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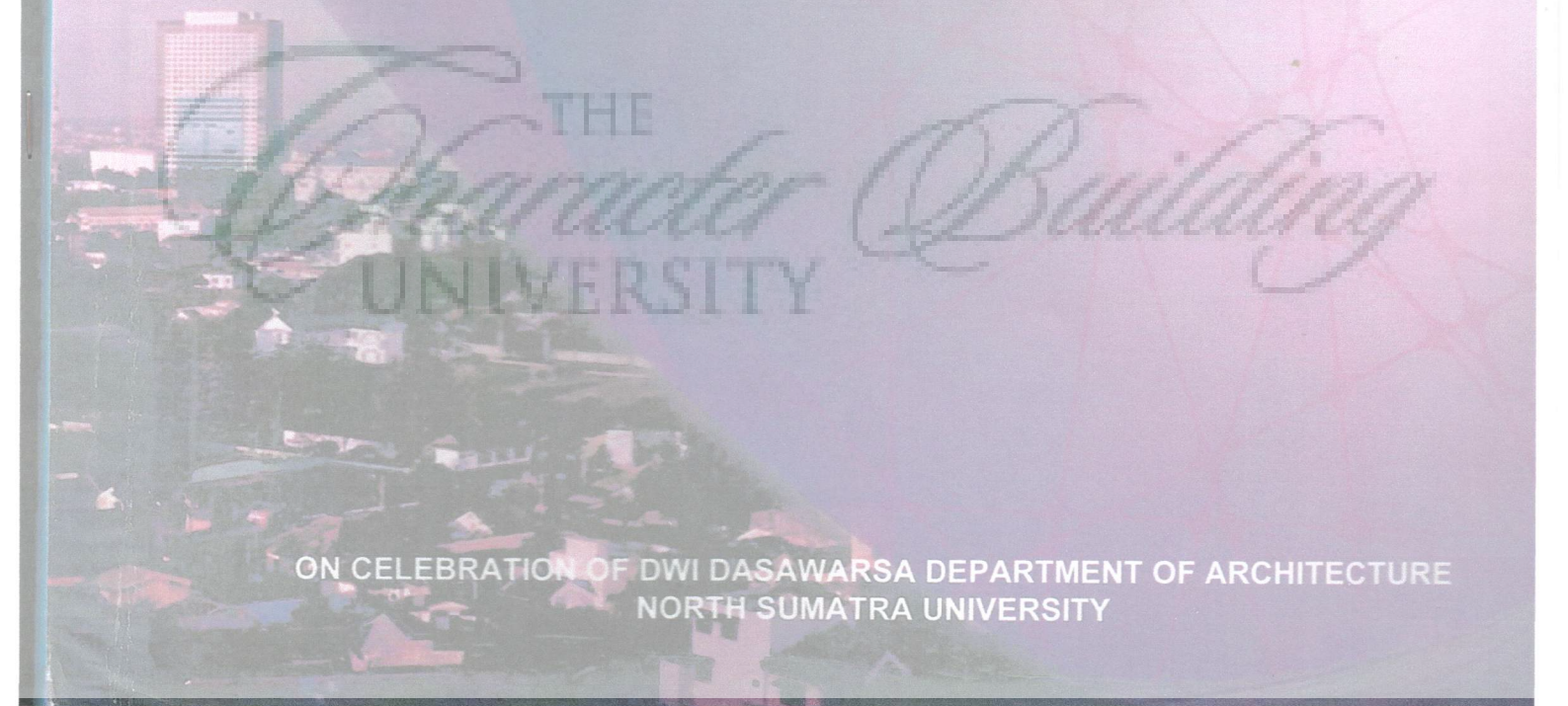

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DEVELOPMENT PRODUCTIVITY, COMPETITIVENESS AND PERFORMANCE INDUSTRIAL CONSTRUCTION WITH A SYSTEM DYNAMIC MODEL

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Abstract. *The construction industry plays an important role in the development of a country's economy, especially in developing countries like Indonesia It is characterized by the construction industry contributes significantly to the growth rate of Gross Domestic Product (GDP) amounted to 6.35% in 2005. The process of world economy is currently growing and increasingly high level of competition has encouraged construction companies to undertake the production process faster and more precisely in serving consumers., In improving the competitiveness of the timeliness issue becomes very important for the implementation of sustainability construction process.*

This research has the objective was to identify the factors that affect the productivity of time performance, competitiveness and the construction industry. This study also discusses the dynamic system simulation model that includes micro-level (project), meso (company), macro (industry)

The analytical method used in this study using Hierarchy Process (AHP) and statistical analysis. Results of regression will be performed Montecarlo simulation with Crystal Ball software and simulation of dynamical systems with software Power Sim.

The first phase of the research results of 73 variables that influence performance when there are 6 variables that can not be accepted

Keywords: time of performance, productivity, competitiveness, construction industry, AHP, simulation

1. Introduction

The construction industry is one of the important sectors for the development of a nation such as Indonesia. Construction services business contributed significantly to the growth rate of Gross Domestic Product (GDP). Construction services sector since the year 1998 accounted for approximately 7.54%, the economic crisis caused a sharp decline recorded in 1999 to minus 1.63%, (BPS, 2006)[1]. Furthermore, since 2003 the sector again showed a marked tendency to improve with the contribution of GDP amounted to 6.35% in 2005, (Suraji, 2007) [2]. As one of the important sectors, the growth of the national construction industry is certainly a golden opportunity for perpetrators of national construction services for more work and participate to improve the competitiveness of national development.

The world economy is currently growing has encouraged construction companies to undertake the production process faster and more precisely in serving consumers. Performance improvement of competitiveness of labor to reach maximum performance when all factors including the factors of labor efficiency, effectiveness, timeliness, productivity, quality, and improved safety, (Suntana, 2008)[3].

Michael Porter clearly states the level of productivity is the root determinants of competitiveness both at the micro level (the project), meso (company), macro (industry) and also at the state level. Itself is a source of productivity and living standards of individual and per capita income source. While competitiveness itself is basically the ability to create a degree of prosperity.

The OECD defines competitiveness as a country's level of ability to produce goods and services in accordance with the demands of international markets and with it the ability to create a sustainable

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[1] BPS, 2006.

[2] Suraji,A (editor)(2007),"Konstruksi Indonesia 2030: Untuk Kenyamanan Lingkungan Terbangun dengan Menciptakan Nilai Tambah Secara Berkelanjutan Berdasarkan Profesionalisme, Sinergi dan Daya Saing, LPJK..

[3] Suntana Sukma Djatnika,Disertasi, Peningkatan Kinerja daya saing tenaga kerja konstruksi pekerjaan jalan, Universitas Indonesia, 2008-2009.

prosperity for its citizens. So there is a consistent relationship between levels of productivity and competitiveness levels. Based on the above can be understood that the productivity in the construction industry is important because it deals directly with the level of competition and the competitiveness of a country's construction industry.

2. Problem Identification

- Survey Report APO (Asian Productivity Organization) in 2004, the average TFP (Total Factor Productivity) in Indonesia -0.80 (minus). .
- According to the report of the World Economic Forum in 2003-2004, Indonesia's competitiveness ranked 37th in the year 1999, in the year 2003 reached the lowest ranking to number 72. It is clearly seen that the competitiveness of Indonesia continued to decline, especially when compared with other ASEAN countries.
- According to the guidance of Construction "BAPEKIN" [4] in Act No. socialization. Implementing Regulation 18/1999 and construction services in Bandung there are some phenomena that occur on Potential Construction Services business or the condition in Indonesia in general is: Not yet the realization of construction quality, timeliness of execution, and efficiency in resource utilization as planned.
- Research conducted Alwi et al., (2002)[5] to identify the problems of inefficiency in Indonesia concluded that there were inefficiencies in the contractor in Indonesia: delayed schedule .
- According to sources above that a precise time of execution is a phenomenon that is being faced by the construction services in Indonesia, which causes a lack of productivity and competitiveness with foreign contractors. With the existence of such phenomena then presumably it is necessary to do a research what caused the timeliness of implementation has not been reached and how to overcome them and how timely can improve productivity, competitiveness and national contractors, especially the construction industry.

3. Research Aims

- Discovering the factors that affect the execution time performance of low-rise buildings which raises productivity, competitiveness and declining construction industry.
- Identifying the causes of low performance of impact and implementation time-storey building on the productivity, competitiveness and the construction industry
- Conducting an analysis to recommend how the performance of time can increase productivity, competitiveness and the construction industry in the implementation of multilevel buildings.

4. Research Limitation

Restricted problem is necessary for research and discussion, not too broad, that is only on:

- Research about the factors that affect the performance of time that cause delays in the implementation of multilevel buildings thereby reducing the productivity, competitiveness and industrial construction.
- The variables studied are the factors that affect the implementation time-storey buildings which affect the productivity and competitiveness of construction industry.
- This research is specialized for controlling the work in order to avoid deviations of the time verified by the experts from previous studies are caused by the owner, contractors, planners and supervisors as well as environmental and political conditions.
- The object of research is focused on job-rise buildings that have been done or is underway.
- System and method of implementation of work and the equipment used is considered relevant in different provinces.

5. Research Methodology

This research was conducted with a qualitative approach with interview techniques and the spread of the questionnaire to some perpetrators construction. Data collector used questionnaire consisting of 3 (three) phases. The first stage is a literature study and interviews to the construction management field to identify the factors affecting construction time performance. At this stage the factors that have been identified will be verified by experts. Having obtained the determinants of time performance, then the next step will be testing the contribution of each factor using a questionnaire to participants to get the model construction.

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[4] Buletin BAPEKIN Edisi ke 6 tahun 2004.

[5] Alwi, S., Hampson, K., Mohamed, S. (2002). *"Non Value-Adding Activities: A Comparative Study of Indonesian and Australian Construction Projects."* Proceedings of the 10th annual conference of the IGLC, Gramado, Brazil.

The last stage will be tested models to the expert as well as to identify actions to be taken to improve the performance of the time.

Methods of data analysis used analytical method hierarchy process (AHP) and correlation analysis and intercorellation (statistical analysis) using SPSS. AHP is used to analyze the impact of variables (risk factors). This method was chosen in order to see the risk factors that influence ranking (dominant) to a small effect, which in this study is called risk ranking. The impact of having the highest risk ranking will be done earlier corrective action.
Criteria frequency of impacts occurring in this study is a combination of qualitative evaluation techniques New Zealand standard on risk management (AS 4360-1995) with the assessment of risk values RAMP (Risk Analysis and management for Project) that have been combined, namely:

1) Never
2) Rarely
3) Sometimes
4) Often
5) always.

Risk analysis of the risk level or Level conducted to determine the level of risk through a questionnaire survey data 2 (table 1). Analysis of risk level or risk level can be done qualitatively by making the risk level matrix of criteria influence the level of impact and frequency of occurrence of impact, which after undergoing modification can be seen in table 1 below: :

Tabel 1: Matrik tingkat risiko berdasarkan tingkat pengaruh dan frekwensi kejadian

Frekwensi / Tingkat pengaruh	(1) Tidak pernah	(2) Jarang	(3) Kadang-kadang	(4) Sering	(5) Selalu
1.Proyek berjalan sesuai rencana	L	L	L	M	S
2. Proyek berjalan sesuai rencana, ada perubahan spesifikasi	L	L	M	S	S
3. Proyek tidak berjalan sesuai rencana, ada perubahan desain dan metode	M	M	S	S	H
4. Proyek tidak berjalan sesuai rencana, ada perubahan desain dan metode yang mempengaruhi kinerja	S	S	H	H	H
5. Proyek berhenti	S	H	H	H	H

Source: Risk Management Lecture Material, Master of Engineering, Specialty Project Management, University of Indonesia, Jakarta

Description:

L : Low Risk, handled by a routine procedure.
M : Risk of being, responsibility, management needs to be explained.
S : Risk of meaning, required the attention of senior management.
H : High Risk, detailed research and management is required at the senior level..

6. Correlation Analysis and intercorellation

Correlation analysis in this study is conducted to measure the strength of association between dependent variables (dependent variables) with free variables (independent variable). For data with interval data criteria / ratios in normal distribution can be carried out data analysis with parametric statistical methods. Correlation analysis performed using Pearson correlation (product moment correlation), with the equation::[6]

Y= f (X i,j,k,l) .....

Where:

i = free variables to i
j = sample number
k = k relationship between variables to
l = linkage between samples to l

From the equation above prepared a mathematical model that describes the relationship between various variables internal constraints and external factors with variables that describe the barriers to improving the performance time. Correlation analysis showed the relationship between two variables or more. Correlation analysis to find relationships between variables regardless of the presence or absence of a causal relationship between these variables-variables.

The method used is a simple correlation analysis, bivariate correlation method. The simple linear correlation is a relationship between two variables which are appointed from the large correlation coefficient is indicated by the symbol "r" (correlation coefficient Pearsonian), shown in table 2.

Table 2: Guidelines for providing interpretation of correlation coefficients [7]

Correlation Interval	Relationship Level
0,00 – 0,19	Sangat lemah
0,20 – 0,399	Lemah
0,40 – 0,599	Sedang
0,60 – 0,799	Kuat
0,80 – 1,00	Sangat kuat

7. Regression Analysis

Regression analysis is one of the important statistical analysis and mathematical modeling related to the problem of a data set of observations. Relationships between pairs of these variables can indicate the relationship of two or more of these variables. This research will use multiple regression analysis is a regression analysis is used when there is one dependent variable or dependent variable depends on more than one variable or predictor variables. The relationship between these two variables can be characterized by mathematical models are referred to as the regression model. The method used was stepwise regression, each variable entered into the regression model based on the sequence of a major contribution to the regression model R2 value is expected. Regression equation for n Predictor is

Y = a+biXi+b2X2.....bnXn

Above regression equation obtained after correlation analysis continues to find the regression equation. The regression equations describing the results of the model between the dependent variable times between the frequency and impact of these elements. biXi = result times and frequency of occurrence and impact of the Sensitivity Chart that happened, that biXi variables have a particular sensitivity to the model.

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[6] Singgih Santoso, *Mengatasi Berbagai Masalah Statistik dengan SPSS*, Jakarta:PT Elex Media Komputindo, 2003)
[7] Boediono dan Wayan Koster, Teori dan Aplikasi Statistik dan Probabilitas, Bandung, PT, Remaja Ropdakarya, 2004.

8. Test Model

From the regression models which have been obtained both the linear model and nonlinear model, then do some test models, namely:

a. R2 coeffecient of derermination test or test

R2 test used to measure the true contribution of independent variable x against variations (rise and fall) the dependent variable (y). Other variables disesabkan by other factors that also affect Y and is included in the error bully. R2 is also used to measure how close the regression line to the data region R2 value is from zero to one. So close to the value Y from the regression model to the data points, the higher the value of R2.

b. F-test

F test used to test the null hypothesis (H0) that the entire value of the independent variables Xi coefficients of regression model is zero, and hipotrsis alternative (Ho) is that all coefficient values the variable x does not equal zero. In other words the ratio of F used to test the null hypothesis (Ho), namely that free variables together did not influence the dependent variable, and alternativenya hypothesis (Ha), namely that the independent variables affect the dependent variable.

c. t-Test

T test was used to test the null hypothesis (Ho) that each koefeisen of regression model is zero and alternativenya hypothesis (Ha) is if each of the model coefficients are not equal to zero. Thus it can be stated as follows: If the null hypothesis is accepted that the model generated can not be used to predict the Y value, conversely if the null hypothesis is rejected, then the value of the resulting model can be used for the value Y. mempredikdi T value of variable X and constant coefficients of regression can be found using the formula (Katz 1982) :

d. Auto Correlation test (Durbin-Waston test)

Durbin-Waston Tets conducted to test the auto-correlation between the variables studied. Auto-correlation test of the restriction value of Durbin-Waston (0 X 4) and used nilia 1.5 2.5 for the Durbin-Waston determine whether there is any correlation or auto correlation of residuals from the regression model produced.

e. Test Multikoliniearitas

Multicollinearity test was conducted to determine whether there is multicollinearity, or the correlation among selected variables. A good regression model should be no multicollinearity (Santoso 1999).[8]

f. Residual Analysis l

Before using multiple regression models generated, we need to analyze the feasibility of the model through analysis of residuals. To test the feasibility and the constancy of regression functions (costancy) of the error variance used residual plots against fitted values. To determine the normality of the error, use the normal probabiloitas plots (normal probability plot[9].

9. Simulation Model

Simulation and modeling can be used to solve a difficult problem solved by the usual analytical way. Modeling is used to build models that can describe the problem, while the simulation is used to demonstrate the process of solving problems and can be visualized so easily analyzed.Simulation is the process of mathematical model or logic model of a system with the aim to gain an understanding of system behavior, which will be used to assist in decision making. Simulation is an analytical method meant to imitate a real situation (real time), especially when analyzed mathematically too complex or too difficult to produce. The main capabilities of the simulation lies in its ability to model appropriate assumptions about a problem or system. Simulation has many benefits including:

1. Allows the Manager and the analysis to evaluate the proposed system.
2. Simulation models are generally more easily understood than many analytical approaches.
3. The ability to model any assumptions, especially when analytical models are not suitable

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[8] Santoso Singgih, Structural Equation Modelling, konsep dan aplikasi dengan AMOS, Elex Media Komputindo, 1999.
[9] Supranto,J, Statistik Teori dan Aplikasi, Erlangga, 1988

Formed model is simulated using the following:

a. Monter Carlo Simulation

Having obtained equation from the simulation of SPSS, then made a probability simulation using Montecarlo simulation method. Montecarlo simulation is an experiment that aims to estimate the sampling distribution of the variable-dependent variable, which is likely influenced by variable-free variable. Montecarlo simulation using Crystall Ball software is a simulation technique to situations of uncertainty to get an approach, if a physical experiment or analytical approach is not feasible. The analysis in this study began with the election results (outcome) with a fixed amount of numbers and perform calculations to obtain the trial outcome in order to obtain the desired response (measure of merit). This calculation is done repeatedly so as to produce outcomes trial which approximates the average value (mean), variant, form of distribution or other characteristics of the desired response. The main requirements of the Montecarlo technique is the outcome of a variable are sorted randomly (random). Random phenomenon, generally have a normal distribution and results (outcomes element) is also desired to form a normal distribution. Methods for determining the number of trials with this technique is to consider the average value generated. The number of trials is determined at the time of the simulation results within the limits of the desired accuracy. The number of simulated events to provide a picture of the possible is to use the formula n, as follows from the above that the number of events randomly to get the value of standard deviation, mean and range

b. System Dinamik Simulation

System Dynamics (SD) is a method for describing, modeling and simulation of dynamic systems. It was created by J. Forrester in the 1960s at the Massachusetts Institute of Technology. The main elements of the methods of dynamical systems are: the difference between stock and flow in the system model. System Dynamics is a methodology for studying and managing complex dynamic systems by building and applying simulation models. System Dynamics (SD) was developed in the late 1950 for the analysis of industrial systems. SD successfully applied to the problem, from the social, industrial and environmental project management system. Dynamic system model is very useful to manage and process simulation with the two main characteristics: (1). involves changes over time (2). let the bait-the sending and receiving information

System dynamics method is a method that examines the structure of the system that causes an event, focusing on the dynamic interactions between system components in a comprehensive manner. Methods used to develop a system dynamics analysis tool in examining the problem of delays that occur on construction projects. Use of system dynamics on the model of construction project focused on the goals increased understanding of how the system's behavior in the transformation process of the construction work. Making the model with the method of construction projects carried out computer-assisted system dynamics, referring to the explanation (Forrester, 1994, 1995), Farnad Nasirzadeh (2008), Moonseo Park because of its ability to determine the consequences of each component of the dynamic model of interacting, and each concept or assumptions about real system, stated more clearly.

Simulation models with dynamic system starts with a mental model, and then translated into a framework of concepts, making causal diagrams, flow charting, simulation models to look at behavior and finally the sensitivity test and policy analysis. The basic structure of dynamic system productivity, competitiveness and the construction industry can be seen in Figure 1

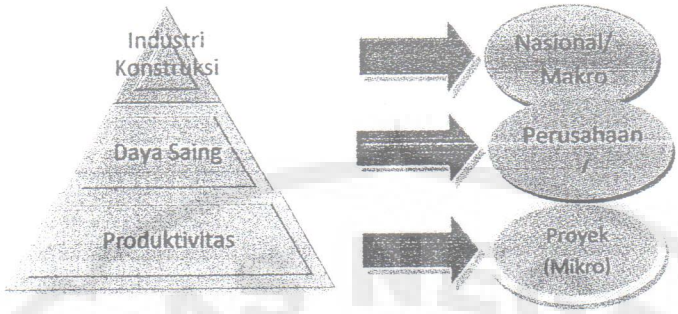

Figure 1: mental models of dynamic system productivity, competitiveness and the construction industry

Mental models of dynamic system productivity, and competitiveness of the construction industry performed systemically mindset that developed into a mental map that can be seen in Figure 2.

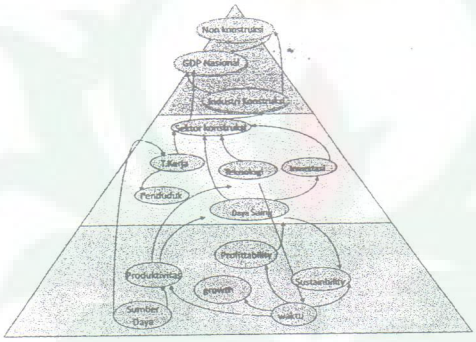

Figure 2. Mental Map System Dynamic productivity, Competitiveness and Industrial Construction

From the framework of existing concepts and then developed into causal loop diagrams to obtain a causal link happens to the model. Causal loop diagrams can be seen in Figure 3.

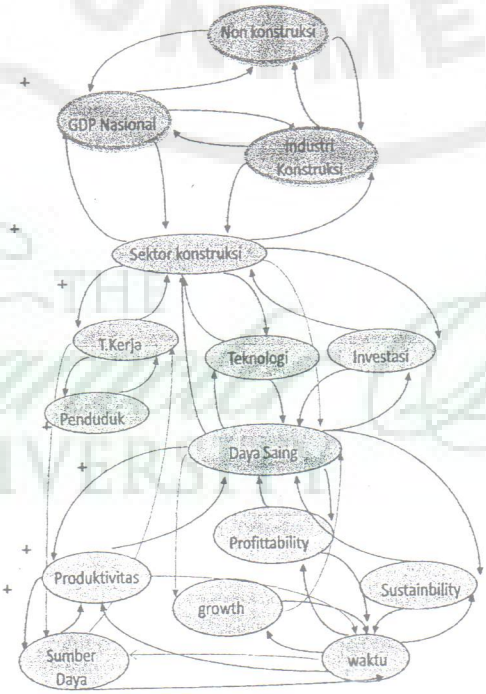

Figure 3. Causal loop diagrams Dynamic System Productivity, Competitiveness and Industrial Construction

10. Conclusion

Based on previous research performance problems of construction services company indicated there are 6 indicators: profitability (rate of companies ability to generate profit), growth (growth rate), sustainability (the ability of companies to improve their business viability, competitiveness (competitive level), productivity (level of ability of the company completed work), and safety (minimize the level of risk). The results of stage 1 of the 73 variables that are distributed to experts, 6 variables that can not be accepted. 2nd phase of the study participants are distributed to stakeholders construction with 67 variables. This research is still in the process of implementation, time performance is expected to increase productivity, competitiveness and dynamic construction industry.

References

[1] Alwi, S., Hampson, K., Mohamed, S. (2002). "*Non Value-Adding Activities: A Comparative Study of Indonesian and Australian Construction Projects.*" Proceedings of the 10th annual conference of the IGLC, Gramado, Brazil

[2] BPS, 2006

[3] Buletin BAPEKIN Edisi ke 6 tahun 2004.

[4] Boediono dan Wayan Koster, *Teori dan Aplikasi Statistik dan Probabilitas*, Bandung, PT, Remaja Ropdakarya, 2004.

[5] James R. Evans and David L. Olson, Introduction to Simulation and Risk Analysis, Prentice Hall Inc., New Jersey, 1998

[6] Muhammadi dkk, " *Analisis Sistem Dinamis*", Lingkungan hidup sosial, ekonomi, manajemen, UMJ, Press, 2001

[7] Singgih Santoso, *Mengatasi Berbagai Masalah Statistik dengan SPSS*, Jakarta:PT Elex Media Komputindo, 2003)

[8] Suraji,A (editor)(2007),"*Konstruksi Indonesia 2030: Untuk Kenyamanan Lingkungan Terbangun dengan Menciptakan Nilai Tambah Secara Berkelanjutan Berdasarkan Profesionalisme, Sinergi dan Daya Saing*, LPJK.

[9] Suntana Sukma Djatnika,*Disertasi, Peningkatan Kinerja daya saing tenaga kerja konstruksi pekerjaan jalan*, Universitas Indonesia, 2008-2009.

[10] Supranto,J, Statistik Teori dan Aplikasi, Erlangga, 1988

[11] Soemardi, tresna, P, Bahan *Kuliah Biaya dan Manajemen Resiko*, Magister Teknik, Kekhususan Manajemen Konstruksi, Universitas Indonesia, Jakarta, 2002

[12] Ronald E. Walpole dan Raymond H.Myers, *Probability and Statistic for Engineers and Scientist*, Edisi IV, (Macmillan Publishing,2002)