INVESTIGATION INTO THE RELATIONSHIP BETWEEN REWORK AND SITE SUPERVISION IN HIGH RISE BUILDING CONSTRUCTION IN INDONESIA

The 2nd CPR, 12-13 July 1999, Sydney

Sugiharto Alwi
Tarumanagara University, Jakarta, Indonesia
Keith Hampson
Queensland University of Technology, Brisbane, Australia
Sherif Mohamed
Griffith University, Gold Coast, Australia

Abstract
The quality of site supervision has a major influence on the overall performance and efficiency of construction projects. Inadequate supervision is believed to be one of the major causes of rework. Therefore, experienced and well-trained supervisors have an important role in minimising the amount of rework due to construction defects.

This paper argues that the quality of site supervision Indonesia is directly related to the supervisor's level of experience gained through formal training. Hence, the paper attempts to explore the relationship between the quality of site supervision, expressed as training cost, and the rework cost borne by contractors in high-rise building construction.

Based a comprehensive data collection targeting ten building construction sites in Indonesia, this paper suggests that inadequate site supervision is a principal cause of rework during construction. It also offers insights into the statistical relationship between the cost of supervisors' training and the cost of rework.

Based on the relevant literature and accounts from site managers interviewed during the course of data gathering, this paper offers practical recommendations to upgrade and maintain construction supervisors' skills in Indonesia.

Keywords: Rework; Rework costs; Training cost, High rise construction, Indonesia.

Sugiharto Alwi is an experienced Civil Engineer and Lecturer at Tarumanagara University in Jakarta. He is currently undertaking his Doctoral studies in the School of Construction Management and Property at QUT.

Keith Hampson is Associate Professor and Director of Research in the School of Construction Management and Property at QUT. His research focuses on project delivery, and implementing technology and innovation in construction.

Sherif Mohamed lectures in Construction Engineering and Management at Griffith University Gold Coast Campus. His active research interests include project delivery systems, engineering economics, computer simulation and information management.

INTRODUCTION

The aim of the study reported in this paper was to identify rework during the construction process and its relationship with site supervision. Rework has become a crucial aspect in the Indonesian construction industry. This is because the construction industry in Indonesia is a relatively young industry. It has grown considerably in the 1970's, yet there still has never been any systematic attempt to observe rework in the construction process. Although some project managers have investigated individual areas to better understand the causes of rework, these studies have not identified the fundamental causes of rework itself.

In addition, this study focused on investigating the performance of supervisors authorised to carry out site supervision during the construction process. The quality of site supervision has a major influence on the overall performance and efficiency of construction projects. The performance of supervisors depends on skilled communication with individual workers, and planning and directing the work. These abilities can be improved by formal training (The Business Roundtable, 1982a). Ineffective manpower training in the construction industry work force, in both numbers and requisite skills, has presented continuing problems for Indonesian industry employers and clients for several years.

REWORK IN CONSTRUCTION

Quality management principles and tools are not strongly embedded in conventional construction management practice. As a result, rework is accepted as an inevitable feature of the construction process. Rework increases the likelihood of project time and cost overruns, and ultimately leads to client dissatisfaction. However, only a few studies in the literature have dealt with the rework issue in construction (Love et al, 1997b). Participants involved in the construction process do not realise the extent of rework that actually occurs. There is an increasing need to improve the quality of operations in the construction process and therefore reduce the incidence of rework.

In some countries, rework is a chronic problem and with these costs ranging between 12% and 15% of the total project cost (Davis et al, 1989; Neese and Ledbetter, 1991). According to Taneja (1994), in structural and interior works of projects, the costs of rework can be range from 4% to 12% - or average 8% of the total budget. These costs comprise approximately 46% for error in execution, 30% for error in designing and the rest are for the poor quality of material, misunderstanding of drawing, and external factors. Another investigation associated of rework costs was conducted by Love et al. (1997b) on two building projects. He found that the rework costs was to be 2.4% and 3.3% of the total project cost.

To effectively reduce the cost of rework in construction, it is necessary to have an understanding of its causes, and the construction industry has to become adoptive of, and responsive to, forces of change, both technological and social (Love et al, 1997b).

PROBLEMS IN THE INDONESIAN CONSTRUCTION INDUSTRY

The growth of construction industry in Indonesia in the past two decades indicates its success in greatly contributing to the country's Gross National Product. This industry sector is the third most important for absorbing human resources after the food and textile industries (Royat, 1994). In the 1990's, approximately 2.5 million labourers were involved directly in construction projects. However, 88% are unskilled or have low levels of skill, 11% have medium to high levels and the rest (1%) are at managerial levels. The large range in this organisational structure is still indicated as a

serious problem in Indonesia as a developing country. In other words, the construction industry is facing a serious labour skills shortage.

Young people are not keen to work in this industry. This is because construction jobs in Indonesia tend to rely on physical work or hard manual labour and offer relatively poor pay conditions. Even when they do, most of them do not receive proper training before entering the construction site and they work as unqualified and unskilled labourers. As a result, extra coordination and supervision is required for the workers. This situation also is often related to productivity problems.

Due to the improved economy in the 1990's, the Indonesian people are demanding better service from the construction industry, and contractors are facing tremendous pressure to increase construction productivity.

REWORK IN INDONESIA

Research into rework was conducted in Indonesia to investigate the following objectives:

1. Determine the quantity of rework costs in the construction process,
2. Identify the causes of rework, and
3. Identify the training costs of supervisors.

In this paper, rework is defined as an activity which has to be redone or altered. According to Love et al. (1997a), rework may also include variations and it can occur at any time and any process, whether during design, construction, or procurement.

In this research, the direct site investigation was conducted for several particular items focusing on columns, beams and slabs targeting ten high-rise building construction sites. The investigation was located in Jakarta, the capital city of Indonesia, during 1995. This detailed site investigation included several issues as follows:

1. Inspecting the erection of scaffolding,
2. Inspecting the installation of reinforced concrete, and
3. Inspecting the quality of concrete.

RESEARCH METHODOLOGY

The initial approach in this research was to conduct a questionnaire survey with approximately one hundred large building contractors in Jakarta. This questionnaire was divided into two sections. The first section was used to gain information of any rework in the construction process. It included the measurement of both the quantity and the causes of rework. The quantity of rework is described as rework costs consisting of the cost of labour, materials and equipment for rework. The second section of the questionnaire concentrated on gathering data about activities for the training of supervisors. These questions investigated the supervisors' training costs to increase their skills.

Intensive interviews were conducted with the ten project managers to clarify the resultant questionnaire survey and, primary and secondary data gathered from existing and previous projects. To analyse the data, a combination of questionnaire survey, interviews, direct site investigation and documentary sources provided by contractors, subcontractors, consultants and suppliers were used.

PRELIMINARY FINDINGS

Rework

According to the questionnaire survey and interviews with project managers in the ten largest contractors in Jakarta, all rework incidents were categorised into qualitative and quantitative data. Qualitative data analysis was used to find out the causes of rework, whereas quantitative data analysis was focused on tabulating the quantity of rework costs.

The resultant data analysis of questionnaire survey, interviews and direct site investigation gave a clear description of rework causes. They are:

- Lack of supervision,
- Lack of skills by labourers,
- Unclear site drawings,
- Error in choosing construction method,
- Equipment shortage, and
- External factors such as redesign, changes by owners, poor environment.

The project managers acknowledged that the causes were interrelated and, in some cases, one cause can lead to another. For example, an inexperienced supervisor who makes a mistake in choosing the right construction method will certainly affect the construction process.

However, each of the project managers strongly argued that lack of supervision and lack of labour' skills played an important role in all kinds of projects. In other words, human skill factors should be considered as a main point in carrying out each construction projects. The results of the questionnaire survey stated that each of the project managers acknowledged that lack of supervision was the main cause of rework during the construction process.

The investigation that focused on the three major issues as has mentioned above gave an illustration that the percentages of the rework costs ranged from 2.0% to 3.2% of the total project costs (see Figure 1.).

The identification and measurement of the quantity of rework costs were conducted by the site engineer and these tasks were under controlled by their project managers. Using their own site-documentation, problems related to rework was recorded during the construction process and reported everyday to the project managers. In this report, project managers are able to identify clearly what the problems are; why, when and where the problems occur; who initiated the problems; and how the problems were overcome. This included as well the estimation of the rework costs. The project managers should approve each of these reports before conducting an action in terms of rework.

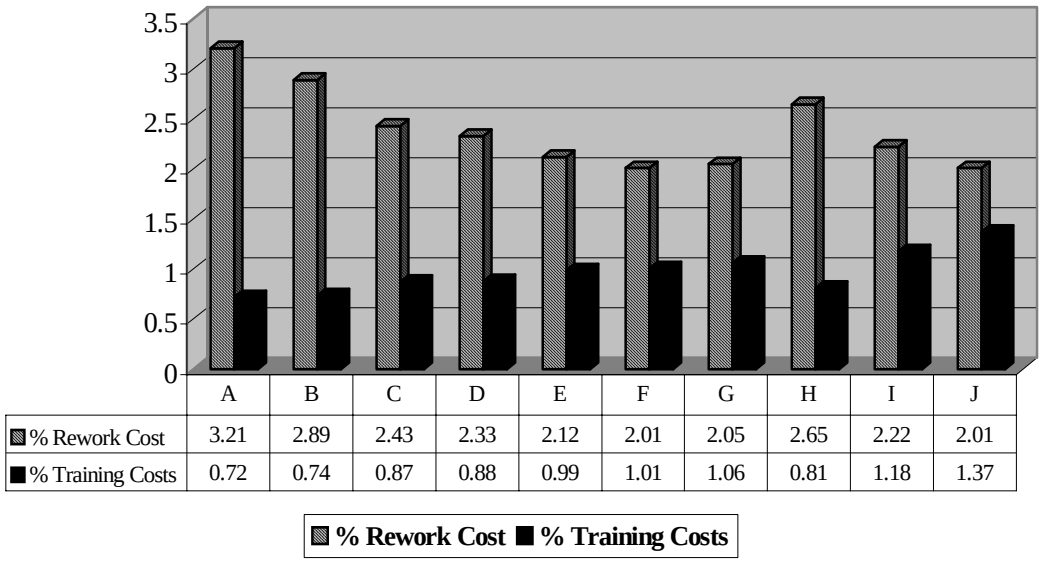
Supervisory Training

Construction supervision is one of the most crucial elements in the construction process. The performance of field labor is critical to the success of any construction project. This performance in turn requires supervisors who are skilled in communicating with individual workers and in planning and directing the work. According to the project managers, lack of proper training of supervisors has contributed to the continued increase of construction costs. Their inability to plan work, communicate with workers, and direct work activities adequately is believe to

be an important factor in increasing rework costs. These abilities can be improved by formal training (The Business Rountable, 1982a).

Most of the project managers argued that formal training can improve the skills of supervisors, decline rework costs and thus improve productivity on construction projects. To find out what contractors currently do about supervisory training, a questionnaire was sent to contractors representing a wide spectrum of the Indonesian construction industry. Several preliminary findings are indicated below:

1. Training is more useful when it is designed to address a specific problem.
2. In order to anticipate additional rework cost, many contractors allow their supervisors to attend regular training programs.
3. There are many training programs available obtained from contractors associations, consultants and universities. These training programs impart both theoretical and practical knowledge.
4. Some contractors are dissatisfied with their training program and they believe that more careful analysis is required to choose the right program to meet their needs.
5. Many contractors have developed their own formal training and evaluation process. (Generally, they do not share their programs with others.)
6. The contractors should finance the training within their company's overhead budgets.
7. In some cases, in order to operate a new machine or to apply a new method, the contractors may jointly finance training with the construction user of the project.
8. The percentage of training costs ranged between 0.7% and 1.4% of the total project costs (see Figure 1).



	A	B	C	D	E	F	G	H	I	J
% Rework Cost	3.21	2.89	2.43	2.33	2.12	2.01	2.05	2.65	2.22	2.01
% Training Costs	0.72	0.74	0.87	0.88	0.99	1.01	1.06	0.81	1.18	1.37

Figure 1. Rework and training costs

Figure 1 demonstrates that usually, rework costs and training costs have an inverse relationship. This means that the more money spent on training, the less the rework cost is. In certain cases, some contractors still have a problem to overcome rework. For instance, it can be seen from Figure 1 that Project J spent more money on training costs (1.37%) than project F (1.01%). According to the relationship above,

Project J should have less quantity of rework costs than project F. However, in this case, Projects J and F have the same quantity of rework costs (2.01%).

Using statistical analysis, the strong relationship between the percentages of training costs and the percentages of rework costs is easily visible in Figure 2.

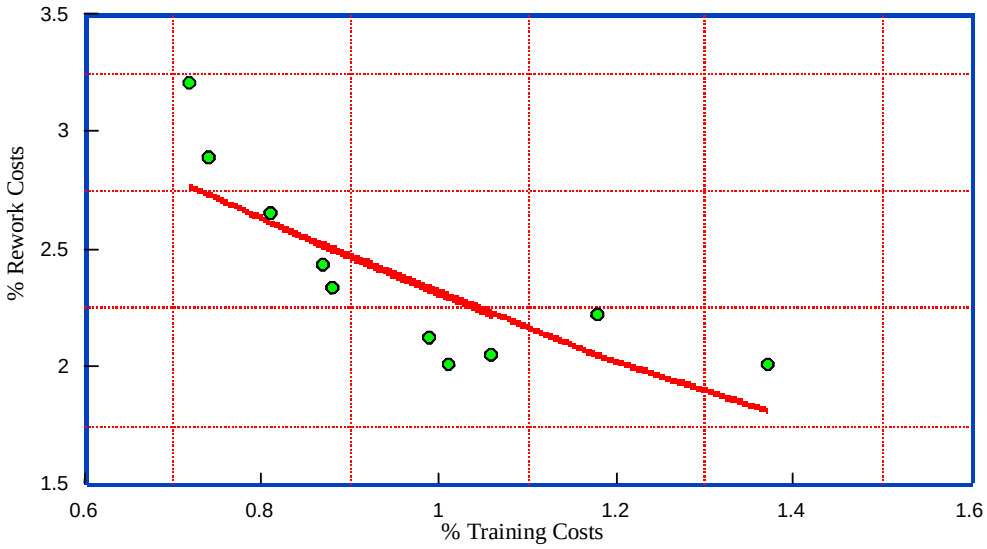


Figure 2. The relationship between rework and training costs.

Savings

Based on the interviews, any estimate of savings to these contractors accruing from construction supervisory training would be subjective. However, according to company documentation and annual records, supervisory training has consistently indicated substantial savings. The savings may result from reduced rework costs. Contractors who have been conducting training programs regularly can reasonably reduce their rework costs between 11% and 22%.

Training content

Each project manager acknowledged that the subjects of the training programs have to be specific and tailored to the needs of both the project and the individuals involved in it as determined by prior analysis. According to the questionnaire survey, each project has different interests in choosing specific subjects for supervisor training, and it is dependent upon the project problems. There are many training subjects available for supervisors, however most contractors are only interested in the four major subjects: Construction Methods, Planning and Scheduling, Material Control and Quality Control. The percentages of each subject reported are shown in Figure 3.

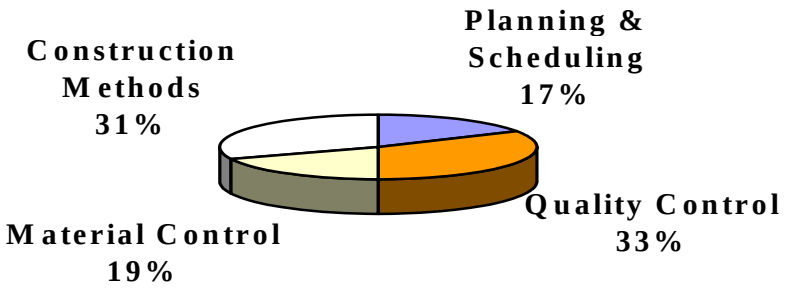


Figure 3. The training content

CONCLUSIONS

Better understanding causes of rework will assist project managers to identify the best methods to improve the performance of contractors to minimise or eliminate rework. Both supervisor skills and labour skills should be considered as a key point in carrying out each construction project.

This paper suggests that the quality of site supervision in Indonesia is directly related to the supervisors' level of experience gained from formal training and it has a strong inverse relation to rework costs.

REFERENCES

Davis, Kent; Ledbetter,W.B. and Burati, James L. Jr (1989) Measuring Design and Construction Quality Costs. *Journal of Construction Engineering and Management*, Vol 115, No III, pp385-399.

Love, Peter E.D.; Mandel, Purnedu, and Li, Heng (1997a) A Systematic Approach to Modelling the Causes and Effects of Rework in Construction, pp347-355.

Love, P.E.D.; Wyatt, A.D. and Mohamed, S. (1997b) Understanding Rework in Construction. *International Conference on Construction Process Re-engineering*, Gold Coast, July, pp269-278.

Neese, Terry A. and Ledbetter, W.B. (1991) Quality Performance Management in Engineering/Construction. *Journal AACE Transactions*, A.2.1-A.2.10.

Royat, Sujana (1994) "Development Strategy of the Construction Industry in Indonesia", *in Workshop on Strategic Management in Construction Industry*, Bandung.

Taneja, Y.R. (1994) Quality Assurance for Building and Construction Industry. *Journal of Construction Management*, Volume IX, No III, 140-149.