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ON REPRESENTING FACTORS INFLUENCING TIME PERFORMANCE OF SHOP-HOUSE CONSTRUCTIONS IN SURABAYA

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ABSTRACT

Some shop-houses were built late and others are on time, or faster than the schedule that had been planned. The questions are how it could happen and what kind of factors that made it happened. This research has an objective to investigate time performance of shop-house constructions in Surabaya by representing factors that influence it. It first assembles potential influencing factors through literature review, and second, conducts an empirical study by collecting data from finished thirty-two shop-house projects throughout the city. Results of analyses using one-way analysis of variance (ANOVA) indicate eight factors to be statistically significant influencing time performance. They are construction design change, schedule of work that will be done, workers discipline, material availability, owner's payment, quality control, workers availability, and material delivery. The paper discusses the factors and proposes possible solutions to improve time performance.

Keywords: time performance, influencing factors, shop house, anova.

INTRODUCTION

Due to the economic crisis starting in 1997 many big construction projects were either stopped or cancelled in Indonesia. The impacts of the crisis can also be found in Surabaya as the second biggest city in the nation. Some high-rise building constructions were stopped and very rare can we see construction of new buildings in the city. Instead, recently many developers are more interested to invest their money to build shop-houses (*ruko*) in strategic area. The construction of this kind of building needs only short-time period compared to those of high-rise buildings. This is because the owner of the shop-house wants to use the building as soon as possible for their business benefit. In Short, the faster the construction period the better will be for the owner. Here, developers or individual contractors, who provide the shop-houses, are required to have a good time management for the construction. Late delivery of the building, as compared to the planning in contract agreement, may result in claim, in which the developer or contractor should pay some amount of money (penalty) to the owner. In addition, a developer or contractor may lose its credibility and reputation and ultimately lose its customers (owners).

Yet in reality some shop-houses were finished behind schedule and others were on time or ahead of schedule. The question is how it could happen? Why some shop-houses could have worse, good, or better time performance? This paper seeks to investigate the time performance of shop-house constructions by representing factors that influence it. In the following sections, the paper first provides a brief overview of the definition of time performance and related literature to assemble factors that may influence it. Next, a methodology used to compare performance of construction time is introduced. Results, practical applications and suggestions for further research are given at the end.

REVIEW OF RELATED LITERATURE

Construction time is one key element of performance indicators of a construction project. In this paper time performance (TP) is defined

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as comparison between actual time (AT) and planning time (PT) to finish a project. TP > 1 indicates bad time performance, which means delay happened in the project. Meanwhile TP = 1 or TP < 1 indicates good or better time performance, in which the project is finished on time or faster than planned, respectively. The scope of time performance is limited during construction phase only, where the contractor is the main party who is responsible for it. It is assumed also that the assignment of PT is correct.

Several literatures, mostly discussing about construction time planning and duration (such as delays), were gathered to assemble factors that were potential to influence construction time performance [1,2,3,4,5,6,7,8]. The factors were grouped into seven main categories. They were labors, materials, equipments, site characteristics, managerial, financial, and other factors. In addition, physical factors of shop-houses were also included. Figure 1 shows the complete list of the factors used in the study. As seen, totally thirty-seven factors were included.

Previous researches in related area [9,10] have shown some interesting findings about factors that caused delays in building projects in Surabaya. Their methodology and findings, however, cannot answer the question of why some projects were built faster than others, as previously stated. A methodology, which enables comparisons between individual time performances, is thus needed. The next section will describe the methodology.

RESEARCH METHODOLOGY

Questionnaire Development and Distribution

The study used an empirical study, where data required for analysis were based on measurements from the projects under investigation [11]. Questionnaire survey was used to collect the data about the factors in each shop-house project. The projects were limited to those, which had been finished since 1997 in Surabaya. The considerations were that: 1) the respondent who answered the questionnaire would still remember the conditions in his/her project, and 2) the situations in the city, such as economic condition, relatively did not change much. Since the consideration in this paper was time performance during construction phase, contractors were targeted as respondent.

The questionnaire had two major sections. First section contained open questions, which cover general information about the project and respondent, questions about the three physical factors, and planning and actual construction time duration. Second section of the questionnaire asked the respondent to consider the condition of the remaining thirty-four factors

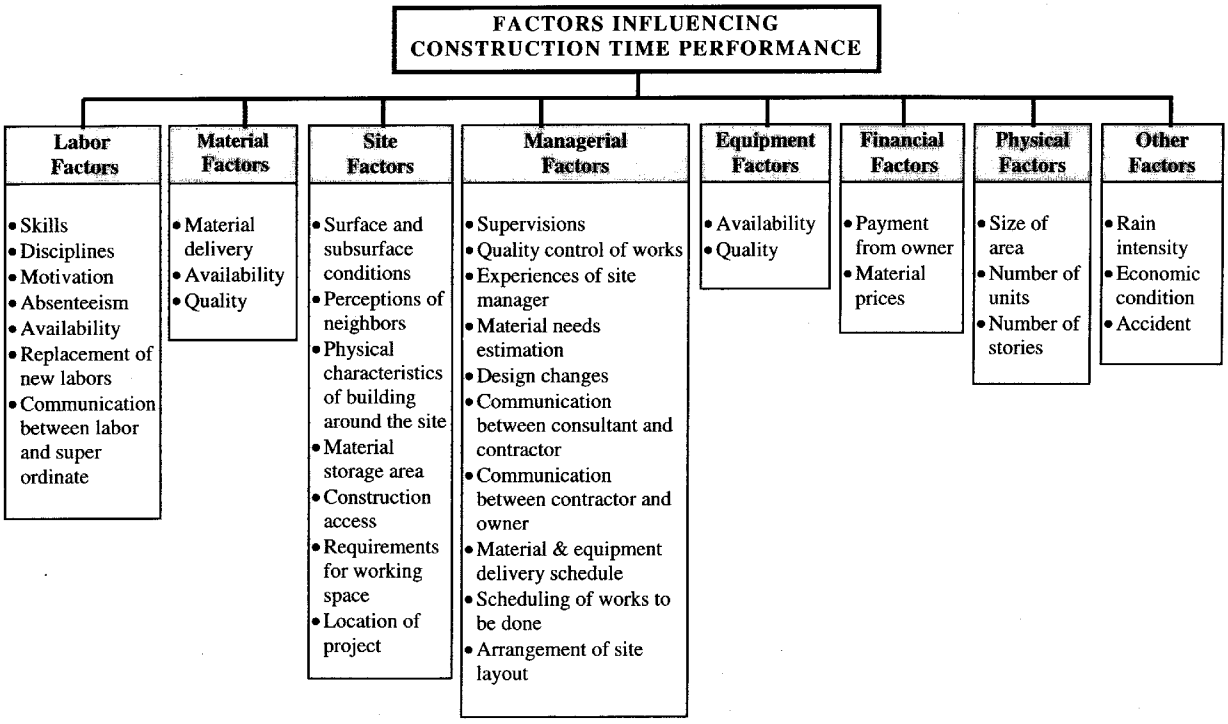

Figure 1. Potential Factors Influencing Time Performance of Shop-Houses Constructions

(Fig 1) in his/her project using a five point scale as follous.
Examples:
1) Design changes
   Often 1 2 3 4 5 Never
2) Discipline of labors
   No discipline 1 2 3 4 5 Very high discipline

The draft of the questionnaire was written in Indonesian and was first distributed to five contractors for pilot study. There was no required change to the draft from the study; so the questionnaire was ready for distribution. Detail of the questionnaire can be found in [12].

Methods of Analyses

Two analyses methods were used in the study. They were descriptive statistics and one-way ANOVA tests. The latter will be discussed in the next paragraph. The descriptive statistics provided general information such as averages, proportions, and frequency counts, all of which related the trend or distribution of opinions on the questions. These statistics were reviewed collectively, or classified by variables. The function of the variables was to group the respondents based on some characteristics and enable their responses to be compared. An example of the variables was construction time performance. For the purpose of analysis described in the next paragraph, the surveyed projects were grouped based on some scales related to the questions of physical factors. For examples, the shop-house projects were grouped as small, medium or large scale based on the size area or the number of units.

One-way ANOVA Tests to Represent Factors Influencing Time Performance

In order to represent factors influencing construction time performance, a new methodology proposed by Walker [2] was utilized. The procedures of the analysis are as follow. First, data of each factor collected from each individual project was plotted against its respective time performance. Figure 2 illustrates the process on a factor, say, X. Each dot in the figure represents a condition in a specific shop-house project. Total number of dots would be the same as total number of projects (respondents).

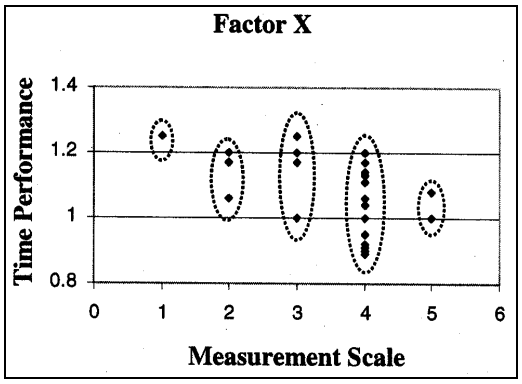

Figure 2. Plot of Measurement Scale Versus Time Performance

Next, a one-way ANOVA test, at a significance level, $\alpha = 5\%$, was performed to each factor. One-way ANOVA tests differences in a single interval dependent variable among two, three, or more groups formed by the categories of a single categorical independent variable [13]. This design deals with one independent variable (which in this study is represented by the influencing factors or Factor X in Fig 2) and one dependent variable (represented by time performance). It tests whether the groups formed by the categories of the independent variable (indicated by dotted lines in Fig 2) seem similar (specifically that they have the same pattern of dispersion as measured by comparing estimates of group variances). If the groups seem different, then it is concluded that the independent variable has an effect on the dependent. For further discussions of the test, readers can consult many statistics books, e.g. [14].

Each test had a null hypothesis (H_0) that construction time performance IS NOT significantly influenced by the factor X; and an alternative hypothesis (H_1) that construction time performance IS significantly influenced by the factor X. The decision rule is that reject H_0 if the significance level (p-value) of the test is equal to or less than the preassigned significance level (that is at 5%), and alternatively accept H_0 if the p-value is higher than the significance level [14]. In total, thirty-seven one-way ANOVA tests would be needed to investigate which factors were significant in influencing time performance. To perform the tests, SPSS statistical program version 10.0 was used.

RESULTS OF ANALYSES

General Information

From total targeted forty-five projects (respondents), only thirty-two projects were obtained (achieving 71% rate of return). The size of projects were between 500 m² to 5000 m². For the purpose of ANOVA analysis, the projects were categorized as small (with area less than 1500 m²), medium (area between 1500 to 3000 m²), and large (area more than 3000 m²). Figure 3 shows the proportion of the categories.

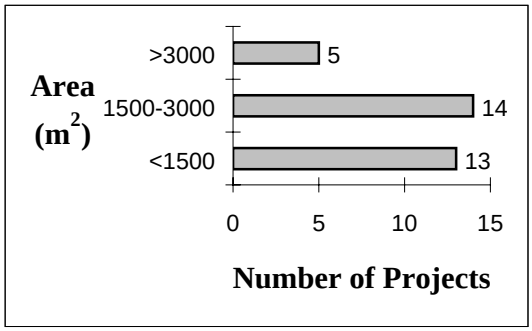

Figure 3. Size of Shop-Houses Projects

The bigger the area of the project the more number of units were there. Small projects commonly had less than ten units shop-houses, whereas medium and large projects commonly had between ten to twenty and more than twenty units, respectively. Moreover, most of the projects (28 projects) were a three-stories shop-house.

Regarding to the time performance, about 60% of the surveyed projects had bad time performance (delay) and only 15% of them were finished ahead of the planned schedule. Figure 4 details the proportions of construction time performance of the projects.

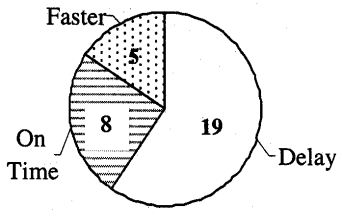

Figure 4. Distributions of Time Performance for Shop-Houses Constructions

Six projects (32%) were found delayed equal to or more than 20% of the planning time. Information about other delayed projects can be observed in Figure 5.

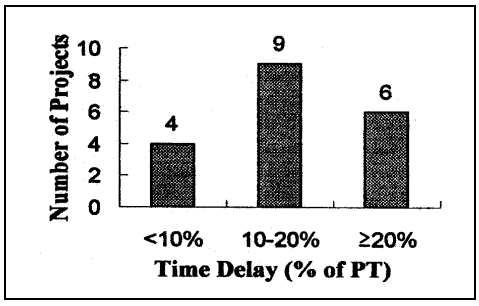

Figure 5. Percentages of Time Delay

Factors Influencing Time Performance

Results from one-way ANOVA tests indicate eight factors to be significant, at $\alpha = 5\%$, influencing time performance. They are listed in Table 1. Meanwhile, factors not significantly influencing time performance are shown in Table 2.

Table 1. Factors Significantly Influencing Construction Time Performance (in rank order)

NO	CATEGORY	FACTORS	*p*-VALUE
1	Managerial	Design changes	0.013
2	Managerial	Scheduling of works to be done	0.019
3	Labor	Discipline of labors	0.021
4	Material	Material availability	0.027
5	Financial	Payment from owner	0.030
6	Managerial	Quality control of works	0.034
7	Labor	Labor availability	0.042
8	Material	Material delivery	0.046

Table 2. Factors NOT Significantly Influencing Construction Time Performance (in rank order)

NO	CATEGORY	FACTORS	*p*-VALUE
1	Site	Construction access	0.057
2	Equipment	Equipment availability	0.089
3	Managerial	Arrangement of site layout	0.095
4	Labor	Labor skills	0.129
5	Managerial	Communication between contractor and owner	0.147
6	Others	Economic condition	0.170
7	Equipment	Equipment quality	0.199
8	Labor	Communication between labor and super ordinate	0.200
9	Labor	Replacement of new labors	0.203
10	Physical	Number of stories	0.232
11	Others	Rain intensity	0.282
12	Managerial	Experiences of site manager	0.290
13	Managerial	Communication between consultant and contractor	0.347
14	Site	Surface and subsurface conditions	0.372
15	Managerial	Material & equipment delivery schedule	0.378
16	Labor	Labor motivation	0.383
17	Site	Material storage area	0.387
18	Others	Accident	0.425
19	Site	Location of project	0.435
20	Managerial	Supervisions	0.512
21	Labor	Labor absenteeism	0.516
22	Managerial	Material quality	0.552
23	Site	Requirements for working space	0.642
24	Site	Physical characteristics of building around the site	0.839
25	Site	Perceptions of neighbors	0.881
26	Financial	Material prices	0.885
27	Managerial	Material needs estimation	0.897
28	Physical	Size area	0.943
29	Physical	Number of units shop-houses	0.983

DISCUSSIONS OF SIGNIFICANT INFLUENCING FACTORS

"Design changes" were found to be the most significant factor influencing time performance of shop-houses constructions in Surabaya. Results from other researches have shown that this factor is one major source of construction claims [15] and has a detrimental effect on time performance [9,10,16]. It is also recognized as one of the most critical construction risks in several countries, including in Indonesia [17,18,19]. Kaming [6] has shown that design changes were the most important causes of rework, which lead to poor productivity and ultimately impact construction time performance. Design changes during construction can be caused by errors and mistakes, incompleteness, ambiguities, conflicts, or impracticalities found in the provided design documents. It can also occur due to changes of the owner's requirement [20]. Though designs of shop-houses projects are commonly not as complex as those of high-rise buildings, result of this study suggests that developers or contractors should give special attention to this factor. It is not only will influence the time but also other project performances, such as cost or quality. In order to anticipate the problems, owners or developers should give clear requirements about the designs to the consultants. The consultants then should review the designs for the aforementioned aspects before delivering them to the contractors. For complex projects, contractors' involvement during planning and design is recommended. Such valuable inputs may be obtained from them are constructability aspects or innovative methods of works, which may result in faster or more economical projects.

The second most significant factor is "scheduling of construction works." Without proper planning and time scheduling, it is very easy for a project, either small or large, to slip from its intended time duration. Study to several high-rise buildings in Surabaya [21] discovered that improper planning and scheduling was the most adverse factor affecting construction productivity. The finding of the current study thus confirms it. The more proper the schedule, the better the productivity of the labor and accordingly the better the time performance of the project will be. It is argued that many shop-houses contractors pay little attention to this factor due to several reasons. First reason is the scale of the shop-houses constructions. They might think that there was no need to make a proper plan or schedule. This, however, may result in uncoordinated construction works, especially if there are several or many contractors at the same location. Many problems because of this factor, such as stoppages, waiting, and moving from one work (location) to other work, have been shown to severely impact the worker motivation and productivity [22]. Second reason is lack of understanding and knowledge by management regarding to project planning and scheduling [21].

The next most important factor, "discipline of labors," is also very related to labor productivity. Here contractors, who want to have a better time performance, should consider ways to enhance the disciplines. Better wages, close supervisions, and other motivational programs are some examples. Santoso [19] has recommended supervision (an insignificant factor) as an important weapon to prevent the inherent problems of Indonesian labors' indiscipline.

"Material availability," at the right time and specified quality, is a must for productive construction works. Thus, contractors should exercise a good material management system. This should involve both suppliers, to appropriately deliver the materials when needed (which is also a significant factor, ranked eight in the list), and also the contractors to have a sound schedule for the deliveries (an insignificant factor) and to select and manage their suppliers. Having several reliable material suppliers is one example the contractor may do to avoid occurrences of the problem. Other important points to ensure the availability of material are sufficient on-site transportation and proper material storage.

"What you pay is what you get" may be a suitable truism to explain why the factor "payment from owner" is significant influencing time performance. The factor will especially play a pivotal position when a limited-capital contractor is employed in a project. Without sufficient and timely payment from the owner (developer), the contractor may not be able to afford essential resources (i.e. materials, labors and equipments) needed by the project. For a better management of this factor, the role of owner is called on. Both contractor and owner should set and agree on a suitable payment system. Readers may consult [23,24] for good discussions of the payment system.

Contractors should have a good and practical "quality control" program during execution of construction works. People tend to misunder-

stand that good quality will require more time to finish the work. On the contrary, the quality can speed up the construction periods, by reducing reworks due to poor quality. Reworks are also regarded as major problems causing low productivity [6,22]. Poor or low quality can happen because of using unspecified material or wrong executions of work. Quality control of works is intended to prevent these problems to occur.

With the current economic condition, it can be predicted that there are abundant workers available in the market. Interestingly, "labor availability" was ranked as a significant factor. The problem here maybe is not about the unavailability of worker, but whether the workers are available when needed. Labor absenteeism has been listed as one most important problem leading to poor productivity in Indonesia [6]. There are several circumstances that may cause this problem. One typical example is to find out many workers were absent on Monday. This endemic problem is more prevalent where the workers are from the same city as the projects (Surabaya in this paper). Some contractors mentioned that it was better to have workers from other cities or rural areas. It is because they did not want to spend money for transportation. Other circumstances tending to coin the problem are (religious) holidays, such as *Idul Fitri*, and planting and harvest seasons. There is no way, however, for any contractors to eliminate these constraints. Instead, the contractor should take them into account in the planning time by allocating contingencies.

The last significant factor is "material delivery." This factor has been partly discussed with the fourth significant factor. Several other related factors that may cause difficulties in material delivery are project location (in remote or densely populated areas), availability of access and delivery facilities (e.g., roads and transporting vehicles), and contractor's payment to the material suppliers. In short, the contractors should consider all these factors when they plan the project.

CONCLUSION AND FURTHER RESEARCH

Six out of ten shop-houses projects in Surabaya experienced bad time performance. The paper has represented significant factors influencing time performance of shop-houses constructions in order to answer why those projects were in delay, but some others were on time or ahead of schedule. Benchmark measures, using thirty-seven potential factors, were assembled to compare time performance of thirty-two finished shop-houses projects. The analytical methodology, by way of one-way ANOVA tests, found eight factors to be significant influencing the time performance. They were (in rank order) construction design change, schedule of work that will be done, workers discipline, material availability, owner's payment, quality control, workers availability, and material delivery. On the other hand, physical factors of the projects were identified as having no significant influence upon the time performance.

It is interesting to see that most of the significant factors are under the contractor's management control. In other words, the contractors are indeed able to take actions to the factors before becoming a problem. The results and discussions are thus targeted to equip the management team with a valuable means in achieving faster completion of shop-houses projects. More importantly, the presented methodology furnishes a benchmarking tool against best practice in time performance. It allows contractors to gauge the gap in performance and to set targets aimed at closing the gap and eventually achieving superiority.

This paper has a limitation, however. It does not investigate the interrelationships among the influencing factors. This will be particularly very important to represent the positions of the insignificant factors. Hypothetically, an insignificant factor may influence the time performance indirectly by having strong interrelationships with the significant factors. This thus opens an opportunity for further researchers to study them. In addition, the methodology can be used for formulating benchmark measures to investigate other project performances, such as cost, quality, or safety performances. A more detail research on the significant factors found in this study is also encouraged. Finally, the collection of factors influencing time performance in this paper is far from complete. There are still many other factors not considered here; thus they need to be explored more.

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