IMPROVING MATERIALS MANAGEMENT PRACTICES ON FAST-TRACK CONSTRUCTION PROJECTS

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A key factor adversely affecting project performance is the improper handling and management of materials on site. Materials management is particularly problematic on fast-track projects where design and procurement decisions are made concurrently with construction activities. This paper reports on the early stages of research which is developing a new ICT-based approach to managing materials on fast-track schemes. As a precursor to this work, the paper reviews current material management practices on fast-track construction projects and explores the ICT tools and techniques currently being employed on such projects. The findings reveal the need for more sophisticated materials management solutions which accord with the needs of fast-track schemes. The paper concludes by presenting a research framework for developing such a system in the future.

Keywords: fast track projects, concurrent engineering, material management, ICT.

INTRODUCTION

'In an era of high-speed down-loads and instant gratification, it's not surprising that companies want their new buildings finished yesterday' (Kaelbe 2001). Many clients aim to finish their construction project as fast as possible in order to gain a faster return on their investment. Fast-track construction involves the reduction of time from the normal duration of project activities and should not allow delays during the process. Many factors can cause delays on such projects. Ogunlana (1996) suggested that the main reasons for project delays on housing projects in Thailand were incomplete drawings, material management problems, deficiencies in organisation, shortages of construction materials, and inefficiencies in site workers. Dey (2000) also suggested that delays in materials supply was a major cause of time overrun. Thus, it would seem that materials delays are a major cause of delays in projects.

In order to make materials management on site effective for fast-track projects there needs to be an integrated material handling process from the design stage to the usage of materials. This paper reviews current materials management practices on fast-track projects and explores the Information and Communications Technology (ICT) tools and techniques implemented. It starts with a review of current materials management practices in construction projects and the common problems. The ways in which materials are managed on fast-track projects are discussed and areas for improvement

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are highlighted. The paper concludes with a discussion of the findings showing the outline features of a research framework for more sophisticated materials management solutions which accord with the needs of fast-track schemes.

MATERIALS MANAGEMENT IN CONSTRUCTION PROJECTS

Materials management is an important function in order to improve productivity in construction projects. Bell and Stukhart (1986) defined materials management functions which include planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution. The result of improper handling and managing materials on site during a construction process will influence the total project cost, time and the quality (Che Wan Putra et al. 1999). Proverbs et al. (1999) stated that costs for materials handling may range from 30-80% of total construction costs. In addition, Dey (2001) indicates that almost 60% of the total working capital of any industrial organisation consists of materials costs. Therefore, there is a need for efficient materials management in order to control productivity and cost in construction projects.

There are many issues which contribute to poor materials management in construction projects. Zakeri et al. (1996) suggested that waste, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect materials management. Furthermore, Dey (2001) noted that the common issues related to materials management are as follows:

- Receiving materials before they are required, causing more inventory cost and chances of deterioration in quality;
- Not receiving materials at the time of requirement, causing loss of productivity;
- Incorrect materials takeoff from drawing and design documents;
- Subsequent design changes;
- Damage/loss of items;
- Selection of type of contract for specific materials procurement;
- Vendor evaluation criteria;
- Piling up of inventory and controlling of the same; and
- Management of surplus materials.

Planning

Stukhart (1995) stated that the needs an appropriate materials planning to be done concurrently with engineering, construction, and other project plans. He also mentioned that material planning would provide guides to all the subsequent activities and that this could have a great impact on the project plan. The materials planning process covers the set up and maintenance of records and determines the target inventory levels, and delivery frequency (Payne et al. 1996). Planning of access and routing of materials within a construction site has an important implication for the development of an effective materials management strategy (Faniran et al. 1998)

particularly in terms of increasing productivity and profit, and facilitating the timely completion of construction projects (Wong and Norman 1997).

Procurement

The term procurement encompasses a wide range of activities that includes purchasing of equipment, materials, labour and services required for construction and implementation of a project (Barrie and Paulson 1992). The objective of procurement in materials management is to provide the materials in the right time, place, quality and an agreed budget. Payne et al. (1996) stated that procurement is about organising the purchasing and issue delivery schedules to suppliers and following-up to make sure that suppliers deliver on time. A failure in the purchasing process or in overseeing and organizing the buying functions listed by Canter (1993) could result in:

- Over-ordering of materials (wastage problems);
- Over-payments for materials (inadequate administration procedures);
- Loss of benefits (lack of skilled negotiating procedures);
- Lack of knowledge (when and where the best service/source might be available at any particular time).

Handling

Tompkins and White (1984) defined effective material handling as using the right method, amount, material, place, time, sequence, position, condition, and cost. This involves handling, storing, and controlling of the construction materials. Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and engage critical decisions. Due to the frequency of handling materials there are quality considerations when designing a materials handling system. Material handling equipment selection is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility (Chan 2002).

Material storage on site requires close attention in order to avoid waste, loss and any damage of materials which would affect the operation of the construction project. Problems always arise during materials supply because of improper storage and protection facilities (Canter 1993). Previous studies have identified that building materials often require a large storage capacity which is rarely available on site (Agapiou et al. 1998). However, Stukhart (1995) suggested that there are a few considerations to take in the planning of the storage space such as timing of the initial buy, and historical information and experience. Materials management on site should seek to reduce loss of profit due to theft, damage and wastage, as well as running out of stock. It is also important to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, are obtained at a reasonable cost, and are available when needed (Bell and Stukhart 1986).

Stock and Waste Control

The European Construction Institute's Total Productivity Management report (ECI 1994) states that *"materials delivery to site is a critical, productivity-related aspect which demands the introduction of a carefully developed system of monitoring and control as early as possible"*. The bulk of construction materials delivery requires proper management of stock control. Stock control is a technique devised to cover and ensure all items are available when required and can include raw materials, processed materials, components for assembly, consumable stores, general stores, maintenance materials and spares, work in progress and finished products (Prabu and Baker 1986).

Construction activities can generate an enormous amount of waste (Teo and Loosemore 2001) and materials waste has been recognised as a major problem in the construction industry (Formoso et al. 2002). The cause of waste in construction projects indicates that it can arise at any stage of the construction process from inception, right through to design, construction and operation of the built facility (Faniran and Caban 1998). Waste can be reduced through the careful consideration of minimisation strategies and through better reuse of materials in both the design and construction phases (Dainty and Brooke 2004).

Logistics

Logistics is a concept that emphasises movement and it may encompass planning, implementing, and controlling the flow and storage of all goods from raw materials to the finished product to meet customer requirements. Construction projects require active movement of materials from the suppliers to the production areas in both the factory and the worksite (Pheng and Chuan 2001). Previous research suggested that the routing of materials is one of the main points which affects cost and time during construction projects (Varghese and O'Connor 1995). Hence, these factors should be taken into consideration during the logistics process for effective materials management and should include:

- optimum forecasting for materials movement (Mahdjoubi and Yang 2001);
- planning of access and routing of materials within a construction site

  (Faniran et al. 1998).

FAST-TRACK CONSTRUCTION PROJECTS

The term 'fast-track' is used to describe something that takes place more quickly than normal (Eastham 2002). Williams (1995) suggested that fast-track projects are those completed in less than 70% of the traditional project duration. Fast-track projects are closely related to the time or duration which needs to be shortened by overlapping the activities or using concurrent (simultaneous) engineering approaches. Many articles support the fact that overlapping or running the activities of construction processes simultaneously is a definition of fast-track construction (Laiserin 2002, Knetch 2002, Kerzner 1995 and Burgmann 1982).

Faster construction can be achieved through the preparation of appropriate designs and the selection of the right methods and material. For instance, the fast-track design/build delivery method can significantly reduce total project time-up to 50%, depending on the job (Waltz & Montgomery 2003). It achieves this by compressing the project schedule by running design and construction phases simultaneously (Knecht 2002).

Burgmann (1982) suggested that, strong discipline and monitoring of all activities, particularly with regard to programme and costs, are important in the management of fast-track projects. Kwakye (1997) supports this view, suggesting that the management of fast-track construction should meet the following requirements:

- The integration of design and production phases of construction projects.
- The involvement of building contractors in both the design and production phases.
- Work packaging - the arrangement that breaks down works into trades or skills, or to a group of closely related trades or skills.
- Overlapping of work packages to enable production of sections of the construction project to proceed while the design for other sections is being considered or progressed.
- The employment of the expertise of works contractors and the recognition of their active participation in both design and production phases of construction projects.

Overlapping project stages

A principal concept of the fast-track system is the running of the design and construction processes of a construction project concurrently or simultaneously as shown in Figure 1(c). Fazio et al. (1988) suggested that, phased construction and fast-tracking management techniques have been developed as part of the Professional Construction Management (PCM) approach in an effort to ensure faster and economical project completions. They also pointed out that phased or integrated (Figure 1 (b)) and fast-track approaches reduce project durations by overlapping work packages, but fast-tracking further overlaps design and construction and hence, is also known as an 'accelerated phased construction'. Thus in comparing fast-track with other methods, there are clearly time savings in using the fast-track technique in construction projects as depicted in Figure 1 below.

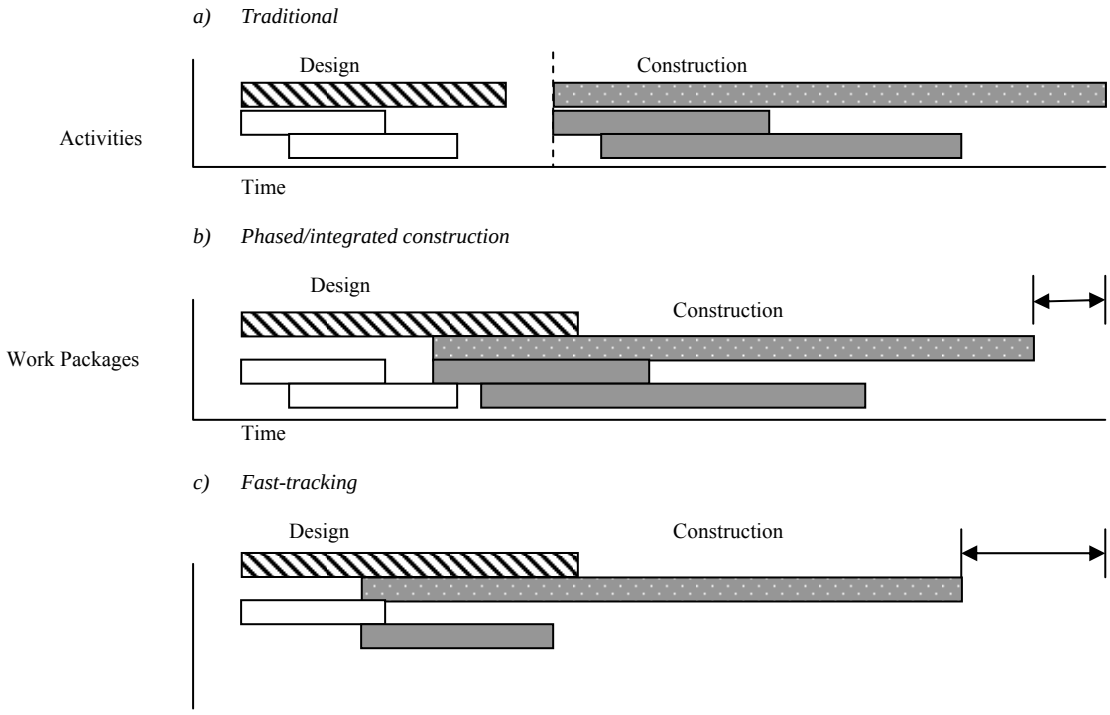

Figure 1: (a) Traditional, (b) Phased construction and (c) Fast-tracking approaches (adopted from: Fazio et. all. 1988)

MATERIALS MANAGEMENT PRACTICES ON FAST-TRACK PROJECTS

Implementation of IT in materials management could facilitate the effective and efficient control of materials on site. Common use of IT in materials management is cost estimating process by using database management software such as Microsoft Excel and Lotus 1-2-3 (Sun and Howard 2004). Internet is widely used for electronic mail (e-mail) and electronic commerce including electronic invoicing, payments and receipt of materials process (Harris and MacCaffer 2001). In order to improve productivity in ordering and quotation activities, contractors and suppliers could change their activities from conventional to more sophisticated or innovated tools and techniques. Accordingly, there is a need to make use of more computer-based systems to improve material management in construction sites (Faniran et al. 1998). For example, applications developed for this purpose by many researchers include the following:

● *Construction Materials Planning System (CMPS)*- for planning of construction materials to achieved the right materials in quantities, time and meet the work programs (Wong and Norman 1997),

● *Material Handling Equipment Selection Advisor (MHESA)* - for material handling equipment selection (Chan 2002),

● *Construction Materials Exchange (COME)* – E-Commerce system for material procurement (Kong and Li 2001),

● *Bar-code system* - for material storage application (Chen et al. 2002) etc.

Before exploring the improvement of materials management for fast-track projects, it is essential to explore current practice in materials management in fast-track construction projects. CIRIA (2001) stated that in relation to materials management, faster construction can be achieved on site through the following:

● *Extra space for the site compound*: to ensure sufficient materials storage space to supply the site at the speed of anticipated delivery and construction demand.

● *Maintain good vertical site access*: consisting of cranes, hoists, lifts, pumps, ladders and stairs to form double handling for vertical handling.

● *Keep the site compound well surfaced, well organised, clean and tidy*: to minimise damage and the soiling of materials for the purpose of immediate work.

● *Good access for material/plant deliveries*: comprehensive facilities for transport arrivals and departures.

● *Delivery of bulk materials in large*: transportation for large quantities by rail (eg reinforcement/steelwork) or barge (eg ballast from a dredger) and for large volume by pipeline (eg water/gas/oil/chalk/cement/concrete) or conveyor (eg excavated material/fill).

IMPROVING MATERIALS MANAGEMENT FOR FAST-TRACK PROJECTS

The traditional construction methods apply more paper-based work during the construction process. The emergence of ICT systems could transform conventional to modern methods in managing construction activities. Knecht (2002) mentioned that advances in communication have had a huge impact on fast tracking. In order to make faster construction more reliable and practical, there is a need to implement concurrent engineering (CE). Implementation of CE is intended to cause developers to consider all elements of the product life cycle from conception to user requirement (Ranky 1994).

CE is widely used in manufacturing engineering in order to get a faster production time. Dey (2000) described the concurrent engineering technique as being adopted into the project which needs to drastically reduce the project duration. On the other hand, in the context of the construction industry, Evbuomwan and Anumba (1998) defined CE *'as optimising the design of the project and its construction process to achieve reduced lead times, and improved quality and cost by integration of design, fabrication, construction and erection activities and by maximising concurrency and collaboration in working practices'*. It is important for the management of construction organisations to set out some strategies in order to reduce the duration of construction projects.

Baker & Boyd (1983) stated that rapid communication, rational and effective routines for the dissemination of information and instructions, and the recording of agreements are essential during fast-track construction. Good communication skills among all project team members are also necessary for fast-track construction. There is also a need to manage disputes with proper resolution strategies during the construction period in order to get a better result. Kwakye (1991) outlines the strategy options for managing fast-track construction projects related to materials as illustrated in Table 1 below.

Table 1: Summary of strategy options for fast tracking
(sources: Kwakye 1991)

Strategy option	Description
Advance purchasing of essential materials	Require advance purchasing material and plant to ensure their availability on site when required.
High preference for steel frame	Preference of steel frame rather than reinforced in situ concrete for reasons of speed of erection, reduced site labour requirements, prefabrication, standardisation for versatility and dimensional accuracy, and easy site modification.
Wet trade operations avoided	Use of prefabricated materials and components and avoid wet trades as possible to reduce waiting time at trade interfaces and maintain working tempo.
Standard and easily available components preferred	Maximise the utilisation of standard components and easily available.

NEED FOR IMPROVEMENT

An initial assessment of the tools and techniques currently in use in materials management suggests that most of them are under development with a few being used on a commercial basis. According to a Building Research Establishment report (BRE 2005), IT applications in the construction industry are now commonplace for facilitating procurement, collaboration and knowledge management. For example,

product procurement has such features as direct and indirect purchasing, electronic payment, and material aggregation. This can eliminate paper work, lower product and operational costs, and reduce cycle times. However, more sophisticated solutions in the future are expected to use wireless communications and tagging technologies such as radio frequency identification (RFID). Accordingly, this research will explore practical applications for these emerging technologies, particularly for facilitating materials management on large and complex projects.

CONCLUSION

This paper has presented a brief overview of materials management practices on fast-track construction projects. It is clearly important to manage all materials from the design stage to the construction stage. Poor handling of construction materials affects the overall performance of construction projects in terms of time, budget (cost), quality and productivity. The wastage of materials should also be minimised during construction in order to avoid loss of profit for construction companies. There is a need to develop new approaches to materials management in fast-track construction projects in order to improve the efficacy of the production process. The potential of IT applications provides a basis for developing an effective framework to support the improvement of materials management for such projects. The next stages of this research will examine the extent and nature of automation of the materials management process and will develop new ICT-enabled approaches to improving materials management.

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