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STUDY ON FACTORS AFFECTING PROJECT LEVEL PRODUCTIVITY IN INDONESIA

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ABSTRACT: The most challenging issue in Construction industry in the last decade is how to improve the productivity. Many researches have been done in the last decade however a deeper understanding is still needed to improve the productivity. The aim of this study is to get the latest information and to identify the key factors that affect project-level productivity in Indonesia. Data were collected through questionnaires distributed to respondents who work at various projects in wide area in Indonesia. The questionnaire explores factors identified from past researches and then measured their level of affect to project-level productivity in Indonesia. The data collected were analyzed using the Relative-Importance-Index (RII) to find the key factors. The results show that the most influential factors to project level productivity in Indonesia are: design, implementation plan, labor, supervision, material, field management, equipment, leadership and coordination. Furthermore, each factor has their key component. Research finding also identifies seven components which have high influence to project-level productivity, that is inaccurate design, unclear command to workers, changes in design, incomplete design, low skill levels of worker, inappropriate work methods and poor schedule plan. The results will become worthwhile information in efforts to improve the productivity in Indonesian construction industry.
KEYWORDS: Influence factors, project-level productivity, project completion

❖ INTRODUCTION

Problems in increasing productivity has long been a concern to the researchers, in which the identification and evaluation of the factors that affect productivity have become critical issues faced by project managers for a long time in order to increase productivity in construction (Motwani et al., 1995). Various factors have been generated in past research, including: factors associated with management (Khoramshahi, F. et al., 2006; Weng-Tat, C., 2007; Kazaz, A. et al., 2008); factors relating to the method of construction and weather (Sanders, SR and Thomas, HR, 1991; Thomas, HR et al., 1999; Weng-Tat, C., 2007); factors associated with working hours arrangements (Thomas, HR, 1992; Hanna, AS et al., 2005, 2008; Ibbs, W., 2005; Nepal, MP et al., 2006); and factors related to characteristics of labor (Oglesby et al., 1989; Baba, K., 1995, Langford, D. et al., 1995).

However, these studies generally only focus on the evaluation of productivity at the level of activity of a job. Productivity itself can be measured at various levels, such as: at the national level, at industry level, at company level, at project level, or at the level of task or activity of a job. Productivity data at the level of activity can not be directly used to measure productivity at the project level because there is missing in linkages between the activity factors.

Meanwhile, research Haskell (2004) in America found that many productivity data in the construction industry are incomplete and contradictory. Besides that, there is no regular data collection and no regular measurement of productivity, either by industry or by government.

The productivity data on Haskell's research taken in the period 1966-2003 indicated that the results of previous studies did not fully describe the facts of productivity in the construction industry in America. Thus, although much research has been done and produce the factors that affect productivity, but there are still many things still unknown (Makulsawatudom and Emsley, 2002). Of all the existing research, the problem of measuring productivity in construction is still a complex issue and there is no single formula that can be used in general to increase productivity in various conditions of project. So even though the construction industry is very important for the economy of a country, construction productivity is still controversial and many determinants factors of productivity are not well understood, besides that the measurement of the productivity of the existing data are still contradictive and conflicting (Lim and Price, 1995b).

In addition, the determinants of productivity is not necessarily independent. Productivity of project completion is a function of input and output, where the input is transformed into output through the management / project management. This relationship forms a complex system of various factors interacted each other. For that it needed the efforts to understand the productivity as a whole that includes the identification of the determinants of productivity at the project level and understand the interaction and interdependence of factors in order to obtain a more complete picture that will facilitate in determining the productivity improvement measures. In this case, study on project level productivity has not been much conducted in previous researchers. This study will examine the determinants of productivity at project level that will facilitate in determining the effort of productivity improvement.

❖ FACTORS AFFECTING PRODUCTIVITY

There are many things that can affect the productivity from the problem of workforce motivation, issues of supervisory, issues of management and project management till weather problems, methods, occupational safety and health, and so forth. In this case it has been many studies about factors that affect productivity in construction and many previous studies have found factors influence construction productivity. Meanwhile, despite many studies have been done, but there is no general agreement on the grouping of the factors that significantly affect the productivity. In this case the classification of factors that influence the productivity was carried through various individual approaches from researchers, so produce different versions of the classification of factors influence the productivity.

In this research the factors will be grouped using a combination of two recent studies, the research by Enshassi et al. (2007) and the National Construction Services Development Board (2008), in which:

1. Enshassi et al. (2007) classifies factors affecting productivity in the construction into 10 groups, namely: factors associated with the internal workforce, factors associated with leadership, factors associated with work motivation, factors associated with time, factors associated with materials and equipment, factors related to supervision, factors related to project characteristic, factors related to security, factors related to quality, and external factors.
2. While the National Construction Services Development Board (2008) classifies factors affecting productivity in construction into 6 groups, namely: factors associated with management, factors associated with the technology, factors associated with the regulations, factors associated with labor and skilled labor, factors associated with design and technical, and other factors.

Based on previous research, were identified 113 factors affecting productivity of then grouped into 15 groups based on their characteristics, namely: 1. factors associated with design (5 factor); 2. factors associated with implementation of planning (5 factors); 3. factors related to the material (8 factors); 4. factors associated with equipment (6 factors); 5. factors associated with labor (18 factors); 6. factors related to occupational safety and health (4 factors); 7. factors related to supervision (6 factors); 8. factors related to working time (6 factors); 9. factors associated with the project conditions (15 factors); 10. factors related to quality (3 factors); 11. factors associated with financial (6 factors); 12. factors related to the coordination and leadership (5 factors); 13. factors associated with the organization (12 factors); 14. factors related to the owner / consultant (4 factors); 15. factors associated with external factors (10 factors). These factors were used as the basis for preparing a questionnaire to assess its effect on construction productivity in Indonesia.

❖ RESEARCH METHOD

The data collected to determine the most influence factors on productivity of project completion is done through survey by explorative questionnaire to the respondents who are involved in the management of projects in various regions in Indonesia. The questionnaire was designed so respondents can give the rank to their answers based on the Likert scale (Kothari, 2003).

Various approaches to the respondent is required related to many items that must be filled. There were 89 questionnaires from various regions in Indonesia that was succesfully collected. The respondents work in various construction companies both private and government as: director of operations, project managers, site managers, site engineers, superintendent, estimator, and supervisor. Meanwhile based on work experience, the majority of respondents (88.76%) have work experience of more than 5 years even more than 50.56% have experience of more than 10 years. Work experience of Respondents covered a variety of projects, such as: roads and bridges, water buildings and irrigation, lowrise building till highrise buildings (see Table 1).

Table 1: Type of Project.

Road and Bridges	Water Building and Irigation	Buildings < 3 floors	Buildings 3 - 10 floors	Buildings > 10 floors	Others	Number of respondent
17	6	30	18	17	1	89

The data in this study were measured using ordinal scale to determine the level of influence of each research variable (1 = small, 2 = medium, 3 = adequate, 4 = large, 5 = very big). Respondents were asked to rate how much influence the factors used as indicators of research on productivity from the aspects of cost, quality, and time. Collected data were analyzed using the value of Importance Index through the equation from Lim et al., 1995a:

$$\text{Importance index} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5(n_1 + n_2 + n_3 + n_4 + n_5)} x100 \qquad (1)$$

where: n_1 = number of respondents who gave the ratings of influence "small"; n_2 = number of respondents who gave the ratings of influence “medium”; n_3 = number of respondents who gave the ratings of influence “adequate”; n_4 = number of respondents who gave the ratings of influence “large”; n_5 = number of respondents who gave the ratings of influence “very big”.

The value of Relative Importance Index (RII) of each factor can be determined directly from the equation, while the value of index group of factors is determined based on the mean value of the indicator. The maximum value of the index is 5 if all respondents answered "very big influence" and the minimum value of the index is 1 if all respondents answered "small influence". Because the average results obtained in the form of decimal numbers, it is necessary to determine the rating scale. For it 5 rating scale is determined by the interval 0.80 to classify the level of influence from the respondents' answers (see Figure 1).

20.00 — 36.00 — 52.00 — 68.00 — 84.00 — 100.00

Small — medium — adequate — large — very big

Figure 1: Evaluation Scale.

❖ ANALYSIS AND DISCUSSION

The result shows there are 7 factors that have large influence on the productivity of project completion with the importance index value from 68.00 to 84.00. The seven factors are: (1) inaccuracies in the design, (2) unclear instruction to workers, (3) changes in design, (4) incompleteness of design, (5) low level of skills owned by workers, (6) inaccurate working methods, and (7) bad working order planning. Meanwhile, 67 factors have enough influence with the importance index value 52.00 to 68.00, in which ten of them are: (1) poor management of material, (2) bad leadership, (3) low quality of materials, (4) lack of material, (5) poor field management, (6) lack of work experience, (7) repair and repetition of work, (8) there is no method of supervision, (9) bad weather, and (10) labor indiscipline. In addition, there are 31 factors that have medium influence with the importance index value 36.00 to 52.00 and the remaining 8 factors have little influence with the importance index value 20.00 to 36.00.

From 113 factors studied, factors in the top 30 rank was taken as the key indicators that affect construction productivity (see Table 2).

Table 2: Rank Factors Affecting Productivity.

	Factors Affecting Productivity	Mean according to cost	Rank according to cost	Mean according to quality	Rank according to quality	Mean according to time	Rank according to time	Importance Index	Rank
	Maximum Value	5	113	5	113	5	113	100	113
1	Inaccurate design	3.6742	2	3.2472	9	3.7528	11	71.1610	1
2	Unclear instruction to laborer	3.1461	26	3.4382	4	4.0337	3	70.7865	2
3	Design changes	3.6517	3	2.9775	22	3.8764	6	70.0375	3
4	Incomplete drawing	3.4494	5	3.0899	18	3.8315	8	69.1386	4
5	Low skill level of laborer	3.2135	18	3.5169	2	3.6067	22	68.9139	5
6	Inappropriate work method	3.4270	6	3.3483	5	3.5169	28	68.6142	6
7	Poor sequencing of work items	3.3483	10	3.2360	10	3.6629	16	68.3146	7
8	Bad material management	3.3708	8	3.1124	16	3.7079	13	67.9401	8
9	Bad leadership	3.2809	12	3.2921	7	3.5955	25	67.7903	9
10	Low quality of material	3.1798	23	3.8427	1	3.1124	56	67.5655	10
11	Lag of material	3.1461	27	2.6404	44	4.3371	1	67.4906	11
12	Bad site management	3.3258	11	3.1685	13	3.5393	26	66.8914	12
13	Lack of labor experience	3.0112	38	3.5056	3	3.5056	29	66.8165	13
14	Repairs and repetitions of work	3.8652	1	2.4944	54	3.6517	17	66.7416	14
15	No supervision method	2.9326	49	3.2921	6	3.7640	10	66.5918	15
16	Bad weather (rain, heat, etc.)	3.2584	14	3.0899	19	3.6292	20	66.5169	16
17	Indiscipline labor	3.1348	30	3.1685	14	3.6404	19	66.2921	17
18	Lag of skill laborer	3.0337	37	3.2247	11	3.6742	15	66.2172	18
19	Frequent damage of equipments	3.3483	9	2.9438	23	3.5955	23	65.9176	19
20	Lag of equipment	3.1573	25	2.8090	30	3.8202	9	65.2434	20
21	Bad resources management	3.2247	17	3.0337	20	3.5281	27	65.2434	21
22	Labor strikes	3.1124	32	2.6180	46	4.0225	4	65.0187	22
23	Incompetence supervisors	2.8090	56	3.2809	8	3.6404	18	64.8689	23
24	Financial difficulties of the owner	3.2697	13	2.5730	48	3.8652	7	64.7191	24
25	There is no definite schedule	3.1461	29	2.8090	32	3.7416	12	64.6442	25
26	Specification changes	3.5506	4	2.7079	40	3.4382	36	64.6442	26
27	Poor communication in site	3.0674	34	3.1124	17	3.5056	30	64.5693	27
28	Supervision absenteeism	2.8652	53	3.1573	15	3.6180	21	64.2697	28
29	Miscommunication between labor and supervisor	2.9551	48	3.2022	12	3.3933	38	63.6704	29
30	Delay in arrival of materials	3.1910	21	2.1910	74	4.1461	2	63.5206	30

The thirty factors come from 9 groups of factors, namely: (1) factors relating to the design (4 factors), (2) the factors associated with planning and implementation (3 factors), (3) factors related to labor (4 factors), (4) factors associated with supervision, (5) factors associated with material (4 factors), (6) factors related to site management (2 factors), (7) factors related to equipment (2 factors), (8) factors associated with leadership and coordination (4 factors), and (9) external factors (3 factors). All of the nine groups of factors and their factors can be seen in Table 3.

Table 3: The Rank of Group and the Most Influence Factors.

Factors Affecting Productivity		Mean Value Top 30 Factors	Imp Index Top 30 Factors	Rank Factor	Top 30 Factors	Mean Group Based on Top 30 Factors	Imp. Index Group	Rank Group	Level of Influence
	Maximum Value		100	113		5	100		
A	Aspects Relating to Design					3.4373	68.7453	1	High
A1	Inaccurate design	3.5581	71.1610	1	?				
A2	Design changes	3.5019	70.0375	3	?				
A3	Incomplete drawing	3.4569	69.1386	4	?				
A4	Specification changes	3.2322	64.6442	26	?				
B	Aspects Relating to Execution Planning					3.3596	67.1910	2	Average
B1	Inappropriate work method	3.4307	68.6142	6	?				
B2	Poor sequencing of work items	3.4157	68.3146	7	?				
B3	There is no definite schedule	3.2322	64.6442	25	?				
C	Aspects Relating to Labour					3.3586	67.1723	3	Average
C1	Low skill level of laborer	3.4457	68.9139	5	?				
C2	Lack of labor experience	3.3408	66.8165	13	?				
C3	Repairs and repetition of work	3.3371	66.7416	14	?				
C4	Lag of skill laborer	3.3109	66.2172	18	?				
D	Aspects Relating to Supervision					3.3315	66.6292	4	Average
D1	Unclear instruction to laborer	3.5393	70.7865	2	?				
D2	No supervision method	3.3296	66.5918	15	?				
D3	Incompetence supervisors	3.2434	64.8689	23	?				
D4	Supervision absenteeism	3.2135	64.2697	28	?				
E	Aspects Relating to Material					3.3315	66.6292	5	Average
E1	Bad material management	3.3970	67.9401	8	?				
E2	Low quality of material	3.3783	67.5655	10	?				
E3	Lag of material	3.3745	67.4906	11	?				
E4	Delay in arrival of materials	3.1760	63.5206	30	?				
F	Aspects Relating to Site Management					3.3034	66.0674	6	Average
F1	Bad site management	3.3446	66.8914	12	?				
F2	Bad resources management	3.2622	65.2434	21	?				
G	Aspects Relating to Equipment					3.2790	65.5805	7	Average
G1	Frequent damage of equipments	3.2959	65.9176	19	?				
G2	Lag of equipment	3.2622	65.2434	20	?				
H	Aspects Relating to Leadership and Coordination					3.2790	65.5805	8	Average
H1	Bad leadership	3.3895	67.7903	9	?				
H2	Indiscipline labor	3.3146	66.2921	17	?				
H3	Poor communication in site	3.2285	64.5693	27	?				
H4	Miscommunication between labor and supervisor	3.1835	63.6704	29	?				
I	Aspect Relating to External Factors					3.2709	65.4182	9	Average
I1	Bad weather (rain, heat, etc.)	3.3258	66.5169	16	?				
I2	Labor strikes	3.2509	65.0187	22	?				
I3	Financial difficulties of the owner	3.2360	64.7191	24	?				

The results also indicate that factors related to occupational safety and health (OSH) has a relatively low position with RII 45.6367. This indicated that the OSH factor has not received adequate attention in the implementation of construction projects in Indonesia. The matters related to OSH need special attention because many studies showed that OSH factor has a great influence on work motivation, even OSH is one of the main factors in improving the "quality of work life" (QWL) (Soekiman 2009). QWL is an important aspect in improving the image of construction that is known as one of the most professions at risk. This image improvement will increase the interest young people to have a career in construction, so that will help solve the problem of scarcity of experts and skilled workers in the future. OSH factors also needed to improve job satisfaction, which in turn will help to increase the loyalty of existing workers (Soekiman and Setiawan, 2009).

❖ RELIABILITY OF RATINGS

To test the consistency of the rating, two set of hypotheses were set to be tested as follows:

- □ Initial hypothesis, H_o: "*there is no significant conformance in rank of factors among the respondents*"
- □ Alternative hypothesis, H_1: "*there are significant conformance in rank of factors among the respondents*"

This test is intended to ensure that the rating variables is not obtained by chance, but achieved through a conformity of opinion among the respondents, so the results can be considered reliable. To test these hypotheses, non-parametric test using the coefficient of Kappa (K) can be used (Siegel and Castellan, 1998). Testing this hypothesis does not depend on the distribution of data, unlike the parametric test. In this case the parameters of test are: N = 113 the number of variable, with I = 89 total respondents to rate the influence of productivity factors on a scale 1-5, M = 5. The value of conformity Kappa coefficient (K) is calculated using the equation of Siegel and Castellan (1998).

$$K = \frac{P(A) - P(E)}{1 - P(E)} \tag{2}$$

where P (A) is the proportion of respondents who have suitability; P (E) is the proportion of respondents who happened to be the same. If there is a compatibility among all respondents, then K = 1; and if there is no suitability, then K = 0.

$$P(E) = \sum_{j=i}^{m} P_j^2 \text{, where: } P_j = \frac{C_j}{NI} \tag{3}$$

C_j = frequency of a factor in the ratings of j

$$P(A) = \left[\frac{1}{NI(I-1)} \sum_{i=1}^{N} \sum_{j=1}^{M} n_{ij}^2 \right] \frac{1}{I-1} \tag{4}$$

N = total variable = 113; M = rating scale = 5; I = total respondent = 89; n_{ij} = score in the matrix of rating.

Based on Siegel and Castellan, the value of K is generally has a normal distribution with zero mean and variance, var (K), follow the equation as follows:

$$z = \frac{K}{\sqrt{\mathrm{var}(K)}} \text{, and } \mathrm{var}(K) = \frac{2}{NI(I-1)} \frac{P(E) - (2I-3)P(E)^2 + 2(I-2)\sum P_j^3}{[1 - P(E)]^2} \tag{5}$$

The statistic value of z was used to test the null hypothesis, H_0: K = 0 against the alternative hypothesis, H_1: $K \neq 0$.

Based on the equation (2), (3), and (4) above, the values of P (A), P (E) and K are calculated and tabulated in Table 4.

Table 4: Calculating The Z Value.

Influence Factor pengaruh	P(A)	P(E)	K	Var (K)	Z
Against cost	0.2701	0.2302	0.0519	3.4E-06	28.272
Against quality	0.2963	0.2372	0.0774	2.7E-06	47.376
Against time	0.2837	0.2180	0.0840	2.7E-06	51.015

The values of the variance (K) and its z value can be seen in Table 5. For the 5% significance level, z = 1.645. Since all the calculated value is greater than the value of $z_{0.005}$, it can be concluded that there is conformity in the rating factors in accordance with the expected degree of confidence. Therefore, the null hypothesis is rejected.

❖ CONCLUSIONS

Groups of factors that need special attention in an effort to increase the productivity of project completion are: (1) factors relating to the design, (2) the factors associated with implementation and planning, (3) factors related to labor, (4) factors associated with supervision, (5) factors associated with material, (6) factors related to site management, (7) factors associated with equipment, (8) factors associated with leadership and coordination, and (9) external factors.

Factors associated with occupational safety and health (OSH) also require attention even if only a has relatively low position, according to its role in improving motivation and loyalty of workers and increasing dignity, and quality of life of workers.

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