

TRAINING FIELD PERSONNEL FOR SMALL TO MEDIUM CONSTRUCTION COMPANIES: AN ALTERNATIVE TOOL TO INCREASE PRODUCTIVITY

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ABSTRACT

Poor quality of construction personnel has a major influence on the overall performance and efficiency of construction projects. In general, contractors rely heavily on medium to high levels of construction personnel such as Site Engineers, Site Managers and Project Managers to successfully complete a construction project. The role of low levels of construction personnel, known as field personnel, is normally overlooked.

This paper argues that well-trained field personnel have an important role in minimising the amount of waste activities during the construction process leading to reducing company's productivity. Hence, the paper attempts to explore the significant role of field personnel in completing construction projects productively.

Based on a comprehensive data collection through a survey research and case studies targeted at small to medium construction companies in Indonesia, this paper states that a significant achievement in minimising the amount of waste and increasing company's productivity has been attained by contracting companies that have been conducting training for their field personnel. Evidence of the increase of the company's productivity is expressed by measuring the value of PPC of the projects.

KEY WORDS

Field personnel, training, small to medium contractors.

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INTRODUCTION

In general, contractor companies in Indonesia merely rely on medium to high levels of construction personnel such as Site Engineers, Site Managers and Project Managers to successfully complete a construction project. Contractors believe that such construction personnel, who are well-educated through formal educations, have better knowledge in planning and managing construction projects. They are regularly trained and educated by attending seminars, short courses and workshops. Contractors argue that the key to success of any construction project depends on a good planning that is prepared by medium and high levels of construction personnel and then passes the planning to field personnel as a guidance for them to execute all works. With this in mind, the role of the low levels of construction personnel, known as field personnel, is normally overlooked. As there is no specific regulation in terms of the ability for field personnel to enter construction projects, contractors do not strictly consider the skill of the field personnel to be employed in their projects.

Contractors do not realise that poor quality of construction field personnel has a major influence on the overall performance and efficiency of construction projects leading to reducing construction productivity. The overall performance and efficiency of construction projects can be identified by measuring the amount of waste activities during the construction process. The term waste activities used in this paper was derived from the Lean Production Philosophy described by Koskela (1992). A number of definitions of waste are available. In general, Koskela (1992) argued that all those activities that produce costs, direct or indirect, and take time, resources or require storage but do not add value or progress to the product can be called waste. These waste activities are measured as a function of their costs, including opportunity costs. Furthermore, other types of waste are related to the efficiency of process, equipment or personnel.

Prevention of waste must begin the moment the client first decides to go ahead with the project. No practical and acceptable method has been agreed upon by all parties involved in construction projects to reduce waste levels. On some construction projects in Indonesia, the extent of waste is significant throughout the entire construction process – its participants, activities and the facilities constructed. In fact, waste occurs right across the construction industry irrespective of (Alwi et al. 2002a):

- The size of the building organisations,
- The value and duration of the contract,
- The building type, or
- The nature of the building (new buildings or buildings being refurbished and maintained).

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 (Alwi et al. 2001).

This ongoing research study has two aims. The first aim is to investigate the significant role of field personnel in minimising the amount of waste activities during the construction

process. The quality of field personnel has a major influence on the overall performance of the project, and this quality can be improved not only by formal training, but also by informal training or on-site training. The second one is to investigate the significant effect of on-site training program for field personnel on the construction productivity.

CONSTRUCTION INDUSTRY PROBLEMS

The majority of the Indonesian construction labour forces are self-employed, and are often farmers from rural areas. Typically young workers are often recruited through friends or relatives (often of the foremen). They are low-skilled, earn low wages, and hence are less effective (Kaming et al. 1997b). These young workers enter the pool of construction workers, for it is the only industry that can provide employment for those without any qualifications, even though continuous employment is not guaranteed. Most construction workers learn their skills informally, observing and learning from experienced workers. Individuals who learn the trade on the job usually start as helpers. These workers perform routine tasks, such as cleaning and preparing the worksite and unloading materials. When opportunity arises, they learn how to do more difficult tasks, such as operating tools and equipment, from experienced workers. Becoming a fully skilled construction workers by training on the job normally takes longer than six months.

The client, contractors and other project participants complain of the difficulty in finding sufficiently skilled workers. Most skilled workers enter the industry and receive informal training from a master craftsman, rather than following a formal course conducted by an institution. There have been dire shortages of skilled manpower to cope with the boom in construction activities in Indonesia. The performance of field labour is critical to the success of any construction project.

According to the recent research (Alwi and Hampson 2003), contractors are still facing lack of workers' skill to complete the projects satisfactorily. In fact, the paper stated that "skilled" operatives were often not skillful, having gained their experience on the job site, learning construction skills through trial and error. The trend observed with activities on the project was that field personnel/workers do not use their own initiative, and instead rely on both the foremen and the supervisors' ability to check and approve all works. For many activities field personnel are unable to interpret site drawings. Most construction workers require instructions from foremen or supervisors.

Considering the lack of accumulated experience, the scarcity of skilled workers, and the unsophisticated equipment and technology, I can say that there are many opportunities for improving productivity in the Indonesian construction industry, especially in today's complex and competitive market.

The ongoing improving economy that started in the middle of 2001 led people to demanding better service from the construction industry. However, considering several of the problems mentioned above, Indonesian contractors are facing high pressure to increase construction productivity.

TRAINING FOR CONSTRUCTION PERSONNEL

Many construction worker jobs require no experience or training related to the occupation. Many workers enter the occupation with few skills because training is not encouraged and available through labourer training centres. In 1986, the government organised training programs in cooperation with the National Contractors Association of Indonesia (GAPENSI) for bricklayers, rodmen, carpenters and draughtsmen. However, today there is no regular and proper training provided by the government to increase the pool of skilled workers (Alwi et al. 2001). As a result, field personnel are predominantly unqualified and unskilled.

Lack of workers' skill within the Indonesian construction industry has been acknowledged over the last ten years. In fact, the workers' level of skill is the responsibility of the foremen. However, most of the project participants argued that either contractors or the government should take a part of the responsibility as well. Training programs are identified as the only key issue and needed to be organised by the government. In contrast, contractors experienced that workers were not willing to undertake training programs to develop their ability. There are main reasons why they are not keen to do it.

First, there are no regulations for workers to undertake training programs before entering construction projects. Second, fees of the training program are normally expensive. With their limited incomes, workers find it almost impossible to join training programs. There is no allowance from the government and contractors to assist workers. This occurs because many workers are hired on a project basis only. Third, due to family commitments, they prefer to develop their ability by learning from experienced workers as this allows them to continue earning a wage. Fourth, some contractors and clients do not demand workers to have a training certificate for employment. As long as workers' ability fulfils project standards, contractors and clients are willing to employ them. To anticipate these problems, some contractors have developed their own formal and informal training and evaluation process (Alwi et al. 2002b).

Generally, training centre requires workers to be at least 18 years old and physically able to perform the work. However, mostly people can find that some workers are below 18. Most of the workers argued that experience and training was helpful but usually was not necessary to obtain a job. Relevant work experience that provides construction-related job skills can often reduce or eliminate a wide range of training. However, only few contractors understand that workers also need the ability to read and comprehend all warning signs and labels on a construction site and reading skills sufficient to understand and interpret plans, drawings, and written instructions and specifications.

Supervisory skill or the lack of it, directly affects every company's bottom line. Each day, decisions made by every foreman and supervisor are crucial to the success or failure of every construction project. It is interesting to note that although project managers accept that some form of supervisory training is essential, and show initial enthusiasm towards this topic when it is discussed, only few seem prepared to take any practical step. Some managers said that supervisors either cannot be spared or are too busy to make the arrangements. Others ignore the facilities offered, possibly because they think the subject is unimportant.

Training institutions that may educate construction workers are limited in Indonesia. Worker as a resource have specific characteristics. The production output of workers is a

function of skill and motivation. It is clear that Indonesia has similar problems to other developing countries, i.e.: poor worker productivity. In Indonesia, training for workers by contractors is virtually of no existence except in specialised areas such as railways, power plants and irrigation, which are still under the government's control. An experience from another developing country such as Sri Lanka identified that Sri Lankan industry is dominated by unskilled workers (Jayawardane and Gunawardena 1998). Kaming et al. (1997a) reported that approximately 86% skilled workers in Indonesia are informally trained by a senior workers only. The same situation exists also in other developing countries such as 80% of skilled workers in Sri Lanka (Jayawardane and Gunawardena 1998) and 95% in Iran (Zakeri et al. 1996).

RESEARCH METHOD

DATA COLLECTION AND ANALYSIS

The data was collected through a comprehensive survey research and case studies targeted at small to medium contractor companies that got involved in building construction projects. The survey research was carried out towards 26 contractors to identify the number of waste cost and the management tools used to reduce the waste cost. Whereas case studies were undertaken targeted at three contractors and focusing on identifying the effects of on-site training programs on labour productivity.

Using a survey research, respondents were asked their opinions through a questionnaire and followed up by direct or face-to-face interviews to clarify doubts, and ensure that the responses were properly understood by repeating or rephrasing the questions.

The questionnaire was designed into three sections questioning the characteristics of waste activities during the construction process. Respondents, projects and company profiles were detailed. The first section contained questions referring to the frequency of waste activities and what the levels of effects of waste activities have on construction projects. Section two dealt with the number of waste cost that occurred and the management tools that have been used to reduce the waste cost. In this section, the company was asked to estimate (by ticking the appropriate number from 1 to 12 as seen on Table 1) the direct cost of waste in relation to the total of project costs and identify certain management tools that have been used to reduce waste cost.

Table 1: Percentages of Direct Cost of Waste

1	2	3	4	5	6	7	8	9	10	11	12
0-2%	>2-4%	>4-6%	>6-8%	>8-10%	>10-12%	>12-14%	>14-16%	>16-18%	>18-20%	>20%	Do not know.

For the last section, respondents were asked to estimate (by ticking the appropriate number from 1 to 12, as seen on Table 2) what percentage of the cost of waste the management tools were able to reduce. Collected data of waste cost and waste cost reduction amongst all respondents were tabulated and compared one to another. The mean was also calculated.

Table 2: Percentages of Waste Cost Reduction

1	2	3	4	5	6	7	8	9	10	11	12
Cannot reduce	0-10%	>10-20%	>20-30%	>30-40%	>40-50%	>50-60%	>60-70%	>70-80%	>80-90%	>90-100%	Do not know.

Interviews involved almost all levels of project participants such as Project Managers, Site Engineers, Supervisors, Foremen and Labourers. The interviewer conducted two forms of interviews: open-ended interviews and focused interviews. In the open-ended interviews, the respondents were asked for facts, in addition to their opinions about specific waste activities that occurred on-site and how they overcame the waste problems. In some situations the interviewer asked the interviewee to propose their own insights into certain occurrences.

Case studies were conducted towards three different contractors that were involved in building construction projects up to five levels. The case studies aimed to monitor the effects of on-site training programs on field personnel productivity. The effects of the training programs are reflected by measuring the Percent Plan Completed (PPC). PPC can be described as a percentage of the ratio of the number of completed assignments to the total number of planned assignments in a week. The metric values of PPC can be ranged from 0 to 100%, where the higher the value is, the better the productivity of the project will be. Explanations about the relationship between training, productivity and PPC are described in the next section. The term “PPC” derives from The Last Planner System developed by Ballard (2000). The explanation of The Last Planner System is beyond the scope of this paper.

Three contractors that were targeted in the case studies are named Company-A, Company-B and Company-C. These contractors have never been conducting any on-site training program for their field personnel. By using a master schedule, the number of assignments planned in a week was designed together by Site Engineers, Supervisors and Foremen. Through daily visual inspection and based on foremen/supervisors weekly reports, the number of completed assignments was determined. A weekly PPC of the three projects were monitored over the total of 26 weeks period. The monitoring of the PPC was divided into two phases. The first phase was carried out over the first 18 weeks and the second phase was carried out from week 19 to week 26.

During the first phase, the field personnel did not receive any on-site training. They completed all works required based on a regular basis and PPC was monitored weekly. The number of assignments planned in a week was designed based on a constraint analysis and the level of labourer productivity. As there are no standards of labourer productivity in Indonesia, the determination of the level of their productivity was based on foremen’s experiences. The matching between load of works and capacity of labourer was conducted by trial and error method. At the end of each week, the analysis of root causes of non-completed works was also carried out and the level of labourer productivity was then determined.

At the end of week 18 or before entering week 19, on-site training was conducted regularly to all the field personnel. The training was given to the field personnel in order to increase their productivity. From week 19 to week 26, PPC was monitored again. The comparison of labour productivity between the first phase and second phase was conducted

by measuring the percentages of work completed against work planned. Finally, for each phase, an average PPC was calculated based on the weekly PPC determined.

The type of the training programs was selected by Quality Control Department (QCD) according to the needs of works to be done and was described more in detail in the next section.

ON-SITE TRAINING PROGRAM

The most common form of on-site training program is on-the-job training, in which field personnel learn by doing a job or receiving one-on-one instruction that is usually from a supervisor in how to do a job. Field personnel or labourers apply this learning immediately to tasks for which they are responsible.

On-site training program is a method of training that was applied to contractors during the case studies. This training program was executed on site during the construction process. This training, which was under the responsibility of Quality Control Department (QCD), was designed for field personnel who were working on-site to specifically fulfill the needs according to their specific jobs such as painting, plastering, tiling, and bricklaying. The QCD scheduled and chose the type of training with an approval by a Project Manager. The training focused on educating the field personnel not only of how to complete their jobs both effectively and efficiently in the correct manner without compromising the quality, but also how to identify all errors occurred, as earlier as possible, during the construction process and report the errors, if any, to their supervisor.

The number of field personnel involved in this training varies from project to project. They were normally around 12 people including foremen and supervisors. The length of the training was normally 30 minutes or longer, but not more than one hour and it depended on the complexity of the works to be done.

The training was divided into two sessions. Firstly, all field personnel were given an explanation or theory in relation to the materials used, method and quality of work, waste activities and equipment/tools to use. Secondly, an instructor from the QCD physically showed how to complete the job in the correct manner. In this session, all field personnel were given the opportunity to practice and ensure that they understood clearly of how they should carry out their job productively.

As field personnel in the Indonesian construction industry are identified as free workers which means that they are able to “come and go” at any time they want, there is still debate amongst contractor companies as whether they should train their field personnel or not. Interviews confirmed that normally field personnel who work on-site change in between two and three months. To cope with this problem, training program was designed for every two or three months period. The type of the training program was selected by QCD according to the needs of work to be done. Root causes of why work was not completed were determined and analysed. This analysis assisted QCD in designing the type of training that suited work for the following week.

To better meet on-site training needs it is important that training programs are designed to be responsive to the demand for training rather than simply providing a supply mechanism to deliver pre-packaged courses in pre-determined areas of training. Training should bear a high degree of relevance to the work that labourers currently do, or to the work that is planned to

do. Ultimately, the success of any training activity will depend on individual motivation of the participant and the commitment of the companies from which they come.

Badge or card identification was given to the field personnel who had received on-site training program, so foremen or supervisors were able to identify a new field personnel who just joint the project and needed proper training before starting the jobs.

TRAINING, PRODUCTIVITY AND PPC

The main purpose of the on-site training is to increase labourers' productivity during the construction process. Training benefits companies by providing qualified labourers especially field personnel who are better able to handle the demands of today's construction environment. The companies will appreciate on-site training programs as a result of the increased quality of field personnel. By increasing their quality, higher field personnel productivity is achieved.

As having been mentioned before, the Percent Plan Completed or PPC is described as a percentage of the ratio of the number of completed assignments to the total number of planned assignments in a week. According to Ballard (2000), a high PPC reflects a well-planned production process with high workflow reliability between production units. A PPC less than 100% reflects a failure in the production planning process. Understanding the causes of the failure will enable future improvement of the planning process. During the planning process, planners are empowered to schedule day-to-day assignments according to the prevailing conditions of the site. This includes the productivity rate of field personnel. The higher the productivity of field is, the better the planning process will be and it will lead to an increase in PPC.

WASTE COST AND WASTE COST REDUCED

The result of the survey research indicated that the score of the waste cost occurred amongst the 26 contractors ranged from 1 (0-2%) to 4 (>6-8%) of the total project cost, with the average score of the waste cost 2 (>2-4% of the total project costs). These figures can be seen in Figure 1. Numbers 1 to 16 indicated the names of the companies involved in the survey. The waste cost could be described as any expense allocated for activities that were not added to project values such as rework and repair, or for wasting of raw materials and loss of materials on-site. The waste cost indicated in this paper was similar compared to the results of the previous research conducted by Alwi et al. (2001) in relation to rework cost. Alwi et al.(2001) identified that the rework cost ranged from 2.01% to 3.21% of the total project cost.

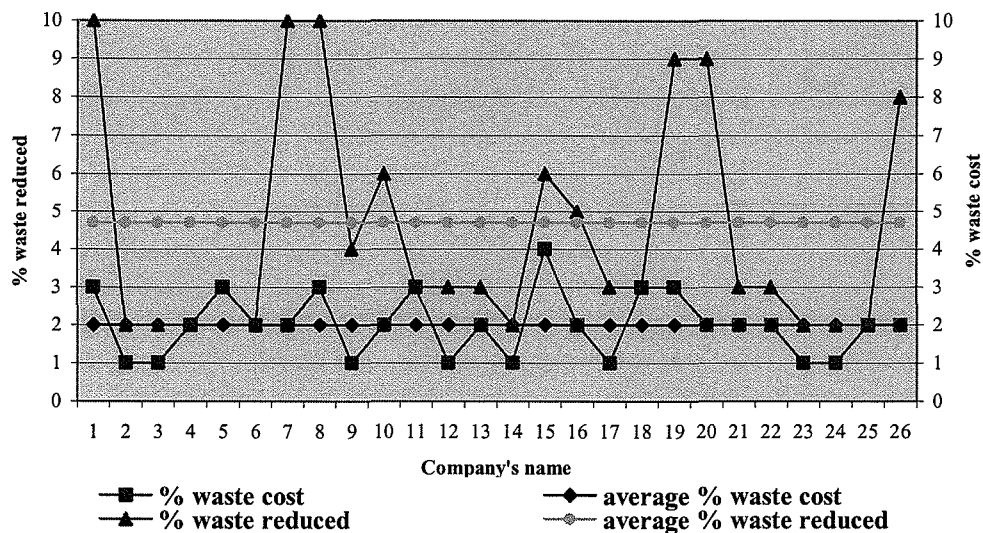


Figure 1: Waste Cost and Waste Cost Reduced

The survey indicated that almost all of the respondents argued that training program was a robust management tool to enhance construction productivity. Of 26 contractors, 24 stated that their internal training program for their construction personnel could reduce their waste cost significantly. Contractors that have been conducting internal training program for their construction personnel were able to reduce their waste cost up to 90%. The percentages of the waste cost reduction of each of the contractors are shown graphically in Figure 1. The result indicated that the score of the waste cost reduction ranged from 2 (0-10%) to 10 (80-90%), with the average score of the waste cost reduction was 4.7 or close to 30-40%.

The reduction of the waste cost differed from one contractor to another. For examples, the score of the waste cost of Company-1 was 3 (>4-6% of the total project costs). After conducting the training program, Company-1 was able to significantly reduce their waste cost up to 90%, with the score 10. On the other hand, Company-15, whose waste cost score was 4 (>6-8% of the total project cost), could only reduce the waste cost up to 50%. It is important to note that the reduction of the waste cost does not depend only on the amount of waste cost that occurred, but also on company's commitment to conduct training programs for their construction personnel.

The construction personnel included all level of management from senior management to technical or field personnel who work on-site. The interviews conducted showed that supervisory and management personnel received more training than employees in technical and field personnel did. This happened because the companies believed that the key success of completing a project relied heavily on management level personnel. Senior executives and business development personnel were the most likely employees to receive training from external sources conducted by external consultants and public seminars. For the technical and field personnel, most of the training provided were done informally through on-the-job instructions or were provided by a supervisor. This was particularly suitable for field personnel and smaller contractors.

CASE STUDIES

The main purpose of the case studies was to identify the effect of on-site training programs of field personnel on construction productivity. The results of the survey research indicated that a regular training program for the management level of the construction personnel could reduce the amount of waste cost significantly. The PPC of Company-A, B and C are tabulated and graphically presented in Figures 2 to 4, respectively.

There were two important issues that could be noted when the PPC of the first and second phases were compared amongst the three companies. The first important issue related to the average PPC, whereas the second important issue dealt with the fluctuations of the PPC. The PPC shown in Figures 2 to 4 indicated that the average PPC in the first phase was lower than that in the second phase. In the first phase, the average PPC of the Company-A, B and C were found to be 28.10, 30.60 and 41.45, respectively. However, in the second phase, the average PPC data increased to become 50.31, 48.79 and 49.77. Figures 2 to 4 also showed that the fluctuations of the PPC in the first 18 weeks were found to be greater compared to the PPC on the weeks 19 to 26. It is worth noting here that in the second phase, contractors had better understanding of the productivity level of their field personnel, because the field personnel have received a proper on-site training. By knowing the workers' productivity level, the matching between load of the works and the capacity of the workers could be reached easily leading to reducing the fluctuations and at the same time increasing the PPC.

It is important to note that the performance of field personnel is critical to the success of any construction project. According to the project managers, lack of proper training of field personnel has contributed to the continued increase of waste costs. Contractors argued that informal training such as on-site training could improve the skills of field personnel, decline waste costs and thus improve productivity on construction projects.

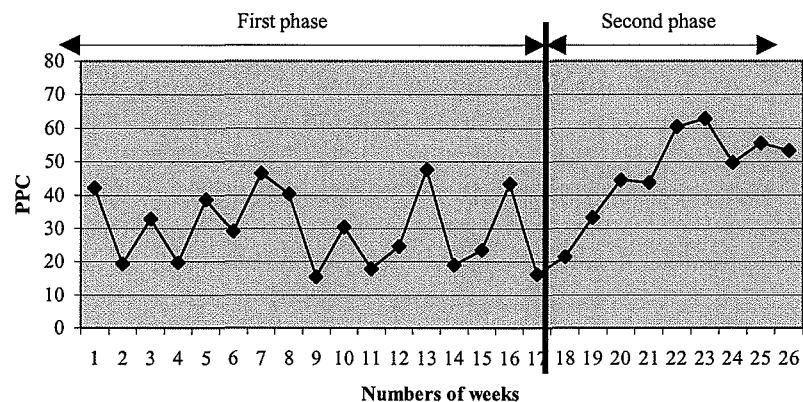


Figure 2: PPC Data of Company-A

Second phase

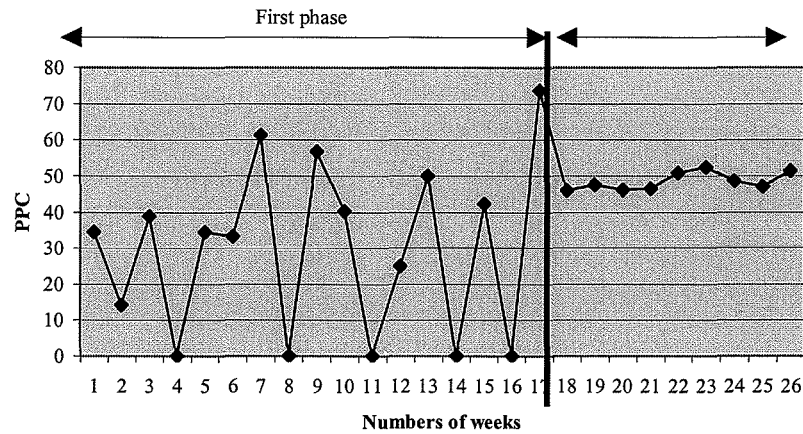


Figure 3: PPC Data of Company-B

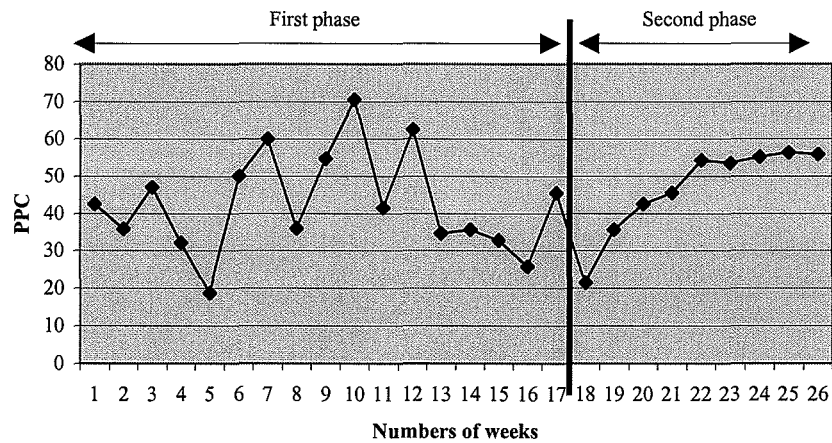


Figure 4: PPC Data of Company-C

CONCLUSIONS AND CONTRIBUTIONS

The construction industry, especially consisting of small to medium contractors, is operating in a tight but growing economic market. These conditions make for fierce competition for jobs and skilled personnel. Many of the challenges that have been faced by the construction industry over the past five years continue to be compelling issues such as lack of skilled people at both the field and management levels. The need for training at the field personnel level is obvious, and, if addressed can improve construction productivity and competitiveness within a company and across the industry. While companies consistently identify the lack of skilled field personnel as a major challenge, they are investing the least amount of training dollars in this area. Training is more useful when it is designed to address a specific problem. Providing training opportunities for employees beyond the executive level enhances employee morale, skills, abilities, and, hence productivity.

This paper described the significant role of field personnel to reduce the amount of direct cost of waste. By conducting proper on-site training programs for their construction personnel, contractors were able to reduce direct cost of waste up to 90%, with the average reduction cost around 40%. Moreover, the results of the case studies concluded that regular on-site training for field personnel has significantly reduced the fluctuations of PPC, and also at the same time increased the PPC itself. It can be said that on-site training for field personnel enhanced construction productivity. The average PPC of three companies increased from 28.10, 30.60 and 41.45 to 50.31, 48.79 and 49.77, respectively. On average, significant achievement has been obtained by increasing more than 50% of the PPC.

Despite a number of studies addressing the concept of training programs and their effects leading to improving labour productivity, to the best knowledge of the author, investigations of the effects of on-site training for field personnel in the Indonesian construction industry have never been studied before. Therefore, this research has been valuable in creating the foundations for exploring the alternative tool to increase labour productivity. There is a whole range of issues that merit further attention, and their investigation could make a significant contribution to the advancement of this new and important area of research. In particular, this paper contributes significant benefits for construction industry by providing:

- A comprehensive documentation of waste cost during the process, and
- An alternative tool to be applied on-site and as the same time to measure labour productivity.

The results of the waste cost and waste cost reduction of the research are based on individual respondents' perceptions. It has perhaps been the case that perceptions are subjective views about an issue which may or may not reflect the reality. In other words, while collecting data from respondents who are involved in a project, the personal bias of respondents, influenced by personal qualifications and work experience, may reduce the objectivity of the responses. The current economical and political issues, of which Indonesia is experiencing economic crisis, may affect the perceptions of the respondents as well. This problem may be exacerbated by the choice of the research approach, random selection and unfamiliarity with the subject matter.

REFERENCES

- Alarcon, L.F. (1994). "Tools for the Identification and Reduction Waste in Construction Projects." In Alarcon, Luis, (Ed.) *Lean Construction*, A.A.Balkema, Netherlands 1997.
- Alwi, S. and Hampson, K (2003). "Identification the Important Causes of Delay in Building Construction Projects." *Proceedings of the Ninth East Asia-Pacific Conference on Structural Engineering and Construction*, Bali, Indonesia.
- Alwi, S.; Hampson, K. and Mohamed, S. (2002a). "Factor Influencing Contractors' Performance in Indonesia: A Study of Non Value-Adding Activities." *Proceedings of the International Conference on Advancement in Design, Construction, Construction Management and Maintenance of Building Structure*, Bali, Indonesia.

- Alwi, S.; Hampson, K. and Mohamed, S. (2002b). "Waste in the Indonesian Construction Project." *Proceedings of the 1st International Conferences of CIB W107 – Creating a Sustainable Construction Industry in Developing Countries*, South Africa.
- Alwi, S; Hampson, K. and Mohamed, S. (2001). "Effect of Quality Supervision on Rework in the Indonesian Context." *Asia Pacific Building and Construction Management Journal*, 6 () 2-6.
- Ballard, G. (2000). "The Last Planner System of Production Control." Doctoral Dissertation, The University of Birmingham.
- Jayawardane, A.K.W. and Gunawardena, N.D. (1998). "Construction Workers in Developing Countries: A Case Study of Sri Lanka." *Journal of Construction Management and Economics*, 16 () 521-530.
- Kaming, P.F.; Olomolaiye. P.O.; Holt, G.D. and Harris, F.C. (1997a). "Factors Influencing Craftsmen's Productivity in Indonesia." *International Journal of Project Management*, 15 (1) 21-30.
- Kaming, P.F.; Olomolaiye, P.O.; Holt, G.D and Harris, F.C. (1997b). "Factors Influencing Construction Time and Cost Overruns on High-Rise Projects in Indonesia." *Construction Management and Economics*, 15 (2) 83-94.
- Koskela, L. (1992). "Application of the New Production Philosophy to Construction." *Technical Report No. 72*, CIFE, Stanford University.
- Zakeri, M., Olomolaiye, P.O., Hold, G.D. and Harris, F.C. (1996). "A Survey of Constraints on Iranian Construction Operatives' Productivity." *Journal of Construction Management and Economics*, 14 (5) 417-426.