Modern Construction Project Management, Second Edition

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Published by Hong Kong University Press, HKU
1. **Introduction**

Resource management is an essential element in construction. The basic resources in construction are often called the four M's: Men, Machines, Material and Money. In this chapter, all these four resources are to be discussed.

Interviews with 15 large construction sites' managers in Hong Kong were conducted and their views on resource management are summarized in this chapter, with the exception of section 7, for which the number of interviewees was 20.

2. **Manpower Management**

2.1 **Number of Labourers**

The number of labourers in a construction project is found to increase with the increase of the following two indicators:

1. The contract sum
2. The S/D ratio (i.e. contract sum/project duration ratio)
The S/D ratio represents the speed of the programme of work. The higher the S/D ratio, the greater the number of labourers is on site.

2.2 Factors Affecting Labour

There are a number of factors which affect the decisions on the number and type of labour. They are listed in the order of decreasing importance as shown below.

1. Programme of work
2. Nature of work
3. Subcontractors employed
4. Overall cost
5. Financial condition
6. Location of site

The programme of work is found to be the most important factor. At the peak of the work programme, more labour would be employed, and vice versa. This finding can verify the finding in section 2.1 also. Other than the programme of work, the factors 'nature of work' and 'subcontractor employed' are also of considerable importance.

2.3 Subletting

Subletting works by the main contractor to subcontractors is a very common practice in Hong Kong. Over 90% of the labourers in a building site belong to subcontractor and only less than 10% belong to the main contractor. The situation is less extreme in a civil engineering construction site. About 75% of the labourers belong to subcontractors and 25% belong to the main contractor in the latter case. Such a phenomenon can be explained by the fact that the nature of work in buildings is too diversified and specialized. It is not economical for the main contractor to employ too much labour as the management cost would be increased. On the contrary, the works executed in civil engineering construction is relatively simple, and the contractors are more willing to employ their own labour who can do a wider range of jobs.

There are several factors which affect the decision of subletting. They are listed in the order of decreasing importance as shown below:

1. Nature of work
2. Cost consideration
3. Operation of work
4. Provision of labour
5. Provision of plant

It is found that the nature of work mostly controls the decision on subletting. The main contractor often sublet such kinds of works which are too specialized. The cost is also an important consideration. It is often true that the cost in subletting is less than the cost incurred by the main contractor if the latter is carrying out the work himself because of the higher flexibility on the part of subcontractors.

The advantages of subletting works to subcontractors are:

1. The main contractor finds it easier to control the cost of the works.
2. The risks of works can be transferred from the main contractor to subcontractors.
3. It is easier to control the allocation of resources, particularly equipment and plant.
4. The productivity through subcontracting system is usually higher.

3 Plant Management

3.1 Factors Affecting Plant

The factors affecting the number and type of plant are listed in decreasing order of importance as shown below:

1. Programme of work
2. Nature of work
3. Overall cost
4. Limitations on site
5. Self owned (stock of company)

The programme of work controls the number and the type of plant most of the time. The nature of work is also a crucial factor; different types of plant have different functions in executing works, especially for building works. Cost is also an important consideration. Moreover, the limitations on site also control the use of plant. For example, it is difficult to install a large plant on a small and congested site.
3.2 Ownership of Plant

The plant on site can be divided into self-owned or not self-owned by the main contractor. The latter can be further subdivided into hiring or subcontractors' provision. Tower cranes, material hoist and concrete pumps are usually owned by the main contractor. Mobile cranes, backhoe, bulldozer and rollers are usually not self-owned.

The factors affecting the ownership of plant are listed in decreasing order of importance as follows.

1. Policy of company
2. Further usage of plant
3. Overall cost
4. Duration of project
5. Self-owned (stock of company)

Company policy is the most important factor in the ownership decision. This means that the decision is usually made at the contractor's head office where the management considers the total situation (i.e. other construction projects also) instead of a particular project.

4 Material Management

4.1 Ordering of Materials

Materials with a high and frequent demand throughout the construction period, such as ready-mixed concrete, are ordered directly on site. On the contrary, materials like sanitary fittings and waterproofing material are usually ordered through the head office because the quantity and the timing of their demand can be easily predicted. These are usually ordered in advance by one to several months. The ordering periods for materials ordered directly on site are much shorter of course, usually within days rather than months compared with head office ordering.

Because the working cycle for building projects is shorter than that for civil engineering projects, the average ordering period of materials in the former sites is significantly shorter than that in the latter sites.
4.2 Reordering
There are several factors affecting the frequency of reordering of materials. The most important factor is the progress of work. The frequency of reordering increases as the progress of work increases. The next important factor is the existing stock level. The third factor is the availability of storage area. For the third factor, it is less significant for civil engineering sites than building sites, as storage spaces are usually more readily available in the former case.

4.3 Storage
Besides ordering and reordering practices, a good storage practice on site is also important. Materials are mainly stored in storage rooms, covered storage yards and open air storage spaces. Fig. 6.1 shows how some common construction materials are stored in building sites. Fig. 6.2 shows the same in civil engineering sites.

![Storage spaces for construction materials in building sites.](image-url)
Usually, the open space of civil engineering sites is much more than that of building sites. The limitation on storage areas becomes less significant in the former sites and construction materials can be conveniently stored in open air storage areas. Furthermore, other than such common materials as concrete, cement, reinforcement and timber, some major types of materials in building and civil engineering construction are different. A large variation of types of materials are used in building sites. Such kinds of materials like sanitary fitting, electrical installations and finishing materials are expensive and easily damaged. It is therefore reasonable that materials for building sites are usually stored in storage rooms or covered storage yards.
5 Costs of Each type of Resources

5.1 Cost Proportions for Main Contractor

The total costs on a construction site mainly consist of labour cost, plant cost, material cost and overheads. The proportions of these costs for a main contractor are shown in Table 6.1.

<table>
<thead>
<tr>
<th></th>
<th>Building work</th>
<th>Civil engineering work</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>9%</td>
<td>26%</td>
</tr>
<tr>
<td>Plant</td>
<td>21%</td>
<td>14%</td>
</tr>
<tr>
<td>Materials</td>
<td>35%</td>
<td>32%</td>
</tr>
<tr>
<td>Overhead</td>
<td>35%</td>
<td>28%</td>
</tr>
</tbody>
</table>

Table 6.1 Cost proportions of resources for a main contractor.

It can be observed that materials form the major cost for both building and civil engineering projects. The cost proportions for labour, however, are very different in building and civil works; the former is much lower than the latter. This is consistent with the finding in section 2.3 of this chapter, that is, the percentage of subletting in building works is higher than that in civil works. This means that the number of direct labourers of the main contractor is much lower in building works than in civil works. Because of the big difference in the labour cost, the overhead cost for civil works becomes lower than that for building works.

5.2 Cost Proportions for Subcontractor

On the contrary, the cost proportion of labour is much higher for subcontractors than for main contractors. Usually, subcontractors only provide labour and plant (and in some cases materials too) in construction processes. The need for administration and organization of works is not much compared with main contractors. Cost proportions for building main contractor and building subcontractors are shown in Table 6.2.
### Cost Proportions (Building Works Only)

<table>
<thead>
<tr>
<th>Resource</th>
<th>Main Contractor</th>
<th>Subcontractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>9%</td>
<td>33%</td>
</tr>
<tr>
<td>Plant</td>
<td>21%</td>
<td>28%</td>
</tr>
<tr>
<td>Materials</td>
<td>35%</td>
<td>34%</td>
</tr>
<tr>
<td>Overhead</td>
<td>35%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table 6.2 Cost proportions of resources between main contractor and subcontractor.

Unfortunately, the same comparison for civil work main contractors and subcontractors could not be obtained in the interviews.

#### 5.3 Cost Control

The measures for cost control of resources adopted on construction sites were also investigated. Fig. 6.3 shows the measures taken by main contractors to control costs. The use of bonus systems and the frequent check of stock of suppliers are the control measures adopted by less than half of the sites interviewed.

It can be seen that contractors in Hong Kong usually focus on control of daily work, particularly the regular checking and maintenance of plant and equipment as it is the contractors' responsibility by law. They do not seem to have enough concern about backup activities (e.g. bonus systems, checking of stock of suppliers, checking of quality of materials received). This might reflect the fact that construction management in Hong Kong has not yet attained the level of total quality management.
Fig. 6.3 Cost control measures for resources adopted on sites.
6 Planning and Monitoring of Works

6.1 Planning a Work Programme

In order to have an effective allocation of different kinds of resources, a good planning of work programme is important. A programme of work should be produced by a person with experience in construction processes and good understanding in the limitations due to resources, finance and client's requirement.

There are a number of factors which must be considered in planning a work programme. These factors are listed below in decreasing order of importance:

1. Date of completion of contract
2. Nature of work
3. Particular specification of the engineer
4. Labour force
5. Provision of plant
6. Limitation of site
7. Time of the year of construction
8. Supply of material

6.2 Charts for Monitoring

During construction, the managerial staff on site have to continuously monitor the execution of work so that a thorough comparison between the original plan (work programme) and the actual progress can be made. Usually, charts are used to act as tools of monitoring. The following lists these charts according to their importance:

- **Used most**
  - Work progress chart
  - Financial progress chart
  - Manpower chart
  - Material usage chart
  - Plant usage chart
  - Cost of material usage chart

- **Used least**
  - Subcontractor progress chart

It can be observed that the majority of contractors in Hong Kong apply monitoring charts of work progress and financial progress. It is rare to find monitoring charts of costs of materials and subletting schedule.
6.3 Method Statement

The preparation of method statements plays an important role on construction operations. The factors which are considered in drafting method statements are listed below in decreasing order of importance:

1. Cost of work
2. Safety consideration
3. Limitation of site environment
4. Programme of work
5. Time required
6. Experience on the work
7. Demand of plant
8. In-house technical support
9. Demand of labour
10. Supply of materials

The general route from drafting to approving a method statement is as follows:

Draft by site engineer/planning engineer

\[ \downarrow \]

Discuss with subcontractor

\[ \downarrow \]

Coordinate with the site agent

\[ \downarrow \]

Endorsed by the contracts manager

\[ \downarrow \]

Submit by the engineer for approval

In general, the site agent usually has the power to make decisions as to construction operations. Such a kind of decision-making framework can eliminate the time for documentation and discussion between different departments in the head office. In other words, such a practice speeds up the progress of work when changes occur on site.
7 Subcontractor Management

In Hong Kong, subcontracting agreements are mostly confirmed in the form of formal letter of award. However, it still exists, in occasional circumstances, that the agreements be in the forms of endorsement on quotations or verbal confirmation. In this section, some important issues on subcontracting management are discussed.

7.1 Criteria for the Selection of Subcontractors

There are several criteria which affect the selection of subcontractors. They are listed in the order of decreasing importance as shown below:

1. Quality of work
2. Financial stability
3. Technical ability
4. Safety track record
5. Labour force stability
6. Management ability
7. Ability in meeting schedules
8. Work ethics

It is interesting to observe that the interviewees considered subcontractors' work ethics as a very low priority.

7.2 Criteria for the recruitment of new subcontractors

If a main contractor wishes to look for a new subcontractor, there are certain criteria for doing so. These criteria are listed in the order of decreasing importance as shown below:

1. Track records
2. Accumulated work experiences
3. Past client records
4. In-progress projects
5. Capital assets
6. Quality of human resources
7. Visit to subcontractor's factory
7.3 Problems and Difficulties Encountered With Subcontracting

Main contractors usually encounter problems/difficulties with subcontractors. The followings are the common problems/difficulties, shown in the order of decreasing importance:

1. Quality of work
2. Progress of work
3. Lack of cooperation
4. Difficulties in controlling
5. Excess material wastage

7.4 Suggestions for improvement of subcontractors

Suggestions are given by the interviewees for improving the deployment of subcontractors in construction contracts. These suggestions are listed in the order of decreasing importance as shown below:

1. Improvement on workers' skill
2. Quality assurance improvement
3. Improvement on labour supply stability
4. Safety management improvement
5. Improvement on method of work (method statement)
6. Improvement on schedule control

Readers may observe that the points in section 7.3 are somehow related to those in this section. This is logical and reasonable.