
A FEASIBILITY STUDY OF IMPLEMENTING MATERIAL MANAGEMENT IN CONSTRUCTION: UNITED KINGDOM AND HONG KONG EMPIRICAL STUDIES

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ABSTRACT

Construction organizations have a common practice to purchase and to deliver required materials to construction sites about one month before activities start. This leads to uneconomical inventory on site and contractors' warehouses. This paper investigates the feasibility in implementing material management in construction. United Kingdom and Hong Kong are selected for the investigation as one has a long implementation period and another one is just implementing material management as noted by interviewed contractors. Questionnaires and structured interviews are conducted. It is found that United Kingdom construction industry benefits are more significant than that in Hong Kong. This can stimulate interests in implementing material management in Hong Kong. Respondents from Hong Kong claimed that their companies will be willing to implement material management where practicable. This study can also help countries currently implementing material management. From that, waste generation can be reduced and a green construction environment can be achieved. Recommendations to improve the implementation are also discussed.

KEYWORDS

feasibility, material management, construction, United Kingdom, Hong Kong

INTRODUCTION

Material cost constitutes about 60% of the total cost of construction [1, 2]. In the common practices, construction organizations are likely to order required materials about one month before activities start and store it on-site. This building material inventory practice increases cost of procurement, storage, and insurance. This shows ineffective management skills in companies' material management [3].

A material management system is necessary for every construction organization. An effective material management system can help achieve the following benefits: i) reduce cycle time; ii) increase productivity; iii) lower cost; iv) perform accurate material information; and v) streamline communication [4]. A study from Bell and Wooten examined that a material management system can gain an improvement of about 12% in productivity [5]. Better productivity can also help reduce construction costs, and thus improve profitability and competitiveness for the contractor.

This paper examines the feasibility of implementing material management in the construction industry. The focus of this paper is:

- To investigate current practices in implementing material management in the construction industry;
- To examine the applicability of material management by empirical studies in the Hong Kong and United Kingdom construction industries; and
- To recommend measures in effectively and efficiently implementing material management.

CRITICAL ELEMENTS OF MATERIAL MANAGEMENT

Material management techniques in other industries are now based on the concept of just-in-time. In this approach the right material is delivered to site, at the right quality, to the right place, and at the right time to enable construction work to proceed according to

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program and to the necessary quality standards [3, 6, 7]. Material management can also help achieve continuous waste elimination and consistent improvement in productivity [8, 9]. Material management is a key part of production and service at each project activity from vendor to customer [10]. Material management based on just-in-time goals are to: i) seek a produce-to-order production schedule; ii) seek unitary production; iii) eliminate waste; iv) continuously produce product flow improvement; v) produce product quality perfection; vi) respect people; vii) eliminate contingencies; and viii) maintain long-term emphasis [10, 11]. Successful implementation of material management is dependent on supplier flexibility, user stability, total quality management, employee commitment and teamwork.

Fourteen critical elements of material management need to be considered for effective implementation [3, 12-14]:

- *A small-scale pilot project* is the best way to gain experience and guidance for a company-wide material management implementation. Implementing a new system requires many changes within an organizational structure.
- *A pull system* operates in a production environment where customer orders drive the production effort. A customer placing an order acts to pull the inventory through and out of production operations, while a *push system* decides what is to be produced based on the forecasted demand.
- *Reduction in machine set-up time* is required to accomplish an ideal lot size of one unit. Machines should frequently be set up for producing small lot sizes. Simplified and standardized set-up procedures should also be developed.
- *Group technology* is a technique of grouping machines with similar tasks in order to perform those tasks without moving individual work-in-progress inventories among departments. This can eliminate operator idle time, promote production in smaller lot sizes, and can increase operator responsibility for product quality. It can significantly reduce lead time, set-up time, cycle time, inventory and manufacturing waste.
- *Training* is necessary when workers are encouraged to operate multiple machines. This enables workers to understand the procedures in implementing material management. Job enrichment and quality of products can be enhanced.
- *Preventive maintenance* is required to provide a smooth production flow in implementing frequent preventive maintenance and minor repairs.
- *Sole sourcing* can help buyers develop trust with suppliers to deliver high quality raw materials at the desired frequency.
- *Quality certificate from vendors* allows the quality of raw materials to be assured. This impacts the quality of products before arriving at buyers.
- *Commitment* is crucial for success in implementing material management. Employee suggestions should be encouraged and rewarded through formal and informal lines of communication. Top management should be willing to devote resources that are necessary to support this program.
- *Quality circle* is a group of employees with different levels of management to discuss quality problems and to improve products' quality.
- *Daily material requirement plans* should be used instead of a master schedule. This can adjust the product mix after each production run to suit demand.
- *Communication* is important with all levels of employees for any change within an organization. Such communication can allay fears, misunderstandings and lack of confidence.
- *Flexibility* is necessary to provide capabilities at producing varieties of products to suit customer needs and requirements.
- *Continuous improvement* involves changes in attitudes toward overall effectiveness within an organization for improving its operations, products and customer satisfaction.

RESEARCH METHODOLOGY

To examine the feasibility at implementing material management in the construction industry, a questionnaire survey was conducted. United Kingdom and Hong Kong were selected to conduct empirical studies. As noted by interviewed contractors, the United Kingdom has been attempting to adopt just-in-time material management for a number of years. On the other hand, Hong Kong is only just at the

beginning of adopting this type of materials management approach. It was thought that a comparison between these two markets would highlight some interesting issues. The survey was randomly sent to two hundred and fifty construction organizations from United Kingdom and Hong Kong contractor directories. Sixty-eight had been received with a response rate of about 27.2%. However, two of the questionnaires were not properly completed and only sixty-six questionnaires were valid, including thirty from United Kingdom and thirty-six from Hong Kong.

After receiving questionnaire responses, individual structured interviews were arranged with eight respondents, selected from United Kingdom and Hong Kong: two from United Kingdom large-sized construction organizations, two from United Kingdom small-sized construction organizations, two from Hong Kong large-sized construction organizations, and two from Hong Kong small-sized construction organizations. The interviews were intended for gathering further comments, elaboration and interpretation on the results obtained from the questionnaire.

RESULTS AND DISCUSSIONS

From the survey results shown in Table 1, about 92% and 91% of the Hong Kong and United Kingdom respondents respectively had more than 25% of material cost from the total construction cost. This highlighted that material cost incorporated a high proportion in the total construction cost. An interviewee from a large-size United Kingdom company explained that his company adopted direct purchase management to reduce unnecessary material cost; this brings about 10% reduction of the material cost.

In investigating the attitude of workers in implementing a new system, the majority of the respondents are against implementing a new system in Hong Kong and United Kingdom with about 50% and 60% of the respondents respectively. An interview with a large-sized United Kingdom construction organization explained that most of the workers are not clear about their actual benefits gained after the implementation of a new system. The interviewee recommended providing in-house seminars to train and to explain the benefits that would be

gained after implementation. This can help build a supportive culture within workers to help implement the new system.

Respondents from Hong Kong and United Kingdom had different understandings of material management. About 89% of the Hong Kong respondents did not have a clear understanding of material management. However, about 73% of the United Kingdom respondents fully understood material management and are implementing it into their projects. In the discussions with the interviewees, material management has been in use on the United Kingdom for at least ten years, whereas it has only been used in Hong Kong for less than five years. This may explain, the different understanding of material management between the United Kingdom and Hong Kong. The interviewees suggested that industry associations and universities should provide seminars and conferences to show benefits from the implementation of material management.

Limited space is always a major problem on construction sites. Seven major elements were examined for their role in creating space difficulties in the survey including: i) material storage; ii) parking; iii) plant and equipment; iv) wagon; v) welfare; vi) manager office; and vii) delivery on time. From the survey results, delivery on time was found as the most difficult item in providing sufficient space for both Hong Kong and United Kingdom with about 30% and 27% of the respondents respectively. In an interview with a large-sized contractor, the interviewee stated that that implementation of material management could effectively solve problems of insufficient space, particularly for delivery on time. Material management can reduce excess on-site stocks and numbers of deliveries, which can also reduce material waste due to damage or variation designs.

In implementing material management, several benefits can be achieved including: i) saving inventory; ii) reducing damage in storage; iii) reducing double handling; iv) reducing obstruction on site; v) enhancing labour performance; and vi) others. From the survey results, reduced double handling and reduced obstruction around site were found as the major benefits gained in implementing material management in Hong Kong and the United Kingdom. An interviewed Hong Kong contractor explained that a congested construction site causes

TABLE 1. Summary of survey results

	Percentage	
	Hong Kong	United Kingdom
Proportion of material cost		
Below 10%	1%	1%
10% to 25%	7%	8%
25% to 40%	45%	15%
40% to 55%	29%	28%
More than 55%	18%	48%
Total	100%	100%
Attitude of worker in implementing a new system		
Supportive	11%	13%
Neutral	39%	27%
Resistance to change	50%	60%
Total	100%	100%
Understanding of material management		
Fully understand but did not implement it	11%	73%
Heard about it but not fully understand	61%	20%
Never heard it before	28%	7%
Total	100%	100%
Difficulties in providing sufficient space for		
Material storage	22%	19%
Parking	14%	11%
Plant and equipment	18%	18%
Wagon	9%	11%
Welfare	5%	7%
Manager office	2%	7%
Delivery on time	30%	27%
Total	100%	100%
Benefits in implementing material management		
Save inventory	16%	13%
Reduce damage in storage	20%	17%
Reduce double handling	28%	20%
Reduce obstruction around site	16%	24%
Enhance labour performance	14%	17%
Other	6%	9%
Total	100%	100%
Providing space for material storage		
Very important	89%	47%
Important	11%	53%
Not important	0%	0%
Total	100%	100%
Proper storage space in affecting on-site construction activities		
Very important	28%	93%
Important	72%	7%
Not important	0%	0%
Total	100%	100%
Material management helps delivering materials on a right time		
Extremely significant	28%	20%
Significant	72%	60%
Fairly significant	0%	20%
Least significant	0%	0%
Total	100%	100%

TABLE 1. (continued)

	Percentage	
	Hong Kong	United Kingdom
Material management in providing low inventory level		
Extremely significant	17%	33%
Significant	55%	54%
Fairly significant	28%	13%
Least significant	0%	0%
Total	100%	100%
Material management in providing cost saving for storage area		
Extremely significant	72%	53%
Significant	28%	47%
Fairly significant	0%	0%
Least significant	0%	0%
Total	100%	100%
Affecting working progress by insufficient material		
Extremely significant	83%	67%
Significant	17%	33%
Fairly significant	0%	0%
Least significant	0%	0%
Total	100%	100%
Material management for congested site condition		
Extremely effective	56%	80%
Effective	44%	20%
Fairly effective	0%	0%
Least effective	0%	0%
Total	100%	100%
Attitude in changing the existing congestion problem		
Supportive	56%	47%
Neutral	22%	33%
Unsupportive	22%	20%
Total	100%	100%
Maintaining long-term relationship by delivering on time with suppliers		
Extremely important	67%	80%
Important	33%	20%
Fairly Important	0%	0%
Not Important	0%	0%
Total	100%	100%
Availability in frequently delivering by supplier		
Extremely important	33%	67%
Important	67%	33%
Fairly Important	0%	0%
Not Important	0%	0%
Total	100%	100%
Providing education and training when implementing a new system		
Extremely important	22%	60%
Important	78%	20%
Fairly Important	0%	20%
Not Important	0%	0%
Total	100%	100%
Implementation of material management		
Implemented or implementing	0%	13%
Planning to implement	78%	27%
Not planning	22%	47%
Others	0%	13%
Total	100%	100%

serious problems in double handling of materials. He also highlighted that material management implementation would encourage delivery of materials at the right time, which can effectively minimize the process of double handling and shorten the construction period.

About 89% and 47% of the respondents from Hong Kong and the United Kingdom respectively considered that providing sufficient space for material storage is very important for construction projects. During the interview discussions, it was stated that congested site conditions is one of the major problems in the Hong Kong construction industry. This causes difficulties in providing sufficient space for storing different types of materials, which also induces material damage and waste.

Although the Hong Kong respondents highlighted that sufficient space for material storage is very important, they were not overly concerned about improper storage space effecting on-site construction activities. However, about 93% of the United Kingdom respondents considered proper storage space as very important for on-site construction activities. In an interview with a large-size United Kingdom contractor, it was noted that implementing material management can be done in initial project planning. This will help achieve a smooth project and avoid project delays.

The survey results showed that material management can help with delivering materials at the right time. One hundred percent of the responses from Hong Kong considered this link significant, while 80% of respondents from the United Kingdom considered the link significant. In an interview with a Hong Kong contractor, it was explained that most of the Hong Kong contractors accept innovative technologies and methodologies in improving on-site situations. Limited site space is one of the major problems on the Hong Kong construction sites. Hong Kong contractors would like to use methods to improve the current situation. They believed that it can bring positive results when implementing material management.

Concerning low inventory levels and cost saving for storage area in implementing material management, the survey received similar responses from the Hong Kong and United Kingdom respondents. In the interview discussions, interviewees agreed that

delivery at the right time by implementing material management can achieve high flexibility for material storage areas, which can directly bring cost savings in reducing material damages by weather and avoiding variations in the use of materials. An interviewed small-sized contractor explained that cost saving is not the major concern in considering the implementation of material management; solving problems of limited on-site space is the major concern in the Hong Kong construction environment.

From the survey, all respondents from Hong Kong and United Kingdom are concerned that insufficient material is significantly affecting work progress. One of the interviewees from a small-sized Hong Kong company pointed out that it is necessary to deliver required materials to the site at least two weeks before the actual activities start in order to ensure the project progresses adequately. However, this can cause congested site environment.

One of the objectives in material management is to deliver materials at the right time. The respondents from the survey supported on it. During the interview discussions, a project manager pointed out that congested site conditions bring difficulties in implementing environmental management, for examples, material sorting, reusing and recycling of materials, and using environment-friendly facilities and equipments.

About half of the respondents are supportive in changing the existing congestion problems with about 56% and 47% from the Hong Kong and United Kingdom respondents respectively. Congestion on site can obstruct work and affect work progress. An interviewed Hong Kong contractor explained that congestion is a practical characteristic in the construction industry. It is nearly impossible for contractors to control it. Contractors can only plan a better schedule for the construction process in order to efficiently run a project, minimize unnecessary processes, and remove excess stock.

About 80% of the respondents from United Kingdom considered maintaining long-term relationship with suppliers as extremely important to delivering on time. However, only 67% of the respondents from Hong Kong felt this way. Probing further, about 67% of the respondents from the United Kingdom considered supplier delivery frequency as extremely important, whereas only 33%

of the respondents from Hong Kong felt this way. The interview with one of the United Kingdom contractors highlighted the importance of delivering the required material on time; otherwise, progress and overall project duration can be affected. If suppliers can supply material on time, contractors like to continue ordering materials from them.

The United Kingdom contractors are more positive in implementing a new system than in Hong Kong. About 60% of the United Kingdom respondents considered providing education and training in implementing a new system extremely important; while only 22% of the respondents from Hong Kong felt the same way. From the interview discussions, one of the interviewees suggested that Hong Kong contractors are not eager to implement new and innovative systems in improving the company performance, as they cannot see the immediate benefits after implementation.

About 13% of the respondents in United Kingdom already implemented or are implementing material management while none of the Hong Kong respondents were implementing it. Material management has been adopted from Japan in Western Europe much earlier than in Hong Kong. Within the United Kingdom construction culture, material management has been well developed. However, material management is still a new method for the Hong Kong construction industry. Contractors are planning to execute material management to improve productivity in the construction industry.

After the analysis and interpretation of the questionnaire results, United Kingdom contractors regard more favourably all the essential elements except *'Attitude of workers in implementing a new system'* than Hong Kong contractors. If the provision of education and training can change the *'resistance to change'* attitude of workers, it is probable that the problems and difficulties in implementation of material management can be solved.

RECOMMENDATIONS

It is clear that the existing implementation of material management is not fully developed in the construction industry. Based on the interview discussions, the following recommendations are suggested to improve the development of material management in construction around the world:

- To deliver training programs to on-site workers and managers in the implementation of material management;
- To provide seminars explaining the benefits from the implementation;
- To enforce legislation by government for the initial implementation; and
- To provide incentives for contractors who finished projects on-time by the use of material management.

CONCLUSION

This paper investigated the feasibility in implementing material management in construction. United Kingdom and Hong Kong were selected for the investigation as the United Kingdom has a long period of implementation of material management and Hong Kong is just starting. Questionnaire survey and structured interviews were conducted. It was found that the United Kingdom respondents understand the benefits gained from the implementation of material management more than that those from Hong Kong. Providing a positive attitude, creating long-term relationships with suppliers, delivering frequently by suppliers, and providing education and training seem to have been key to the United Kingdom's adoption of material management. These are certainly differences to the Hong Kong experience so far. Importantly, for Hong Kong, adopting these characteristics may speed the development of material management in Hong Kong. This study can also help countries currently implementing material management. From that, waste generation can be reduced and a green construction environment can be achieved. Recommendations to improve the existing implementation were also discussed.

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