The barriers of the implementation of lean construction in Klang Valley, Malaysia

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Abstract. The traditional procurement system, the structure of the industry and the nature of the construction product all influence current practices and thinking within the construction industry. Whilst there have been recent changes in the way the industry operates, the majority of construction projects in Klang Valley are still delivered using traditional practices. The objective of this paper is to evaluate the influence factors of the implementation lean construction at selected construction sites in Klang Valley, Malaysia. Evaluation index system in terms of questionnaire and interview were utilized to evaluate the barriers of the implementation of lean construction. Based on that, questionnaire was selected with workers to evaluate the implementation of lean construction techniques in Klang Valley. After that, interview was selected to study the influence factors on the implementation of lean construction. Structural Equation Modelling was utilized in the survey with the project team (contractors, clients and consultants) to measure the effectiveness of the barriers and strategies of the implementation of lean construction at the construction sites. Based on that, the strategies of the implementation of lean construction can be described as follows. Provide support from the top management, develop strategic alliance between various firms, requirement of staff competent to lean construction, develop the integration between design and construction, educate people about lean construction, encourage clients to adopt lean construction, provide staff training about lean construction as well as disputes and claims. In addition, their standardized estimates (SE) are (β = 0.013, 0.025, 0.023, 0.027, 0.015, 0.034, 0.021, 0.021, 0.023) respectively.

1. Introduction

The construction industry is often criticized for its poor performance. Similarly, other countries are undergoing a similar phase of rethinking and reengineering how construction projects should be delivered and maintained. The construction has a low and unreliable rate of profitability. Margins are characteristically very low and share prices often lag behind companies in other industries. The under-achievement of construction is graphically demonstrated by the City’s view of the industry as a poor investment. The City regards construction as a business that is unpredictable, competitive only on price not quality, with too few barriers to entry for poor performers. With few exceptions, investors cannot identify brands among companies to which they can attach future value. As a result, there are few loyal, strategic long-term shareholders in quoted construction companies. This adversely affects the industry’s ability to generate funding for long term investment and development. Low margins are often associated with bankruptcy, claims, litigation and poor quality. Therefore, the traditional capital and service contracts selected on lowest price are delivered late, over budget and do not meet clients’ needs. Based on the traditional procurement system, the structure of the industry and the nature of the construction product all influence current practices and thinking within the construction industry. Given that these practices are not delivering strong performance, there is a need to re-think the...
traditional procurement system and industry’s structure. Innovations in how projects are procured would undoubtedly influence project management practices and hence the techniques and skills needed by project managers [20].

In spite the fact that there is overwhelming evidence of waste in construction processes which suggests that there is still a tremendous opportunity to develop novel research on lean construction processes. In addition, considerable resistance remains due to construction being viewed as different from manufacturing industries. On the other hand, Lean construction has a huge impact in the construction industry at different levels and it is described as follows [6]. At the project level it reduces risk, improves quality, and reduces cost, completion on time while at the business level it reduces rework, increases profits, increases market share, enhances competitive position, competitive bidding and broadened client base. At the corporate level it is very effective in cost reduction, increasing labour productivity, improving efficiency, and increasing opportunity for innovation, continuous improvement of quality products and services as well as it increasing cultural responsiveness. Presently, Malaysia is still at the early stage in adopting lean construction in spite of the high growth in the construction industry recently.

Ahmed and Wong [1] added that there are six lean construction has been implemented partially in construction projects in Klang Valley as follows. Based on off-site manufacturing of building elements (IBS). This method is widely used for housing and in the education, sector offering economic, environmental and social advantages. Off-site construction refers to structures built at a different location than the location of use. Off-site construction occurs in a manufacturing plant specifically designed for this type of process. Individual modules of the building are constructed in the factory then transported to the site on specially designed trailers [29]. There are a lot of advantages in adopting IBS at construction. It reduces time, decrease site disruption, reduces thermal losses as well as provide higher sustainability [30]. In addition, value management defined as ratio between satisfaction of needs (benefits) and use of resources (expenditure). Reconciling the needs and views of different stakeholders while balancing the use of resources to suit priorities by balancing the overall benefits realised with the use of resources by optimising the value for money ratio. The value would get as follows [29]. Firstly, the client or customer needs must determine. Secondly, the product and service should meet customer needs. Thirdly, product and service with minimum non-value adding activities (optimise process) should be achieved. Fourthly, this must be done with the best cost to your business and customer as well as the enhancement for quality and reduce time and cost is required as well as keeps your business sustainable. On the other hand, Just In Time (JIT) is very effective to reduce inventory waste (Buffers) in the case of delivering off-site components into the construction site [6]. However, lack of skilled labours as well as lack of mutual trust between the contractors and suppliers or pre castors as a main barrier of adopting JIT in construction [1, 7, 9]. Building Information Modelling (BIM) enhances the flow between activities. Therefore, it achieves the customer satisfaction by insuring on time delivery for the resources and reducing materials wastes [30, 31]. However, Ahmed and Wong [1] provided that BIM required more training (professional and skill full people) to accept BIM technology instead of auto Cad. Total Quality Management (TQM) has two main components which are quality assurance (QA) and quality control (QC) [9]. QA is the collective term applied to a wide range of management processes and activities that are applied in order to ensure that products are manufactured to a prescribed level. QA also includes the collection and use of information from outside the manufacturing process that is used as feedback or input for improving the system. Generally, setting up a QA system involves establishing some kind of benchmark or target against which actual performance can be measured. These standards will be derived directly from the individual component objectives that were themselves derived from the policy. Generally, a good QA system will identify objectives in relation to workable standards. It will be multifunctional and will operate as part of a continual cycle for system improvement.

For measuring construction performance [15, 18, 19, 20]. A key aspect in the use of leading indicator performance data in securing project or industry best practice and continuous improvement is feedback [20]. The feedback mechanisms are multiple and may be complex. In addition, Feedback is
the essential component that provides information and data on how a company or a project that is presently performing at X level can actually become a company or a project that performing at or above national or international performance levels.

There is still much that needs to be accomplished to achieve best practice and continuous improvement in the construction sector when compared to other industry sectors (external benchmarking). In particular it must be focusing on what it is that makes projects perform better than the benchmark averages. KPI indicator includes client satisfaction in term of service and product. It also provided predictability in terms of cost and time, profitability, productivity, safety, construction time as well as construction cost [6, 9, 19, 26, 29].

2. Research methods

The researcher examined 18 sites location with different categorization (infrastructure or building) projects in Klang Valley to identify independent variables and the dependent variables affecting the implementation of lean construction practices. The level and characteristics of both variables and their compliance with the lean construction techniques and construction wastes was the focus. The contracting companies in Malaysia categorized according to financial capabilities starting from the lowest (first class) to highest financial capabilities (seven class). The seven class contracting companies was selected according to their high possibility of adopting lean construction. Similarly, interviews cut across various construction sites (8 MRT sites location and 10 residential as well as commercial building) in Klang Valley. A literature review was used to identify the variables (dependents and independents variables). Evaluation index system was utilized to evaluate lean construction techniques according to the theory and practice as it shown in figure 1. Based on that, questionnaire with workers was selected to evaluate the implementation of lean construction techniques in Klang Valley and written questionnaire was adopted according to their low level of education. Later, semi structural interview was utilized to illustrate the barriers of the implementation of lean construction techniques. Then, both online and written questionnaires were adopted to rank the barriers and the strategies of the implementation of lean construction techniques. Thematic analysis was utilized to analyze qualitative research. Software program (Maxqda2018) which involves coding and segmentation, development of themes and connection of interrelated theme related to the feedback of the workers at the construction sites. It used to analyze the barriers of the implementation lean construction at the construction sites in Klang Valley according to evaluation index system. For analysing quantitative data, Statistical Package for Social Sciences (SPSS) version 20 was used to analyse the preliminary collected from the questionnaires. Then, Structural Equation Modelling (SEM) in terms of confirmatory factor analysis and path analysis were adopted to test the hypothesis of the research.

Once the scale had been developed in stage one, the hypotheses were tested in stage two (the structural model). It describes the use of multi-item scales to measure each factor in the measurement model which assessed by describing the estimate (Factor loadings and Average Variance Extracted (AVE) that should be more than threshold 0.50 as well as Composite Reliability (CR) that should be more that 0.70). This is followed with a description of the procedures that were conducted to modify the measurement model. On the other hand, non probability sampling was adopted to select 18 construction sites which are adopted in the research. Accordingly, the research was focused on the respondents at selected infrastructures and building construction projects in Klang Valley. Workers and site foremen were chosen from the population to rate the implementation of lean construction techniques at selected construction sites because they are front line people at the construction phase. Then, project teams were selected from the population according to designation and years of experience (i.e. workers, contractors, subcontractors, site foremen, project managers, clients and consultants) at selected construction sites to rank the barriers and the strategies. Ogunbiyi et al. [25] declared that Quata sampling was adopted with workers from the selected construction sites to evaluate the implementation of lean construction techniques at selected case studies in Klang Valley. Also, the researcher distributed 100 questionnaires to each of the 18 nearest construction sites, 1800
questionnaires overall were distributed among the nearest construction sites. Therefore, (1800) questionnaires were distributed among workers at selected construction sites to evaluate the implementation of lean construction at selected construction sites and only 220 were responded to the questionnaire.

According to the research, different kinds of questions were used to generate statistics such as boxes to tick, yes or no questions as well as scaling to rank (Likert scale of 1 to 5 will be used as a method of scaling). In dependent T test was selected to analyse the implementation of lean construction techniques at selected construction sites. A semi-structured interview was used to illustrate the barriers of lean construction implementation at selected construction sites. Purposive sampling was adopted to interview the people according to their knowledge, experience as well as availability at the construction site. A sample size of key contributors in the case studies for the interview is (consultants, clients, project managers, site managers, site engineers, and supervisors) [7]. A sample of 20 is adequate to conduct the interview 20 respondents were selected (project managers, site engineers, and subcontractors) face-to-face interviews for 45–60 min between that conducted between (December 2017– September 2019) [9, 11]. Convenience sampling was adopted in which the full range of the project teams was surveyed (contractors, clients, developers, and consultants) from the nearest selected construction sites to rank the barriers as well as the strategies of implementing lean construction at selected case studies in Klang Valley. Based on that, 1500 questionnaires overall that were distributed among the nearest construction sites. One of the MRT construction site and two of the residential buildings in Shah Alam were not be considered because they did not agree to contribute in the survey.

Figure 1. Flowchart of the research methodology.

3. Questionnaire with workers to evaluate the implementation of lean construction
There are six lean construction techniques that were considered for the evaluation of LC at the construction sites and it can be described as follows JIT, CM, TQM, H&S, KPI and IBS. On the other hand, BIM will not take into account the evaluation of LC because it is considered part of JIT in contributing into in time materials delivery at the constructionn phase. It was discovered that it reduces
materials wastes in terms of defects and inappropriate processes in infrastructure projects (1.5 tonnes per week) compared with 4 tonnes in building projects. In addition, it was discovered that through conducting the pilot test that most of the respondents (workers) are migrants and have low level of education and are aware of various kinds of software program. There are 40 site foramen and 220 workers were responded to the questionnaires. The results >0.70 for lean construction techniques and construction wastes at both building and infrastructure projects. The average Cronbach’s Alpha coefficient for lean construction techniques and their construction wastes at infrastructure construction projects are 0.781 and 0.811 respectively. Other than that, the average Cronbach’s Alpha coefficient for lean construction techniques and their construction wastes at building construction projects are 0.906 and 0.941 respectively. Therefore, the reliability is accepted.

It can be observed in Table 1 and 2 that for the T-test, the general mean, m is equal to 3.5 for lean construction at infrastructure projects as it is declared in Table 1. The number is higher when compared to that of building construction projects m = 2.11 and such a difference is relatively big and sig is acceptable for all items except the sig value for IBS is 0.906 which >0.05. Whereas, the general mean of construction wastes m is equal to 2.5 which is much lower than in building projects (m=3) and sig is justifiable for all items as illustrated in Table 2. TQM, IBS, KPI and JIT are seen to be highly implemented in infrastructure construction projects as shown by the mean values, m = 4.47, 4.19, 4.47 and 3.93 respectively. On the other hand, IBS has the highest rate of implementation in the buildings construction projects with the mean (m = 3.99). The implementation of CM is much higher as in building projects with values of m=2.52 and m=2.36 respectively. The rate of implementing of H&S is the lowest in building construction projects (m = 1.26). The T-test results confirm the reliability of the questionnaire results in a sense that TQM, KPI, JIT and IBS are regarded as the most as the most implemented techniques of lean construction in building projects while IBS is the most implemented technique in building projects. On the other hand, waiting time, transportation, inventory have low rate of effect in infrastructure projects with mean values 2.34, 2.6 and 2.33 respectively according to high rate of the implementation of JIT (m=3.93). In contrary defects, waiting time and transportation have the highest rate of wastes in building projects with mean 4.3, 3.6 and 3.3 respectively according to low rate of implementation of JIT (m=2.03). The rate of materials wastes in the infrastructure projects (defects with m=2.2 and inappropriate processes with m=2.6) is relatively low based on high rate of implementation TQM with m=4.47 and KPI with 4.17. While the rate of defects and inappropriate processes with m=4.3 and 3.8 respectively are relatively high in the infrastructure projects according to the low rate of implementation TQM and KPI with m=3.05 and 3.14 respectively.

| Table 1. Independent T test for the building and infrastructure projects |
|-----------------------------------|---|---|---|---|
| Lean techniques | Mean | SD | Mean | SD |
| TQM | 3.05 | 0.77 | 4.47 | 0.632 |
| IBS | 3.90 | 0.4513 | 4.19 | 0.715 |
| CM | 2.36 | 0.620 | 2.52 | 0.639 |
| JIT | 2.03 | 0.936 | 3.93 | 0.528 |
| KPI | 3.14 | 0.417 | 4.17 | 0.7687 |
| HS | 1.25 | 0.760 | 1.76 | 0.621 |

| Table 2. Independent T test for the building and infrastructure projects |
|-----------------------------------|---|---|---|---|
| Wastes | Mean | SD | Mean | SD |
| Waiting | 4.04 | 0.557 | 2.33 | 0.5576 |
| Transportation | 3.60 | 0.520 | 2.60 | 0.5203 |
| Inventory | 3.31 | 0.504 | 2.33 | 0.5045 |
4. Interview with project teams to identify the barriers of implementing lean construction

A semi-structured interview is conducted to get the understanding of the project teams. The CIDB representative added that free training used to be provided to the people in the construction industry about several lean construction techniques such as BIM which was mentioned in the text 4 times based on the thematic analysis for coded segment. It was discovered that, competitive tendering is used in many construction projects and critical path Method (CPM) is a common planning method in Klang Valley [16]. Accordingly, it was described 6 times in the text according to table 3 and figure 2 based on coded segments. There are no common agreements among the firms to exchange resources, knowledge, and information in either single project or multiple projects.

The interview results with the project managers and client representatives at infrastructure projects illustrated that (TQM) have a high rate of implementation into their projects according to the clients or the government instructions at both upstream and downstream hence reducing material wastes because it provides services to the public [22]. On the contrary, a quality provision in buildings projects used to be adopted in order to meet the requirements of the municipality Standard and Industrial Research Institute of Malaysia (SIRIM), because it was constructed to meet the marketing purposes. Random visits usually take place from the SIRIM at the building projects to check the quality of their work at the construction phase. H&S has much higher rate of implementation in infrastructure projects compare with building projects because it also meets the public service as well. Based on the interview with some of the site managers, lack of workers’ competency, knowledge, and training as well as cost of adopting H&S are considered as a main obstacle of medium rate of the implementation of TQM and H&S in building projects in Klang Valley [22, 32]. Notably, TQM and H&S barriers were declared 2 times in the text based on thematic analysis for the coded segments as it described in table 3 and figure 2.

It was realized based on interview with the site engineers the IBS used to offer significant time-saving. However, it was realized based on technical point of view the project engineers and site engineers at buildings projects the reasons of lack of using offsite work in their projects due to the time and cost of delivering the prefabricated components to the construction. Also, Lack of staff competent to operate IBS, lack of knowledge and training of the supplier’s workers about their installation at several buildings’ construction sites [23]. IBS barriers were declared 4 times in the text according to table 3 and figure 2 for coded segments. It was discovered that MRT sites location was adopted in precast span-by-span bridge construction at MRT sites to accelerate the construction time.

It was revealed from the interview of the consultants and the client’s representative at infrastructure projects (JIT) which was mentioned has a high rate of implementation compare with building projects. The suppliers were appointed by the client to be managed according to their procurement organization structure with adopting Building Information model (BIM) which show the bill of quantities at construction phase to ensure on-time delivery (JIT) [12, 25, 28, 29]. Notably, all MRT case studies deliver on time except for projects involving Putrajaya MRT Site, Sungai Serdang Putrajaya Line (Elevated station) and KV MRT V209 (Elevated station) which the delay in material due to the influence of the traffic regulations. The interview results with some of the supervisors identified the low rate of implementation (JIT) at selected buildings projects due to conventional procurement structures which prevent frontline workers to communicate and interact with decision-makers in their organizations. It was illustrated 2 times in the text based thematic analysis for coded segment as shown in table 3 and figure 2.

The workers used to write their problems and claims at the construction phase to the project managers who usually resist transferring it to the top management. Accordingly, delay in materials delivery, transportation as well as inventory wastes were extremely high at selected buildings projects.
Due to the most of the workers are migrants; they have a lack of knowledge, training about various kinds of software programs such as BIM and the importance of BIM in delivering the resources on time. It was realized based on the interviews with the site managers at selected buildings projects that Auto Cad was highly used in their major projects compared with building information model software (BIM) due to expensive cost to adopt BIM. Also, lack of knowledge, lack of competent staff to operate BIM, training and client's support for the workers to adopt BIM [8, 9, 13, 16]. Notably, the barriers of BIM were mentioned 5 times in the text due to thematic analysis for segment codes as it declared in table 3 and figure 2. It was revealed from the interview feedbacks of the project managers and consultants, Building Information Model (BIM) was highly adopted at infrastructure to insure on time delivery as well as to participate in reducing materials wastes due to well trained workers. Remarkably, materials waste approximately was estimated around 1.5 tonnes per week in infrastructure projects which was less than material waste in buildings (approximately 4 tonnes in buildings projects). Based on the interview with the site engineers CM has a low rate of implementation in building projects due to competitive tendering. Table 4 describes the barriers and their strategies at the construction sites.

![Figure 2](image)

**Figure 2** Thematic analysis for Coded segments of all documents using Maxqda2018

**Table 3.** The percentages of the repetitively of both parent code and code for all Documents using Maxqda2018
Table 4. The barriers and their possible strategies.

| Barriers                                              | Possible strategies                                         |
|-------------------------------------------------------|------------------------------------------------------------|
| Lack of incentive by the government                   | Provide incentive by the government                       |
| Lack of common goal between various firms             | Develop common goal between various firms at the construction sites |
| Legal and contract issues                             | Legal and contract issues                                  |
| Lack of organization culture                          | Government encourage and force to adopt lean construction. |
| Expensive cost to adopt BIM, IBS, TQM, HS and KPI     | Encourage clients and contractors to pay extra to adopt lean construction. |
| Lack of staff training                                | A requirement for competent staff to operate lean construction. |
| Lack of competent staff to operate BIM, IBS, TQM, HS and KPI |                                                             |
| Lack of staff knowledge on lean construction           | Introduction lean construction into university curriculum |
| Lack of staff training on BIM, IBS, TQM, KPI, HS at the building projects. | Develop staff training at the building projects |
| Lack of organization structure to adopt lean construction | Develop high rate of communication between top management and construction team |
5. Confirmatory Factor Analysis for the barriers and strategies (CFA)

The chi-square for the barriers was \( x^2 = 271.36, \text{df} = 24, \text{P} = 0.000 \). The values of CFI = 0.800, TLI = 0.699, RSMEA = 0.201, and \( x^2 / \text{df} = 11.307 \) as shown in figure 3. While the chi-square for the strategies of lean construction implementation at selected construction projects are \( x^2 = 242.23, \text{df} = 24, \text{P} = 0.000 \). The values of CFI = 0.800, TLI = 0.692, RSMEA = 0.189, and \( x^2 / \text{df} = 10.093 \) as it declared in figure 5. Discriminant validity was improved as follows [21, 17, 27, 31]. In total, five items (three barriers and two strategies items) were removed priori to further analysis (lack of staff training in the building projects, disputes and claims as well as Lack of staff competent about lean construction in the building projects). In addition, a matter of training provision for the staff about lean construction in the building projects, disputes and claims as well as a requirement of staff competent to lean construction at selected building projects). Although the number of deleted items was relatively high compared with the total, their removal did not significantly change the content of the construct as it was conceptualized. The removable factors loadings AVE<0.5 can be described as follows. The value of factor loadings of the barriers were realized to be (0.214, 0.77 and 0.075 respectively) while the factors loading for the strategies were noticed to be 0.207 and -0.004 respectively as it provided in figure 4. As goodness of fit indices were improved, the modified model showed a better fit to the data \( x^2 = 39.684, \text{df} = 6, \text{P} = .000, \text{N} = 271, \text{CFI} = .961, \text{TLI} = .902, \text{RMSEA} = .149, \text{and} 2x/\text{df} = 6.6184 \) as it illustrated in figure 6.

![CFA model for barriers](image)

**Figure 3.** CFA one model for the barriers of adopting lean construction at the selected construction sites.

![CFA model for strategies](image)
Figure 4. CFA one model for the barriers of adopting lean construction at the selected construction sites after items deletion.

![CFA model for barriers](image1)

**Table 1**

| Model  | Chi-square | df | p-value |
|--------|------------|----|---------|
| Final  | 242.330    | 24 | 0.000   |

6. Path analysis

The decision will be supported if the p-value = ***p<0.005, **p<0.01, *P<0.05, however, if p-value > 0.05, the decision will be not accepted. All the barriers and their strategies were adopted in conducting path analysis as it presented in figure 7 indicate that the hypotheses e1, e2, e3, e4, e5, e6, e7, e8, e9,e10, e11, e12, e13, e14, e15, e16, e17, and e18 were accepted, because they were statistically significant with standardized estimates (SE) (β = 0. 013, 0.025, 0.023, 0.027, 0.015, 0.034, 0.021, 0.023, 0.022, 0.009, 0.012, 0.008, 0.019, 0.011, 0.063, 0.035, 0.016, 0.016. 0.025)

Figure 5. CFA one model for the strategies of adopting lean construction at the selected construction projects.

![CFA model for strategies](image2)

**Table 2**

| Model  | Chi-square | df | p-value |
|--------|------------|----|---------|
| Final  | 101.303    | 12 | 0.000   |

Figure 6. CFA model for the strategies of adopting lean construction at the selected construction sites after items deletion.

![CFA model for strategies](image3)
Figure 7. path analysis for the barriers and strategies

7. Conclusions
The model fitness of barriers strategies were critically assessed and the proposed strategies can enhance the effectiveness of implementation lean construction. These strategies are inclusive of providing incentive to reform the organizational approach to adopt lean construction, developing a better communication and integration skills among the top managers and construction team to adopt lean construction at the construction sites, introduce lean construction into universities curriculum and establishing common project goals among the various construction firms. In order to promote lean construction approach in the projects, there is a need to train the staffs to be competent in executing lean construction at the construction sites by providing incentive by the government, solving contract and legal issues pertaining to the impact of executing lean construction, and encouraging clients and contractors to invest in adopting the lean construction techniques. The subject on the strategies of the implementing lean thinking at construction phase in Malaysia is currently important to reduce the construction wastes as well as improve the construction industry. Hence the following research are important. Evaluating the differences between using Last planner Developing appropriate strategy for Last Planner System (LPS) instead of critical path method (CPM) in order to reduce unnecessary cost at the infrastructure projects and insure on time materials delivery with required quality at the building projects.
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