementation challenges of last planner system users", *J. Constr. Eng. Manage.,* vol. 139, pp. 354-360, 2012.
[http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000606]

[60] H.D. Khanh, and S.Y. Kim, "A survey on production planning system in construction projects based on Last Planner System", *KSCE J. Civ. Eng.,* vol. 20, pp. 1-11, 2016.
[http://dx.doi.org/10.1007/s12205-015-1412-y]