Logistics Costs Evaluation in Building Construction Project

Sataporn Amornsawadwatana
Faculty of Engineering, the University of the Thai Chamber of Commerce
126/1 Vibhavadee-Rangsit Rd, Dindeang, Bangkok 10400, Thailand
Tel. +66-2697-6705, Fax. +66-2275-4892
Email: sataporn_amo@utcc.ac.th

ABSTRACT

A building construction project is a kind of fixed position layout. Materials, equipments, resources must be moved to the working area to perform a particular activity. For example, materials, welding machine, steel sheet, and workers must be transported to the area where a steel door installation is performed. In performing this task, logistics costs can be estimated from loading, handling, and unloading activities. Moreover, a cost incurred from material handling equipment used in handling materials or machines must be included in the logistics costs.

At a particular construction project, hundreds of activities are performed to construct buildings. Hence, several materials are required. Examples of these materials are prefabrication concrete, ready mixed concrete, steels, bricks, plastic tubes, paint, etc. Consequently, loading, transporting, unloading activities are performed frequently and contribute significant cost to the construction project. Moreover, materials can be damaged during loading, transportation, and unloading activities (Amornsawadwatana, 2004). These damages also generate loss to the project.

Materials are ordered and delivered from suppliers. Generally, materials are delivered in a large volume and require some space for stock. Hence, ordering and inventory costs are incurred in the project.

Objectives of this research are (i) to determine logistics cost structure in a construction project and (ii) to establish a systematic approach to evaluate the logistics cost in construction project.

In this research, the proposed methodology is implemented in the actual building construction case study.

Keywords: Construction, Project Management, Material Handling, Logistics Cost, Inventory

Introduction

A building construction project is a kind of fixed position layout (Stevenson, 2004). Raw materials from several suppliers are delivered to the construction site as well as materials, labor workforces, machines, and equipments are loaded, transported and unloaded to the working area in the construction site. Consequently, these transportation activities generate handling costs, which are about 30-40% of the manufacturing cost (Chan et al., 2001; Tompkins & White, 1984).
Material orders are placed periodically according to construction requirement. Generally, materials are ordered in large volume. For example, twenty thousand bricks or 200 bags of cement, etc. as represented in Figure 1.

![Figure 1 Large volume of raw materials](image1.jpg)

However, these materials are not used at the time they arrive. Later, these materials are stocked and blocked the working space. This results in adding inventory costs and loosing some workspace. At the working spot, a sufficient space must be available for machines, materials, and workers to perform their tasks. In many cases, limited workspace is the bottleneck of a particular task since workers are not convenient to perform their job e.g. inadequate space makes a worker to perform their task in uncomfortable manner and spend longer time in completing that particular task than usual as depicted in Figure 2.

![Figure 2 Working under uncomfortable manner](image2.jpg)

In this research, costs incurred from loading, unloading, transportation, and inventory are evaluated and validated using the actual building construction case.

**Proposed model**

In construction project, the labor cost is calculated based on man-day, which refers to number of workers and working time (days) (Kerzner, 1998). For example, one worker earns 200 Baht per day. However, this worker has to work following the supervisor’s order. On a particular day, he involves in several activities including loading, unloading, handling materials back and forth, etc.

For loading, handling, unloading, retuning costs estimation, these costs relate to labor costs in terms of man-hour and equipment costs (Amornsawadwatana, 2004). Thus,
number of workforces and time spent for the loading, handling, unloading, and retuning activities in a day are calculated from total working hours. Rental rate per day is used for material handling equipment costs. For example, the cost paid for forklift rental per day.

Suppose that the transportation activity refers to loading, handling materials forward, unloading, and returning backward. Thus, the total costs for these activities are calculated from the equation (1):

\[ C_T = N \times T \times R \]  

Where;
- \( C_T \): Transportation costs
- \( N \): Numbers of workers working in transportation
- \( T \): The total time used in the transportation
- \( R \): Labor rate per day

The ordering cost refers to the cost spent each time the order is place. This cost includes the communication expenses and delivery costs generated from any suppliers to the construction site. In this research, communication expenses are negligible. Then, the ordering cost can be calculated from the equation (2):

\[ C_O = N_O \times R_O \]  

Where;
- \( C_O \): Ordering costs
- \( N_O \): Numbers of orders placed
- \( R_O \): Delivery cost per trip

The inventory cost refers to cost of carrying inventories of materials. In this research, inventory cost is calculated using the percentage of materials costs. Also, material inventory requires extra space area and result in less working space. Hence, tasks performed in that area will take longer duration which result in extra costs. Then, the inventory cost can be calculated from the equation (3):

\[ C_I = M \times R_i + T_L \times R \]  

Where;
- \( C_I \): Inventory cost
- \( M \): Material cost
- \( R_i \): Carrying cost (in percentage)
- \( T_L \): The time extended due to limited space
- \( R \): Labor rate per day

Generally, materials can be damaged during loading, unloading, transportation activities. Also, material inventory can be damaged. Obviously, these damages generated loss to the project. In this research, material damages are calculated according to equation (4):
\[ C_D = M \times D \] 

Where;
- \( C_D \): Damage costs
- \( M \): Material cost
- \( D \): Damage percentages

Finally, the logistics cost (LC) in the building construction project is calculated as the summation of the transportation cost, ordering cost, inventory cost, and damage cost. This can be represented in equation (5):

\[ LC = C_T + C_O + C_I + C_D \] 

This proposed model will be implemented in a real building construction case in the next section.

**Case study**

The project of four buildings construction with a timeframe of one year is considered. An objective of this project is to construct four buildings within a year. Each building has three floors. This project is depicted in Figure 3.

![Figure 3 The project of four buildings construction](image)

Normally, there are twenty workers in the project and each worker earns a labor rate of 200 Baht per day. The study timeframe of this research is 30 working days. Two material types are considered- bricks and cement powder in a 100-kilogram bag. Project information can be summarized in Table 1.
<table>
<thead>
<tr>
<th>Materials</th>
<th>Bricks</th>
<th>Cements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volumes</td>
<td>20,000 pieces</td>
<td>400 Bags</td>
</tr>
<tr>
<td>Workers for transportaion</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Times for transportaion</td>
<td>50 hours</td>
<td>60 hours</td>
</tr>
<tr>
<td>No. of orders placed</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Delivery cost per trip (Baht)</td>
<td>1,000</td>
<td>300</td>
</tr>
<tr>
<td>Material costs (Baht)</td>
<td>10,000</td>
<td>48,000</td>
</tr>
<tr>
<td>Carrying costs (percentages)</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Time extended due to limited space (hours)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Damage percentages</td>
<td>10%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Table 1 Information regarding the building construction project

Results

Logistics costs of bricks and cements are calculated using equation (1) to (5) and information provided in Table 1. Results from the calculation are illustrated in Table 2:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Bricks</th>
<th>Cements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation costs (Baht)</td>
<td>3,750</td>
<td>3,000</td>
</tr>
<tr>
<td>Ordering costs (Baht)</td>
<td>1,000</td>
<td>600</td>
</tr>
<tr>
<td>Inventory costs (Baht)</td>
<td>750</td>
<td>1,460</td>
</tr>
<tr>
<td>Damage costs (Baht)</td>
<td>1,000</td>
<td>960</td>
</tr>
<tr>
<td><strong>Logistics costs (Baht)</strong></td>
<td><strong>6,500</strong></td>
<td><strong>6,020</strong></td>
</tr>
<tr>
<td><strong>Percentages from material costs (%)</strong></td>
<td><strong>65</strong></td>
<td><strong>13</strong></td>
</tr>
</tbody>
</table>

Table 2 Logistics costs of bricks and cements

During 30 working days, logistics costs of bricks and cements are 6,500 and 6,020 Baht, respectively. When logistics costs are compared to their material costs in percentages, they are 65% and 13%, respectively. This is because their physical characteristics are different e.g. volume to weight or value to weight ratio (Rushton et al., 2000). Further investigation for bricks must be carried out to analyze its logistics movement.

Conclusions and discussion

A project manager usually concern only to material cost, labor cost, equipment cost, expenses, and penalty from project delay (Kerzner, 1998). However, he/she does not pay sufficient attention to logistics costs in construction. Logistics costs in construction are significant, especially material handlings and movements. However, these costs are not carefully considered in a real construction project. The selection of
a proper material handling method to match physical characteristics of materials is required to reduce ineffective material handling.

References