

Available online at www.sciencedirect.com

Procedia Engineering 14 (2011) 865–873

**Procedia
Engineering**

www.elsevier.com/locate/procedia

The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction

Factors Relating to Labor Productivity Affecting the Project Schedule Performance in Indonesia

A. SOEKIMAN^{a*}, K. S. PRIBADI^b, B.W. SOEMARDI^b, R.D. WIRAHADIKUSUMAH^b

^aDepartment of Civil Engineering, Parahyangan Catholic University, Indonesia

^bDepartment of Civil Engineering, Bandung Institute of Technology, Indonesia

Abstract

Construction industry faces challenges with regard to problems associated with productivity and the problems are usually associated with performance of labor. The performance of labor is affected by many factors and is usually linked to the performance of time, cost, and quality.

Meanwhile identification and evaluating factors affecting construction labor productivity have been done in the last decade; however, a deeper understanding is still needed to improve the labor productivity. This study conducted with the aim to get the latest information on key factors that affect project performance in terms of project completion time and this is part of major research to model the interaction relationships between key factors affecting productivity.

This paper reports on a survey made on respondents who involve in managing various types of projects in wide area in Indonesia. Respondents were required to rate using their experience how 113 factors identified from past researches, which grouped into 15 groups, affecting project schedule performance and then measured their level of affect. The result show that the groups of factors that give high effect are: *supervision factors*, *material factors*, *execution plan factors*, and *design factors*. In addition to these factors, for large companies *equipment factors* have also high effect. While in small and medium companies, *owner/consultant factors* also need special attention because it has high effect too. Research findings also show that *health and safety factors* has not been a concern of small and medium companies and only has some effect, while in large companies are better, although not as major concern and has average effect.

The results will become worthwhile information in determining the major steps to improve the performance of project completion time and also as part of further research in modeling the interaction relationship between the key factors affecting productivity to improve the labor productivity in Indonesian construction industry.

© 2011 Published by Elsevier Ltd. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Selection

Keywords: Schedule performance, labor productivity, productivity factors, interaction model

* Corresponding author and Presenter

Email: soekiman@home.unpar.ac.id

1. Introduction

The level of productivity in construction showed a decreasing rate compared to other sectors (Bernstein 2007). This also happened in Indonesia. Data from Central Bureau of National Statistics (BPS 2007) showed unsatisfactory level of Indonesian construction productivity. The facts of unsatisfactory projects completion are indicators of problems associated with productivity and productivity problems usually associated with labor performance (Lowe 1987; Handa and Abdalla 1989; Olomolaiye and Ogunlana 1989).

Efforts to produce better performance and increasing productivity in construction requires an understanding of the various indicators of productivity as a path to understanding the performance of the project (Atkinson et al. 1997). Besides that, efforts to improve productivity in construction industry can essentially be done by reducing project cost overrun and also project completion delay (Kaming et al. 1998).

Identification and evaluation of factors affecting labor construction productivity have become a critical issue facing project managers for a long time in order to increase productivity in construction (Motwani et al. 1995). Understanding critical factors affecting productivity of both positive and negative can be used to prepare a strategy to reduce inefficiencies and to improve the effectiveness of project performance.

Knowledge and understanding of the various factors affecting construction labor productivity is needed to determine the focus of the necessary steps in an effort to reduce project cost overrun and project completion delay, thereby increasing productivity and overall project performance.

This study aimed to identify factors affecting or contributing to the delay of projects completion in Indonesia through a survey. The results will be useful information to improve construction productivity in Indonesia.

2. Factors Affecting Productivity

Problems to increase productivity have long been a concern of researchers. Based on previous studies, key factors that can affect labor productivity in construction have been obtained from works by Oglesby et al. (1989); Sanders and Thomas (1991); Thomas (1992); Langford et al. (1995); Motwani et al. (1995); Lim and Alum (1995); Baba (1995); Zakeri et al. (1996); Lema (1995); Kaming et al. (1997); Olomolaiye et al. (1998); Thomas et al. (1999); Makulsawatudom and Emsley (2002); Ibbs (2005); Hanna et al. (2005); Nepal et al. (2006); Khoramshahi et al. (2006); Enshassi et al. (2007); Alinaitwe et al. (2007); Weng-Tat (2007); Hanna et al. (2008); and Kazaz et al. (2008).

Identified Key factors usually were used by stakeholders in each country to formulate its strategies to improve the performance of the construction industry. Although many researches have been done and produce the factors that affect productivity, there are still many productivity problems that remain unknown and need to be further investigated even in developed countries (Makulsawatudom and Emsley, 2002). In addition, policies for increasing productivity is not necessarily the same in every country. Polat and Arditi (2005) showed that the critical factors in developing countries differs from that in developing countries.

Based on past researches, 113 factors affecting construction labor have been identified and were grouped into 15 groups according to their characteristics, namely: 1. *design* (5 factors); 2. *execution plan* (5 factors); 3. *material* (8 factors); 4. *equipment* (6 factors); 5. *labor* (18 factors); 6. *health and safety* (4 factors); 7. *supervision* (6 factors); 8. *working time* (6 factors); 9. *project factor* (15 factors); 10. *quality* (3 factors); 11. *financial* (6 factors); 12. *leadership and coordination* (5 factors); 13. *organization* (12 factors); 14. *owner/consultant* (4 factors); 15. *external factor* (10 factors).

The factors which were identified from previous research are used as a basis for preparing a questionnaire to investigate its influence on the performance of the project completion time in Indonesia.

3. Research Method

3.1. Research method

Survey was made through questioner distributed to respondents who involve in managing various types of projects in wide area in Indonesia. The respondents are people who work as: operational director, project manager, project coordinator, construction manager, site manager, site engineer, superintendent, estimator, supervisor, etc. They work at contractor companies in Indonesia both private and government.

In this study, an ordinal measurement scale 1 to 5 was used to determine the effect level. Respondents were asked to rank factors affecting quality performance according to the degree of importance (1 = affects with little degree; 2 = affects something; 3 = affects with average degree; 4 = affects with large degree; 5 = affects with very large degree). For analyzing data by ordinal scale, a relative importance index (RII) was used by following equation (1):

$$\text{Relative Importance Index} = \frac{\sum_{i=1}^5 W_i X_i}{\sum_{i=1}^5 X_i} \quad (1)$$

where:

- W_i = the rating given to each factors by the respondents ranging from 1 to 5
- X_i = the percentage of respondents scoring
- i = the order number of respondents

The relative importance index (RII) for all factors was calculated. Meanwhile, the group index was calculated by taking the average of factors in each group. The maximum value of the index is 5 when all respondents answered “very high effect” and the minimum value of the index is 1 when all respondents answered “affects with little degree”. Since the results are obtained as decimal numbers instead of integer numbers, a specific scale should be established. Thus, 5 expressions are defined by the intervals of 0.80 to classify the effect level (see Figure 1).

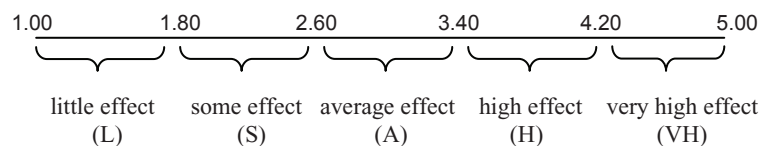


Figure 1: Evaluation scale

3.2. Survey response

As a result of surveying, mailing, and following up, a total of 63 questionnaires were completed and returned from various district in Indonesia (see Table 1). A close personal contact with contractors is needed due to a lot of item in questionnaire to be filled. The respondents come from large contractor (42.86%) and small and medium contractors (57.14%). The classification of large or small and medium contractors is based on the average of project value to be done.

Table 1: Survey area and number of responded

No	Area of survey	Number of respondent
1	West Sumatera	10
2	Jakarta and surrounding area	13
3	West Java	38
4	East Kalimantan	1
5	Middle Sulawesi	1
		63

Meanwhile according to their working experience, the majority of respondents (88.89%) have working experience more than 5 years, more over 49.21% have working experience more than 10 years. The experiences of the respondents include various construction projects from road and bridges, water building and irrigation, and low-rise buildings to high-rise buildings (see Table 2).

Table 2: Type of project

Road & Bridges	Water building & irrigation	Buildings < 3 floors	Buildings 3 – 10 floors	Buildings > 10 floors	Number of respondent
14	4	19	14	12	63

4. Result and Discussion

In general, the groups of factors that give high effect are: *supervision*, *material*, *execution plan*, and *design* (see Table 3). While other groups of factors only give an average affect even a small effect.

Table 3: The rank of group factors with high effect in general (all companies)

Group factors	RII	Effect	Rank
Supervision	3.7328	High	1
Material	3.5179	High	2
Execution plan	3.4413	High	3
Design	3.4317	High	4

Meanwhile, groups of factors that have high effect on large companies in chronological order are: *supervision*, *material*, *design*, and *equipment* (see Table 4). *Equipment* replaced *execution plan* as group factors with high effect, while *execution plan* only have average effect on large companies. It is because the large companies generally doing more complex projects and need more equipment, while *execution plan* generally have been well prepared.

Table 4: The rank of group factors with high effect in large companies

Group factors	RII	Effect	Rank
Supervision	3.8148	High	1
Material	3.4630	High	2
Design	3.4593	High	3
Equipment	3.4570	High	4

In small to medium sized companies, groups of factors that have a high effect in chronological order are: *supervision, material, execution plan, owner/consultant, and design* (see Table 5). *Owner/consultant* has big impact on small and medium companies because they generally get involved in project implementation, not like in big companies. Meanwhile *equipment factors only* have average effects; this is because the small and medium companies do the projects that are relatively not so complicated. So they generally no need to use much equipment unlike the major projects undertaken by large companies.

Table 5: The rank of group factors with high effect in small-medium companies

Group factors	RII	Effect	Rank
Supervision	3.6713	High	1
Material	3.5590	High	2
Execution plan	3.5333	High	3
Owner/Consultant	3.4236	High	4
Design	3.4111	High	5

Result shows that the group factors associated with *health and safety factors* was rank as the lowest position in the consideration of small and medium companies (RII = 2.1389, some effect), while in the perspective of large companies, it was rank as 11th (RII = 2.7222, average). This indicates that on small and medium companies, health and safety factors have not get adequate attention, but in large company is better, although not as major consideration. In the future issues related to health and safety need special attention, because it will affect work motivation. Moreover health and safety is one of factors to improve the quality of work life (QWL) (Soekiman 2009). QWL is also essential to improve the image of the construction world which is known as dirty and dangerous jobs, and improving the image will raise the interest of young people to work in construction so there is no more difficulty in getting skilled manpower in the future. *Health and safety factors* are also needed to increase work satisfaction and loyalties of current labors which will be helpful in maintaining current potential labors (Soekiman and Setiawan 2009).

Table 6: The top 10 rank of factors affecting schedule performance in general (all companies)

Factors	RII	Effect	Rank	Group
Lag of material	4.2222	Very high	1	Material
Delay in arrival of materials	4.0794	High	2	Material
Unclear instruction to laborer	4.0635	High	3	Supervision
Labor strikes	4.0476	High	4	External
Financial difficulties of the owner	4.0317	High	5	Owner/consultant
High absenteeism of labors	3.9524	High	6	Labor
No supervision method	3.8571	High	7	Supervision
Supervisors absenteeism	3.7937	High	8	Supervision
Lag of equipment	3.7778	High	9	Equipment
Design changes	3.7778	High	9	Design
There is no definite schedule	3.7619	High	10	Working time

Meanwhile, the top ten factors that affect in general (see Table 6) are: (1) *lag of material*, (2) *delay in arrival of materials*, (3) *unclear instruction to laborer*, (4) *labor strikes*, (5) *financial difficulties of the owner*, (6) *high absenteeism of labors*, (7) *no supervision method*, (8) *supervisors absenteeism*, (9) *lag of equipment and design changes*, and (10) *there is no definite schedule*.

Meanwhile, the top ten factors that affect large companies (see Table 7) are: (1) *unclear instruction to laborer*, (2) *delay in arrival of materials*, (3) *lag of material and financial difficulties of the owner*, (4) *there is no definite schedule*, (5) *low supervisor's capability/incompetence supervisors*, (6) *no supervision method, lag of equipment, and high absenteeism of labors*, (7) *supervisors absenteeism, frequent damage of equipments, and labor strikes*, (8) *design changes*, (9) *incomplete drawing and inspection delay*, (10) *poor communication in site and inaccurate design*.

Table 7: The top 10 rank of factors affecting schedule performance in large companies

Factors	RII	Effect	Rank	Group
Unclear instruction to laborer	4.1852	High	1	Supervision
Delay in arrival of materials	4.1111	High	2	Material
Lag of material	4.0741	High	3	Material
Financial difficulties of the owner	4.0741	High	3	Owner/consultant
There is no definite schedule	4.0000	High	4	Working time
Incompetence supervisors	3.9630	High	5	Supervision
Lag of equipment	3.9259	High	6	Supervision
High absenteeism of labors	3.9259	High	6	Equipment
No supervision method	3.9259	High	6	Labor
Supervision absenteeism	3.8148	High	7	Supervision
Labor strikes	3.8148	High	7	External
Frequent damage of equipments	3.8148	High	7	Equipment
Design changes	3.7407	High	8	Design
Incomplete drawing	3.7037	High	9	Design
Inspection delay	3.7037	High	9	Supervision
Inaccurate design	3.6296	High	10	Design
Poor communication in site	3.6296	High	10	Leadership

While the top ten factors that affect the small and medium company (see Table 8) are: (1) *lag of material*, (2) *labor strikes*, (3) *delay in arrival of materials*, (4) *Financial difficulties of the owner*, (5) *unclear instruction to laborer and high absenteeism of labors*, (6) *bad weather (e.g. rain, heat, etc.)*, (7) *indiscipline labor and use of alcohol and drugs*, (8) *no supervision method, design changes, repairs and*

repetition of work, and bad resources management, (9) bad supervisors absenteeism and far away from location of material storage, and (10) bad leadership.

Table 8: The top 10 rank of factors in small-medium companies

Factors affecting schedule performance	RII	Effect	Rank	Group
Lag of material	4.3333	Very high	1	Material
Labor strikes	4.2222	Very high	2	External
Delay in arrival of materials	4.0556	High	3	Material
Financial difficulties of the owner	4.0000	High	4	Owner/consultant
Unclear instruction to laborer	3.9722	High	5	Supervision
High absenteeism of labors	3.9722	High	5	Labor
Bad weather (rain, heat, etc.)	3.8889	High	6	External
Indiscipline labor	3.8611	High	7	Organization
Use of alcohol and drugs	3.8611	High	7	Labor
No supervision method	3.8056	High	8	Supervision
Design changes	3.8056	High	8	Design
Repairs and repetition of work	3.8056	High	8	Quality
Bad resources management	3.8056	High	8	Organization
Supervisors absenteeism	3.7778	High	9	Supervision
Away from location of material storage	3.7778	High	9	Material
Bad leadership	3.7500	High	10	Leadership

Incompetence supervisors become a problem in large companies in line with the increasingly high demands of the project. This occurs due to lack of competent supervisors and caused current supervisor must oversee several projects at once, where this later led to *supervisors' absenteeism* and *inspection delays*. This does not happen in small and medium companies because of the complexity of the project is relatively lower. Lack of experienced supervisors is one of the challenges facing the construction industry in Indonesia (Soekiman et al. 2010).

5. Conclusion

The groups of factors that give high effect are: *supervision, material, execution plan, and design*. Moreover, for large companies, *equipment factors* have also high effect. While in small and medium companies, *owner/consultant factors* also need special attention because it has high effect too. Research findings also show that *health and safety factors* has not been a concern of small-medium companies and has some effect, while in large companies are better, although not as major concern and has average effect.

Acknowledgements

The authors would like to acknowledge the support given by all respondents from various companies/institutions that made this research possible.

References

- [1] Alinaitwe HM, Mwakali JA, and Hansson B (2007). Factors Affecting the Productivity of Building Craftsmen–Studies of Uganda. *Journal of Civil Engineering and Management*, XIII(3), 169–176.
- [2] Atkinson A, Weterhouse J, and Wells R (1997). A Sstakeholder Approach to Strategic Performance Measurement. *Sloan Management Review*, 38(3), p. 25–37.
- [3] Baba K (1995). Cultural Influences on Construction Management. *Proceeding of the 1st International Conference on Construction Project Management*, pp. 99-106, Singapore.
- [4] Bernstein HM (2007). *Measuring Productivity in Construction: Improving Business Performance*. Dodge Sweets Architectural Record ENR Regional Publications.
- [5] BPS (2007). *Statistik Indonesia 2007*. Biro Pusat Statistik Indonesia (in Indonesian language).
- [6] Enshassi A, Mohamed, S, Mustafa ZA, and Mayer PE (2007). Factors Affecting Labour Productivity in Building Projects in the Gaza Strip. *Journal of Civil Engineering and Management*, XIII(4), 245–254.
- [7] Handa VK and Abdalla O (1989). Forecasting Productivity by Work Sampling. *Construction Management and Economics*, 7, pp. 19-28.
- [8] Hanna AS, Taylor CS, and Sullivan KT (2005). Impact of Extended Overtime on Construction Labor Productivity. *Journal of Construction Engineering and Management*, 131(6), pp. 734-739.
- [9] Hanna AS, Chang CK, Sullivan KT, and Lackney JA (2008). Impact of Shift Work on Labor Productivity for Labor Intensive Contractor. *Journal of Construction Engineering and Management*, 134(3), pp. 197-204.
- [10] Ibbs W (2005). Impact of Change's Timing on Labor Productivity. *Journal of Construction Engineering and Management*, 131(11), pp. 1219-1223.
- [11] Kaming PF, Holt GD, Kometa ST, and Olomolaiye P (1998). Severity diagnosis of productivity problems – a reliability analysis. *International Journal of Project Management*, 16(2), p. 107–113.
- [12] Kaming PF, Olomolaiye P, Holt GD, and Harris FC (1997). Factors Influencing Craftmen's Productivity in Indonesia. *International Journal of Project Management*, 15(1), p. 21–30.
- [13] Kazaz A, Manisali E, and Ulubeyli S (2008). Effect of Basic Motivational Factors on Construction Workforce Productivity in Turkey. *Journal of Civil Engineering and Management*, 14(2), pp. 95-106.
- [14] Khoramshahi F, Dehghan R, and Mortaheb MM (2006). Factors Influencing Construction Productivity. *Proceedings of the 10th EASEC*, Bangkok, Thailand.
- [15] Langford D, Hancock MR, Fellows R, and Gale AW (1995). *Human Resources Management in Construction*. Longman Scientific & Technical.
- [16] Lema NM (1995). *Construction of labour productivity modeling*. University of Dar Elsalaam.
- [17] Lim EC and Alum J (1995). Construction Productivity: issues encountered by contractors in Singapore. *International Journal of Project Management*, 13(1), p. 51–58.
- [18] Lowe G (1987). The Measurement of Productivity in the Construction Industry. *Construction Management and Economics*, 5, pp. 101-113.
- [19] Makulsawatudom and Emsley (2002). Critical factors influencing construction productivity in Thailand. *Proceeding of CIB 10th International Symposium Construction Innovation and Global Competitiveness*, Cincinnati, Ohio, USA.
- [20] Motwani J, Kumar A, and Novakoski M (1995). *Measuring Construction Productivity: a Practical Approach*. Work Study, 44(8), p. 18–20.
- [21] Nepal MP, Park M, and Son B (2006). Effects of Schedule Pressure on Construction Performance. *Journal of Construction Engineering and Management*, 132(2), pp. 182-188.

- [22] Oglesby CH, Parker HW, and Howell GA (1989). *Productivity Improvement in Construction*. McGraw-Hill.
- [23] Olomolaiye P and Ogunlana SO (1989). An Evaluation of Production Outputs in Key Building Trades in Nigeria. *Construction Management and Economics*, 7, pp. 75-89.
- [24] Olomolaiye P, Jayawardane A, and Harris F (1998). *Construction Productivity Management*. Chartered Institute of Building, UK.
- [25] Polat G and Arditi P (2005). The JIT Management System in Developing Countries. *Construction Management and Economics*, 23(7), p. 697–712.
- [26] Sanders SR and Thomas HR (1991). Factors Affecting Masonry-Labor Productivity. *Journal of Construction Engineering and Management*, 117(4), pp. 626-644.
- [27] Soekiman A (2009). Quality of Work Life as an Alternative Strategy for Managing Human Resource in Construction Industry. *Proceeding of the 1st International Conference on Engineering, Environment, Economic, Safety & Health (1st CONVEESH-2009)*, B-III-2 pp. 1-7, Manado, Indonesia.
- [28] Soekiman A and Setiawan A (2009). Pemeliharaan Tenaga Kerja di Industri Konstruksi. *Prosiding Konferensi Nasional Teknik Sipil 3 (koNTekS-3)*, pp. M.107 – 113, Jakarta, Indonesia (in Indonesian language).
- [29] Soekiman A, Pribadi KS, and Soemardi BW (2010). Challenges in Managing Human Resource in Indonesian Construction Industry. *Proceeding of the 2nd International Postgraduate Conference on Infrastructure and Environment (2nd IPCIE-2010)*, 1, pp.314-321, Hong Kong, China.
- [30] Thomas HR (1992). Effects of Schedule Overtime on Labor Productivity. *Journal of Construction Engineering and Management*, 118(1), pp. 60-76.
- [31] Thomas HR, Riley DR, and Sanvido VE (1999). Loss of Labor Productivity due to Delivery Methods and Weather. *Journal of Construction Engineering and Management*, 125(1), pp. 39-46.
- [32] Weng-Tat C (2007). A Systems Perspective of Construction Productivity Improvement Efforts. *Proceeding of the 1st International Conference of EACEF, Jakarta–Indonesia*.