

# LEAN CONSTRUCTION IN LARGE CHINESE CONSTRUCTION FIRMS: A SWOT ANALYSIS

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## ABSTRACT

*In recent years, there has been a growing trend in applying lean principles outside of manufacturing. In the construction context, lean construction has become an established theme since the early 1990s. However, very limited studies are reported about its implementation in Chinese construction industry. This study undertakes a SWOT (strengths, weaknesses, opportunities, and threats) analysis of large Chinese construction firms, evaluating their potential strengths, perceived weaknesses as well as external opportunities and threats associated with the application of lean construction. This study is qualitative in nature. Using interview questions, face-to-face interviews were conducted with 27 Chinese building professionals from large construction firms in China. It highlights several constraints, ranging from lack of understanding of lean construction; to hierarchical organisational structures that discourage empowerment, use of low skilled workers and a high tolerance for an untidy workplace, and others. The opportunities are realised through government's push to upgrade firms' standards; role of jianli, collaboration with foreign construction firms, and promotion of prefabrication. Furthermore, intense competition, highly-demanding clients, rising material prices, and others are some of the foreseen threats to the adoption of lean construction. This study concludes with some suggestions to improve lean construction implementation in China. These include the establishment of a long-term philosophy and organisational culture that would call for leaders to be more pro-active on the jobsites, to understand the work flow, and to encourage foremen to be committed in work plans. It is also important to introduce, educate and reinforce the lean knowledge to the employees at all levels as they are the real implementers of lean construction.*

**Keywords:** Lean Construction, SWOT Analysis, Chinese Construction Firms.

## 1. INTRODUCTION

In line with China's GDP growth, China's construction industry is booming. During a boom period, concerns about poor quality, inefficient operations, low profitability and others are however frequently heard. Reportedly, the performance of many Chinese construction firms is behind that of international counterparts (Xu, *et al.*, 2006). Lean construction, which aims to eliminate wastes from the construction process and to maximise value to clients, is worthwhile to be promoted at this point. It is an innovative construction management approach which is linked closely to the overall life of the project to ensure project success. The purpose of this study is to examine the strengths, weaknesses, opportunities, and threats (SWOT) affecting large Chinese construction firms which are considering implementing lean construction. This paper concludes by providing technical and management viewpoints on the subject.

## 2. FROM LEAN TO LEAN CONSTRUCTION

Simply put, lean construction is an attempt to apply lean production principles to the construction industry. The principles of lean production originated in the Toyota Production System (TPS), which can be traced back a few decades. It then became a popular recipe which revolutionised the manufacturing industry through its management philosophy and practices. Not only manufacturing companies, but also construction firms have begun to embrace lean thinking concepts and strategies (Egan, 1998) and the associated tools (Salem *et al.*, 2006; Höök and Stehn, 2008). Generally, there are two schools of thought which have emerged in association with the development of lean construction. One view has largely relied on Koskela's (2000) work, which makes use of production views (i.e. transformation, flow, and value

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generation) in the construction context and in order to conceptualise lean construction. The other school of thought is led by Ballard (2000) and his colleagues, who developed the Last Planner System<sup>TM</sup> (LPS) to encourage the use of lean principles in a more practical way at the project level. For example, LPS demands planning actions from the frontline foreman or last planner who “pulls” the work, depending on their actual capacity to perform. In addition, there are other works of lean construction based on lean thinking (see Egan, 1998), as originally outlined by Womack *et al.* (1990) and further elaborated in the book *Lean Thinking* (Womack and Jones, 1996), in which the guiding principles of lean thinking are summarised as value, value stream, flow, pull, and perfection.

1. Value: value can be defined by the end customer, where the customer can be considered to include all downstream operations. It can be applied in the construction context by focusing on client’s value. Diekmann *et al.* (2004:92) outlined that customer focus has little to do with the commercial terms of the contract, but to do with the concept that the customer receives value both from the product and the process of construction.
2. Value stream: the value stream involves analysing three types of actions, namely activities creating value, activities creating no value but determined to be unavoidable, and activities creating no value and determined to be avoidable.
3. Flow: flow is the next step to be considered once waste and variations have been eliminated, and the value stream has been streamlined. Flow is the opposite of batch and queue. The goal of flow is to have a product move from concept to customer, without interruption or delay. In construction, Koskela (2000) developed a number of heuristic practices from the flow principle, including reducing variability (standardisation), increasing process transparency (visual control), and others.
4. Pull: pull is closely related to the “pull system” that is another important aspect of Just-in-time. The end user pulls the production, such that a product is only produced to suit the requirements, and thus avoids overproduction and reduces inventory.
5. Perfection: this indicates that there is an end to how much better a process can become through the constant application of lean methodology. This is very similar to the Japanese concept of *kaizen*, which is often interpreted as continuous improvement in the West.

### 3. THE CHINESE CONSTRUCTION INDUSTRY

Much has been written about China’s construction industry and its leading contractors. In contrast to the West currently in recession, China is still undergoing huge infrastructure growth and urbanisation processes, aimed at building a moderately prosperous society. Projections suggest that the Chinese construction market will be worth almost US\$ 2.4 trillion in the next decade, which represents 19.1 per cent of global construction output (Xinhua, 2009). Leading Chinese construction firms are expected to play bigger roles. Although the number of state-owned enterprises (SOEs) has decreased in recent years (Wang *et al.*, 2006), during the transition period, they have continued to maintain their leading positions in the domestic market. These state-owned construction enterprises have fully demonstrated their leading positions by the fact that, despite their smaller numbers and their fewer employees, they achieved 36.5% of the total output of construction value, and contributed 27.5% of the total taxes paid to the central government (National Bureau of Statistics of China, 2009:43). In the international market, according to Reina and Tulacz (2011), Chinese construction firms, including the China Railway Group, China Railway Construction Corp, and China State Construction Engineering Corp continued their reign at the top in the rankings of ENR’s top 225 global contractors in 2010, and also reappeared on the 2011 list. Among these large construction firms, this study focuses on general contractors with the capability of planning, designing, and research and development, because these capabilities are similar to those of a typical manufacturing company, in which lean concepts might be applied.

## 4. SWOT METHODS

### 4.1. SWOT ANALYSIS

SWOT analysis is widely accepted as an important methodology in guiding a company to formulate a competitive business strategy. It aims to identify the company's strengths and weaknesses, as well as the opportunities and threats to it in the external environment. Generally, SWOT analysis is done by benchmarking, that is, comparing one's performance with the best in the industry, or with the best anywhere in business (Johnson and Scholes, 2002). Hence, it is appropriate to use SWOT to analyse the large Chinese construction firms in the lean construction context.

### 4.2. SWOT IN CONSTRUCTION

SWOT has become an increasingly popular analytical tool adopted by researchers in the construction industry. For instance, at the firm level, Lu *et al.* (2009), Zhao and Shen (2008), and Ling *et al.* (2009) used SWOT methods to examine Chinese international construction companies, foreign construction companies in China, and Vietnamese A/E/C firms, respectively. Moreover, there are also reports that used SWOT to investigate individual construction firms. For example, one of the largest Chinese construction firms, China Communications Construction Company (CCCC)'s SWOT analysis was published in Datamonitor's (2011) database. At the project level, Milosevic (2010) undertook a SWOT analysis from both the investor's and the contractor's viewpoint in the planning, contracting, and construction of a project. In the following section, a similar SWOT methodology will be employed to investigate the gaps which exist in large Chinese construction firms, based on lean construction practice. SWOT is an appropriate approach to use, given that lean construction is known to be associated with change, both organisationally and culturally (Egan, 1998; Höök and Stehn, 2008). SWOT analysis can be an effective tool in a timely manner to identify the specific strengths and weaknesses of the firm, which may be relevant to changes taking place, and capable of dealing with them (Johnson and Scholes, 2002). It is also important for Chinese construction firms to reflect upon their strengths and weaknesses when they decide to implement new management initiatives such as lean construction. Furthermore, SWOT is normally employed in qualitative research (see Zhao and Shen; 2008 and Ling *et al.*, 2009). Lu *et al.* (2009) assert that the widespread survey fatigue as well as the requirement of in-depth information is the reason to pursue SWOT research in the construction industry through interviews and/or case studies. This is the case too in lean construction research, where researchers like Senaratne and Wijesiri (2008), Diekmann *et al.* (2004), and others used survey to explore the applicability of lean in construction. This study however evaluates the SWOT factors, which were derived from the interviews to also serve the same purpose.

## 5. RESEARCH METHODS

Interviews with open-ended questions were the main method used in the SWOT analyses in other earlier studies (Zhao and Shen, 2008; Ling *et al.*, 2009). This was also adopted in this study. This is because in the process of probing questions, respondents were required to provide in-depth answers. Given that the interview was semi-structured with open-ended discussions, the interviewees were encouraged to explain in more details if an individual aspect is of particular important. The data collection began with interviewing several Chinese building professional who are known to the researchers. At the end of the interviews, they were asked to recommend others with the same criteria to participate in this study. The recommended candidates were then contacted and interviewed. This method of sampling is known as snowball sampling in qualitative research. When agreement to a meeting was secured, face-to-face interviews were conducted in the interviewees' offices. The interviews were conducted separately. As a result, 27 participants from 16 large Chinese construction firms were contacted to participate in this research between March and April, 2011 in China (see Table 1). A majority of the Chinese building professionals interviewed are from Chinese State-Owned Enterprises (SOEs). The sample consists of 17 site staff (e.g. project managers and engineers) and 10 management staff (managing directors, deputy managers, and vice presidents).

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\* Datamonitor is a leading business information company specializing in industry analysis.

Table 1: Profile of Interviewees and Their Firms

No.	Code	Designation of interviewees	Grade	Ownership
1	A	1 Project Manager	Premier	SOE
2	B	1 Engineer-in-Charge	Premier	SOE
3	C	1 Engineer-in-Charge, 1 Site Engineer, and 1 Commercial Manager	Premier	SOE
4	D	1 Project Manager, 1 Managing Director, and 1 Contract Manager	Premier	SOE
5	E	1 Project Director and 1 Deputy manager	Premier	SOE
6	F	1 Manager, 1 Head of Engineering Management Department, and 1 Project Manager	Premier	SOE
7	G	1 Vice President	Premier	SOE
8	H	1 Manager	One	SOE
9	I	1 Regional Manager	Premier	SOE
10	J	1 Project Manager	One	Private
11	K	1 Vice President	Premier	SOE
12	L	1 Site Engineer	Premier	SOE
13	M	1 Project Manager	Premier	Private
14	N	2 Project Manager and 2 Site Engineers	Premier	Private
15	O	1 Site Engineer and 1 Quality Engineer	Premier	SOE
16	P	1 Project Manager	Premier	SOE

Note: 27 interviewees in total.

## 6. FINDINGS OF THE SWOT ANALYSIS

This section presents the findings of the SWOT analysis, highlighting constraints, potentials, and challenges for implementing lean construction for large Chinese construction firms. Based on the literature review and the structured interviews during the fieldwork in China, the SWOT analysis brings out some of the peculiar features in terms of lean construction practices in China (see Table 2).

Table 2: SWOT Analysis of Large Chinese Construction Firms when Implementing Lean Construction

<b><u>Strengths</u></b> <ul style="list-style-type: none"> <li>• Skilled and capable management teams (i.e. at project level)</li> <li>• Sufficient resources (materials, labour, etc.)</li> <li>• Meeting of client expectations, and firms becoming more customer oriented</li> </ul>	<b><u>Weaknesses</u></b> <ul style="list-style-type: none"> <li>• <i>The short-term oriented firm culture</i></li> <li>• <i>The use of “guanxi” to solve problems</i></li> <li>• Hierarchical organisational structures discourage empowerment</li> <li>• A lack of awareness of lean construction among practitioners</li> <li>• <i>Use of low skilled workers and a high tolerance for an untidy workplace</i></li> </ul>
<b><u>Opportunities</u></b> <ul style="list-style-type: none"> <li>• Government support and calls for change</li> <li>• Role of <i>jianli</i></li> <li>• Collaboration with foreign construction firms</li> <li>• Slow adoption of prefabrication</li> </ul>	<b><u>Threats</u></b> <ul style="list-style-type: none"> <li>• The intense competition among construction firms</li> <li>• The highly-demanding clients</li> <li>• Rising raw material prices</li> <li>• The separation of design and construction</li> <li>• Employee resistance</li> <li>• High turnover</li> </ul>

It is acknowledged that some of the attributes presented in Table 2 are in the first instance more generic in nature for both the construction industry as well as the construction firms. Nevertheless, prior consideration of these generic attributes is vital to better understand why certain lean construction practices are viewed as more significant than others in China. The reasons why some firms have

implemented lean construction practices cannot be isolated from generic happenings in the construction industry to affect the Chinese construction firms.

### **6.1. STRENGTHS**

The term “strength” identifies resources or capabilities of a firm in implementing lean construction practices. The strengths of the large Chinese construction firms in terms of implementing lean construction practice lie in the following areas:

- Skilled and capable management teams (i.e. at project level)
- Sufficient resources (materials, labour, etc.)
- Meeting of client expectations, and firms becoming more customer oriented

In the first place, the large volume of construction undertaken every year in China allows many project teams to understand technology and construction management in a meaningful way. It is worth mentioning that a number of mega-projects have been undertaken by some of the responding firms, including Olympic games venues and Shanghai’s World Expo, to name a few. Through participating in big projects like these, they acquired and enhanced their management skills in planning, quality control, design coordination, and others. With their leaders’ enhanced skills, the likelihood is increased for lean construction to be successfully implemented.

Secondly, all the responding firms highlighted that they have a database of qualified suppliers, subcontractors, and vendors across China, and the number of their working partners is increasing. A multi-sourcing strategy is prevalent, which ensures that the contractors enjoy a sufficient supply of materials or equipment, even if one supplier fails to meet the requirements, so others can then be quickly counted on as a backup. Additionally, in the case of the frontline workforce supply, several of the interviewed firms claimed that endeavours have been made to establish relationships with selected Chinese counties which are well known for labour outsourcing. Training centres were set up in such places, where basic skills are provided before workers are sent to the projects. Besides, they also built their labour sources into three layers, based on the ability and skill sets. In other words, they maintained appropriate level of skilled, semi-skilled, and average-level workers, respectively. Such a flexible labour resource structure can easily accommodate the varying needs of projects.

Lastly, the interview results revealed that client expectations are the top priority of most of the firms interviewed. This is not simply because clients exert power over them, but most firms realised that meeting their requirements is the key to winning future projects from the clients. Given that clients are satisfied with the performance of the responding firms, several of the interviewees pointed out that their firms have therefore become the clients’ long-lasting working partners, and continued to receive business from these clients.

### **6.2. WEAKNESSES**

Despite the above-mentioned strengths, it is easily recognised that some notable weaknesses still exist in large Chinese construction firms concerning the application of lean construction. These include weaknesses in firm culture, organisational elements, and people. Five key weaknesses are particularly evident:

- The short-term orientation of firm culture
- The use of “guanxi” to solve problems
- Hierarchical organisational structures discourage empowerment
- A lack of awareness of lean construction among practitioners
- Use of low skilled workers and a high tolerance for an untidy workplace

To begin with, a core difference between the firms implementing lean and Chinese construction firms rests in the firm culture (i.e. short-term or long-term). It is worth mentioning that the success of lean

construction is dependent on a firm culture that encourages training, teamwork, commitment, and long-term relationships, and that is able to support and sustain the implementation of such concepts. It should be very clear that implementing lean is an on-going journey, which requires the commitment of top management. On the Chinese side, however, things might be quite different. As highlighted by a few interviewees, several so-called new management initiatives including Just In Time (JIT), TQM, PDCA thinking, and others have been proposed and implemented, but ended up as unsuccessful experiences. The biggest problem is the lack of a long-term philosophy. This is again confirmed by the interviewees that short-term thinking somehow prevented construction firms from investing in people through training and skill development. Firms may take the lowest price offer from the suppliers without considering whether to establish long-term relationships with them.

Secondly, using “*guanxi*”, or the Chinese practice of building relationships in problem-solving slows down the implementation of lean construction. In a lean environment, such as in Toyota, the culture encourages the workers to expose problems. They treat problems as opportunities, and so they then decide to halt production and not let the problem pass into the next process (*jidoka*); they examine the root causes and quickly fix it in a way that will prevent repeat occurrences in future (Liker, 2004). In Chinese construction firms, as revealed by several interviewees, the attitude towards problems is usually understood as “*turn big problems into small ones, and small ones into no problems at all*”. In parallel to Paolini et al.’s (2006) observation, project managers may adopt a quick solution rather than to investigate the root causes. In addition, it is more important for the managers to find a person to take responsibility and to be blamed, than to focus on problem-solving countermeasures.

Thirdly, implementing lean construction involves exercising a great deal of empowerment. The adoption of the LPS self-evidently shows that empowerment is the key here, as the contractor needs to allow the frontline workers to make their own commitments as to what they can deliver, and to highlight them in weekly plans with the relevant participants. Yet, in China, traditional organisational structure is still hierarchical, which prevents empowerment to be widely adopted. This is in line with Tang et al.’s (2009) finding where empowerment was poorly rated as a key factor to the successful implementation of TQM in China’s construction industry. This is confirmed by several interviewees that at the project level, project managers do not often empower their frontline workers to undertake planning work, but demand them simply to execute what have been planned from the top.

Furthermore, low awareness of the lean construction concept among practitioners is yet another problem, not only among construction firms, but also among the suppliers, subcontractors, and clients. The main reason is that they may not be aware of the concept and the associated lean tools, but in reality, they are actually practicing some of the underlying principles, just that was known under this different vocabulary in the Chinese context. This therefore requires more efforts to promote lean construction principles in the same language, and to ensure that all the practitioners understand, especially those regarded as belonging to the extended firms (e.g. suppliers, subcontractors) of the main construction firms.

Lastly, lean construction in China faces equally challenging workforce issues, especially in the case of frontline workers who work only temporarily on project sites. As pointed out by most interviewees, unlike the workforce in the developed countries such as USA or Japan, where the workers are very skilled in various trades, the Chinese construction industry is staffed by low-skilled workers who picked up their skills informally, or even commenced their works without any formal training. If a firm’s skill development and training is absent, it is close to impossible for them to effectively identify the non-value-adding activities, and to continuously improve the construction process as their Japanese counterparts can. Instead, they just cut corners and make things easier in their work. Apart from the low skills set, Chinese frontline workers have no problems working in an environment which makes an overall impression to the public of being dirty, messy, and chaotic. This is partly due to their high tolerance for an untidy and disorganised workplace, which is counter to the principles of 5S, a visual control programme that is essential to any lean initiatives, and which is also promoted by lean construction.

### 6.3. OPPORTUNITIES

There are opportunities stemming from the assumption that lean construction practices can be implemented within large Chinese construction firms. These include:

- Government support and calls for change
- Role of *jianli*
- Collaboration with foreign construction firms
- Promotion of prefabrication

Firstly, as noted, a large number of large construction firms are state-owned enterprises (SOEs), which have close association with the central government. The strategies and plans of such firms are overseen by the government. If lean construction is appreciated by top management, the chances are high that it will benefit from government support, so that specified allocations of funds and materials can be received from official government sources. Moreover, the government has put forward an agenda for improving the management level of firms, and has highlighted that the business and project management of Chinese construction firms must be standardised, normalised, and fine-tuned at all stages of the management process (Ministry of Housing and Urban-Rural Development, 2008:40). Such a strong call is an opportunity for construction firms, as the principle of standardisation - also a key element of lean initiatives - is evidently part of the government's agenda.

Secondly, the role of *jianli* – known as supervision firms – is very unique in China that became compulsory in 2001. This aims to ensure that the construction work is carried out according to relevant stipulations, laws, and regulations (Wang et al., 2009). The main duty of *jianli* is to monitor whether a contractor's quality programmes, safety plans, and others are put in place (Wang et al., 2009). Although extensive quality controls are now widely adopted, which is actually counter to the principle of "building in quality" in any lean initiative, *jianli* has somehow gained experience in assisting construction firms to put quality management into practice. This has laid a much-needed foundation for the adoption of lean construction, because it shares some similarities with TQM (i.e. customer focus and continuous improvement). It is worth noting that all the firms interviewed have already implemented quality management programmes, and with that added supervision from *jianli*, they may find it less difficult to adopt lean construction, since their previous experience can serve as a valuable exercise. Moreover, this opens an opportunity for *jianli* to upgrade their skills and to take on a role as a lean champion or an agent for change in assisting construction firms to promote the lean construction concept in the industry.

Thirdly, the increased involvement of international construction firms in China represents another opportunity. As the interview results revealed, three responding firms have had experience in working with their Japanese counterparts, and they were deeply impressed by the authentic Japanese management style, which pays much attention to details, commitments to quality, schedules and other elements. It is said that these international construction firms have brought not only competition, but also management know-how from the developed countries into China.

Furthermore, another opportunity for lean construction in the Chinese context is the growing adoption of prefabrication methods, especially in the housing sector. Prefabrication minimises on-site operations, while promoting more construction works to be pre-constructed in a manufacturing environment, where lean principles can be applied to a larger extent. On the brighter side, both the prefabricated materials and the methods related to them are being heavily promoted in China. One video clip, titled "*30-story building built in 15 days – construction time lapse*", from YouTube in January, 2012, showcases how a 30-storey hotel can be built by a Chinese construction firm in 15 days (Broad Group, 2012). Moreover, it is also comforting to see that several responding firms have strategically invested heavily in prefabrication; one private firm (firm N) states that their focus on prefabrication is reflected in its firm mission, which is set out as "*from construction to manufacturing*". This ambitiously reveals their next move and their commitment to prefabrication technology. In a more practical way, this firm has set up a research centre for prefabrication. But, the threat here is that clients or construction firms may resist change, so much so that conventional methods of construction are still being widely adopted.

#### **6.4. THREATS**

Impediments to the future implementation of lean construction practice in China's construction industry need to be evaluated and analysed. The interviews with Chinese building professionals revealed several common threats in implementing lean construction practices, including:

- The intense competition among construction firms
- The highly-demanding clients
- Rising raw material prices
- The separation of design and construction
- Employee resistance
- High turnover

Firstly, a majority of the interviewees pointed out that fierce competition is one potential threat. Several interviewees from private firms especially acknowledged that strong competition from large SOEs and others have eroded their market share and therefore forced them to seek out the emerging market in the western region of China. Competition indirectly threatens large construction firms in adopting lean construction, since their revenues and profits are affected. In order to win the work, it is common to see some bidders deliberately lowering their costs by compromising on quality, and increasing revenue later through claims or by subcontracting some portions of the project to unqualified subcontractors at a price that is much lower than the contracted price (Wang, *et al.*, 2009). The greatest threat comes from their working partners (e.g. subcontractors) who are short-sighted in the corporate sense. It is particularly true that some subcontractors may not be competent for the works and, worse, may have different philosophies of conducting businesses, including less commitment to quality, schedule, and the customer. This will quickly hinder the implementation of lean construction.

Secondly, almost all the firms interviewed pointed out that highly demanding clients have become another serious threat too. The root problem is that the binding force of contracts in China is so weak that clients can exert their power intentionally. It is not uncommon to see clients changing the contract even when everything was already "agreed" earlier. For example, clients drastically reducing the project delivery time is a common occurrence in China's construction industry. Even large construction firms can do nothing but to accept this practice, because they are afraid of jeopardising their relationships with the client. In order to deliver the project on time under such time pressure, the "locked milestone" strategy is widely adopted for specific portions of the project. This gives subcontractors and specialised trades locked-in deliverable dates in which the given tasks or packages must be completed. If these are not completed, large penalties would be imposed. In such cases, some interviewees pointed out that it is not possible to "pull" the work from the workers, and the majority agreed that their commitments at this point are unreliable. Hence, a top-down approach is preferable, and the plan is generated from the project team in the absence of any concerns from the frontline workers and foremen.

Thirdly, the interviewees also pointed out that the unstable prices of raw materials, including steel, cement, and others have been a cause of concern in more recent years. Similar to the stock market, the prices of some of these materials fluctuate even on a daily basis. Even so-called long-term partner suppliers or vendors will demand price increases on materials, in order not to lose money. Because of this, construction firms are largely discouraged from adopting the "pull" concept. Rather, in order to minimise the risk of price increases, most responding firms preferred to stockpile materials, and this explains the large piles of materials stocked on the site.

Fourthly, several interviewees also pointed out that less in-house design, or limited design and build process is another potential threat that needs to be addressed. An absence of design and build is generally regarded as reflective of a slow adoption of lean construction (Johansen and Walter, 2007). Under design-bid-build, the contractor is generally appointed at a very much later stage where it has much less opportunity to influence the design. This eventually leads to more communication and coordination being



required in the construction stage between the Chinese design institutes (CDI) and the contractor to verify the design specifications, and to evaluate these in greater details.

The last two threats identified are employee resistance and high turnover. The success of lean construction, like any other lean initiatives, requires a culture change within the firm. For example, lean construction may change the way the current planning process is conducted at the project level. It may also bring about more workloads if the concept of multi-skilling is introduced, or in order to minimise the non-value-adding activities by employing prefabrication techniques. One manager from firm B mentioned that,

*“In the case of prefabrication techniques, the client should be on board and that is the key. In addition, given that our trades are so similar with what they are currently doing at the site, it might need a long time for them to accept the change and take the prefabrication method.”*

The later concern involves the turnover of employees, including frontline workers. The interviewees revealed that large Chinese construction firms, especially SOEs are perfect workplaces for fresh graduates to begin their career, and after a while they typically use it as a stepping stone to seek a more respected position elsewhere. Moreover, the turnover at the site level is more frequent, as frontline workers are tempted by higher wages, even if this is a minor increase. This creates serious threats to the continuity of implementing lean construction since training is required for employees and workers. Several interviewees highlighted that their projects have suffered from productivity loss as a result of this high employee turnover. In addition, when workers leave, they take away the value of the firm's training.

## 7. DISCUSSION

The SWOT analysis highlights an overall picture of the positive aspects of implementing lean construction, as well as the key challenges that may hamper its implementation in the Chinese construction industry. The rule of thumb is to take advantage of the strengths that large Chinese construction firms currently possess, eliminate the weaknesses as much as possible, seize the opportunities, and counter the potential threats. At first glance, some of the SWOT results appear to be generic, to even overlap with other research. However these do reflect the practices of large Chinese construction firms that are relevant to lean construction. “Sufficient resources” identified in the “strengths” is one such example. Hence, “sufficient resources” become one of the strengths of large Chinese construction firms since endeavors have been made to enhance their database of qualified suppliers, vendors, and subcontractors, so that a sustained supply of cheap materials, manpower and other resources can be assured. By the same token, it should be noted that the pull system is not able to work effectively when there are inconsistencies in material supply. Despite the strengths highlighted, there are clearly some tough decisions for large Chinese construction firms to make before they can truly embark on their lean construction journey. Since the negative aspects (mainly weaknesses and threats) have been addressed, what follows is a call for strategies which should facilitate the implementation of lean construction in China. In the case of weaknesses, these have generally been categorised into three areas: firm culture, organisational elements, and people. For instance, the establishment of a long-term philosophy depends on management's commitments and actions that consistently reinforce the objectives deriving from it. These objectives must be elevated to the same level of priority as the financial and profits oriented objectives which enterprises hold today. Strategies here may call for leaders' frequent *genchi genbutsu* or the Japanese way of “go and see for yourself” to visit site at the project level, to ensure that objectives are well understood and executed. Moreover, it is very challenging to ask managers to empower their workforce and subcontractors to make daily plans under time pressure from clients. This is not simply because of management leadership style, but because the culture is such that the project managers do not want to be blamed for the empowerment that results in project delays. If this is the case, it again requires project managers and their teams to be more proactive on the site, to understand the work flow, labour productivity, among other things, to monitor more diligently how the project progresses, and to ensure that tasks only commence on the condition that all necessary inputs are already in place. Lastly, in response to the low skill levels of workers, although training may sound cliché at this point, for the large number of the workers who are unskilled, the construction firms must introduce, educate, and reinforce basic lean knowledge to their employees and workers, starting from waste elimination, or build-in quality,

or cleanliness practices (5S). The *jianli* can also be utilised to assist in facilitating the awareness of lean, rather than simply focusing on quality control and health and safety issues. The important notion here is that the implementation of lean construction comes from the people – the employees who should be aware of implementation, should care about it, and should be committed to it. Moreover, as employees' skills improve, so should their pay, especially in the case of frontline workers. This is because they are most concerned about their daily paycheck. If this is satisfactory to them, it will become an effective way to retain the workforce, and efficiency improvements can be expected.

Fundamentally, the threats existing in China might be more complicated than elsewhere, and therefore may require extra efforts to handle them. Implementing lean construction can easily be a long-term endeavour, since several factors pertain to the industry's inherent problems and structural issues. It requires government support and promotion, as well as efforts on the part of the firm. For example, in the case of the separation of design and construction, this has in fact drawn serious attention from the government. Earlier in 2007, an investigation by a taskforce from the Ministry of Housing and Urban-Rural Development (MOHURD, 2008) has pointed out the low levels of adoption of design and build (DB) in China's construction industry. Meanwhile, it is necessary for contractors to develop their in-house design capacity, and to call for the early participation of the relevant stakeholders. Moreover, to successfully implement the lean construction initiative, it is necessary that employees support it and not resist it. A stable workforce is also an essential factor. Chinese construction firms need to re-evaluate their human resource management strategies, and to find ways to minimise resistance and retain their workforce.

## 8. CONCLUSIONS

Despite the significant achievements of large Chinese construction firms in recent years, in the current economic recession, it is important for them to adopt advanced management practices, such as lean construction, in order to improve project performance. Understanding the strengths, weaknesses, opportunities, and threats of large Chinese construction firms helps them to look at the prerequisites for the implementation of lean construction. It is worth mentioning that although the interviews were conducted separately, the overall analysis must of necessity be conducted collectively to provide consolidated findings at the industry level. Hence, the SWOT analysis highlights the overall responses from the large Chinese construction firms. Nonetheless, in the case of assessing the importance and/or urgency of issues in each of the SWOT components, different results may technically be possible for each and every one of the leading Chinese construction firms. Despite all the weaknesses and threats highlighted above, the SWOT results are not intended to discourage the practitioner from implementing lean construction practice until all prerequisites have been met and the time is ripe. In contrast, it is still strongly recommended that large Chinese construction firms consider giving immediate attention to lean construction practice, with efforts targeted at working on the weaknesses identified. Lean construction is not a destination; it is a journey.

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