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CONTENTS

INFLUENTIAL FACTORS ON THE PROBABILISTIC DURATION OF CONSTRUCTION PROJECT IN JAKARTA

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Abstract

Estimating construction process is somehow similar to an art. This concept becomes more appropriate when process estimating is faced with uncertain condition like such in developing country, Indonesia. The problem is about how to alter the uncertainty into a certain probabilistic calculation which could be used in estimating. The concept of probabilistic scheduling method itself has been developed since then, known as PERT (Program Evaluation Review Technique), which is commonly being used in manufacture process. Since a construction process is unique, gathering data to calculate the optimistic and the pessimistic duration, as the method requirement, becomes difficult. An alternate solution to calculate that type of duration is proposed by using some influencing factors. This paper describes the factors identification and reducing for each type of probabilistic duration as a first step in calculating optimistic and pessimistic duration. This research is funded by the directorate of higher education, education and culture Ministry of The Republic of Indonesia under national strategic competition grant scheme.

Keywords: Factors influence, Probabilistic duration, Optimistic, Pessimistic, PERT.

Introduction

The range of the activity distribution in construction process becomes an important estimating part of scheduling technique in a generally uncertainty environment as in the developing country. That's why in Indonesia, Public Works Department has made a study of the implementation and formulation of national and provincial construction index.

Peter F. Drucker in his book *The New Realities* mention the world economy as a phenomenon that changed, from "international" to "transnational". Michael Porter tried to research in The Competitive of Nations, why some multinational companies succeed in international competition.

In the concept of construction project management, probabilistic approach to accommodate the uncertainty environment in construction planning, where a deterministic approaches scheduling technique usually used (Gabriel A. Barraza, W. Edward Back, Fernando Mata, 2000). This concept expected to improve the quality of the estimator.

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On the other hand, using PERT scheduling techniques for the construction activities have restrictions due to the nature of the PERT method itself and the characteristics of the construction process. PERT is based on the probability distribution that requires the collection of data to characterize the uncertainty of the process and there is no standard method for setting probabilistic variable values. While in the construction process, the uniqueness, complexity, and the relatively long process have made data collecting a difficult matter.

These characteristics are a problem in the application of PERT method in the construction process. On this basis, this paper describes a model study on the factors influence that can be use as a consideration in determining the duration of optimistic and pessimistic duration of an activity in the construction process.

Literature Review

Competitiveness by Porter (1993) is productivity defined as output produced by labor. Meanwhile, according to the World Economic Forum, national competitiveness is the ability of the national economy to achieve high economic growth and sustainable. Competitiveness is a process for achieving a better purpose in the future to increase growth and revenue of the state. Topics competitiveness of a country often associated with the concept of "competitive advantage" that was introduced by Michael Porter.

In the concept of competitive advantage, the government needs to realize that the government can no longer be driving their own economic development through policies and incentives. Today, economic development is a collaborative process between the parties involved in the development process, such as the various levels of government, corporate, educational and research institutions, and community organizations. Thus, the creation of competitiveness should be a process of bottom (bottoms-up process) that encourages individuals, businesses and institutions to take responsibility.

Competitiveness needs to be addressed for the construction industry in Indonesia, because based on data from the Department of Public Works, the number of contractors registered up to 2010 was a dominant 155,775-business entity located on the island of Java and beyond. This illustrates the increasing competition among contractors to compete in capturing the market share that cost, quality, and time must be considered. It is a challenge for the construction industry in improving the competitiveness because if a company wants to achieve sustained competitive advantage (sustainable competitive advantage), they should have and capable of managing the qualified workers who have expertise/skills and want to continue to develop themselves to keep track of technologies, products, and market (Ordonez de Pablos and Lytras: 2008). This is where the main contribution of human resource management for the company's progress.

The construction sector affects almost all sectors of the economy, such as roads, dams, irrigation jobs, housing, schools, and other construction work that is the physical basis for the development and improvement of living standards. The construction industry has a very important role for national development because it produces products such as physical infrastructure.

The role of the construction sector in the national product shown from the two data Gross Domestic Product (GDP) that are the GDP based on current prices and GDP

based on constant 2000 prices. First, the role of the construction sector in the GDP data at current prices, among others, 7.03 percent (in 2005), 7.52 percent (in 2006), 7.72 percent (in 2007), 8.48 percent (in 2008), 9.91 percent (in 2009), and 10.29 per cent (in 2010). Second, the role of the construction sector in the GDP data at constant 2000 prices, among others, 5.92 percent (in 2005), 6.08 percent (in 2006), 6.20 percent (in 2007), 6.29 percent (in 2008), 6.44 percent (in 2009), and 6.49 percent (in 2010). Both the GDP data showed that the role of the construction sector to the national production is likely to increase.

In terms of employment, based on data from the National Labor Force Survey (Sakernas) published by BPS, average ratio of labor force working in the construction sector to the total employment in 2005 to 2011 was about 5.22 percent which is dominated by labor with elementary school education is about 63.2%.

It is a challenge for the construction industry as competitive position of business systems in a global business environment depends on the flexibility, versatility, and workers performance. For that, there needs to be an effort to improve the performance of the construction workers so that the resulting quality can be better.

The activities included in construction projects have specific behaviors and dynamics, and specifically, in other words that the construction project has activities that are unique. This uniqueness means that the activities are included in a construction project can vary from one project to another project. In the management to achieve effective results required the application of specific techniques and methods (Suharto, Iman, 1997). Techniques and methods are planning process, which is the first step in the other processes.

The planning process is fundamental processes that play a role in determining the achievement of a goal. Efforts needed to find out a method that can improve the performance of planning and control that accommodate the number and complexity of the project activities in a systematic and analytical term. Especially with PERT (Project Evaluation Review Technique) method, this gives an activity completion timeframe specified by three values that make up an estimated probabilistic distribution.

PERT was first developed in 1958 with the initial goal to determine the likelihood or probability of reaching a milestone as planned, it can be seen that the PERT method-oriented or focused on the occurrence of events or event. The orientation of the event (event-oriented) is the emphasis on the earliest time and the end time of the occurrence of an event. PERT method based on probability calculations, where it is intended to accommodate the situation of real projects that contain high levels of uncertainty (uncertainty) associated with the aspect of time in each item activities.

In fact, this is usually the case in the delivery of a project due to the nature of the project, which is unique and dynamic. PERT method has a specific way to accommodate the uncertainty in the form of calculation time span (range) that can ultimately result in the likelihood (probability) to meet the target schedule.

It was mentioned above that PERT uses three estimates to provide a period of time due to the uncertainty in the implementation of an activity. For each activity generally consists of three estimates of activities, namely:

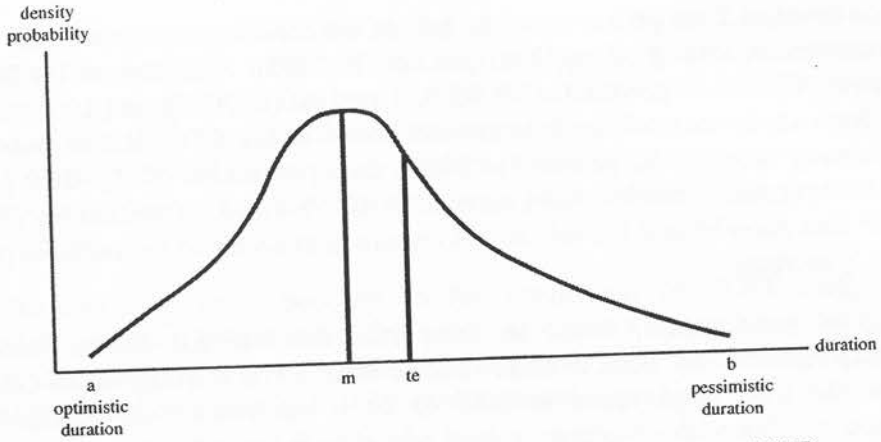


Figure 1. Beta Distribution Curve (Soeharto, Iman, 1997)

- Optimistic duration time (a)

If an activity is carried out in a state that supports and everything went smoothly, then the activity will be completed in a faster time. The shortest time to complete an activity called optimistic time.

- Most likely duration time (m)

Estimated value of duration is the most likely duration, occurs in reality when the same activities performed repeatedly in circumstances similar called the most likely duration (most Likely duration).

- Pessimistic duration (b)

An activity that carries out in unsupportive conditions, it will be completed in a longer time. Longer time is called pessimistic values. The purpose to estimate the value of giving time span (range) of an activity is to accommodate deviations that may occur due to any uncertainty in the implementation. The used of those three estimates completion time of an activity in order to describing more towards possibility rather than to direction assurance given by deterministic manner (HN Ahuja, 1976). The time shown in the calculation of scheduling with PERT method is not an absolute value, but that value has range accommodate element of uncertainty caused by many factors (multi-varied factors) and measured by a variable called the standard deviation and variance.

Methodology

The purpose of this study is to find out the factors that influence project duration conducted by data analysis with multivariable statistical analysis. Factor analysis is used to reduce the factors that influence a variable into several sets of indicators (a new variable), without loss of meaningful information. This analysis was used for initial studies in which the factors that influence a variable have not been identified by either (explanatory research).

Algorithm diagram base on the purpose of the study shown in Figure 2 as follow:

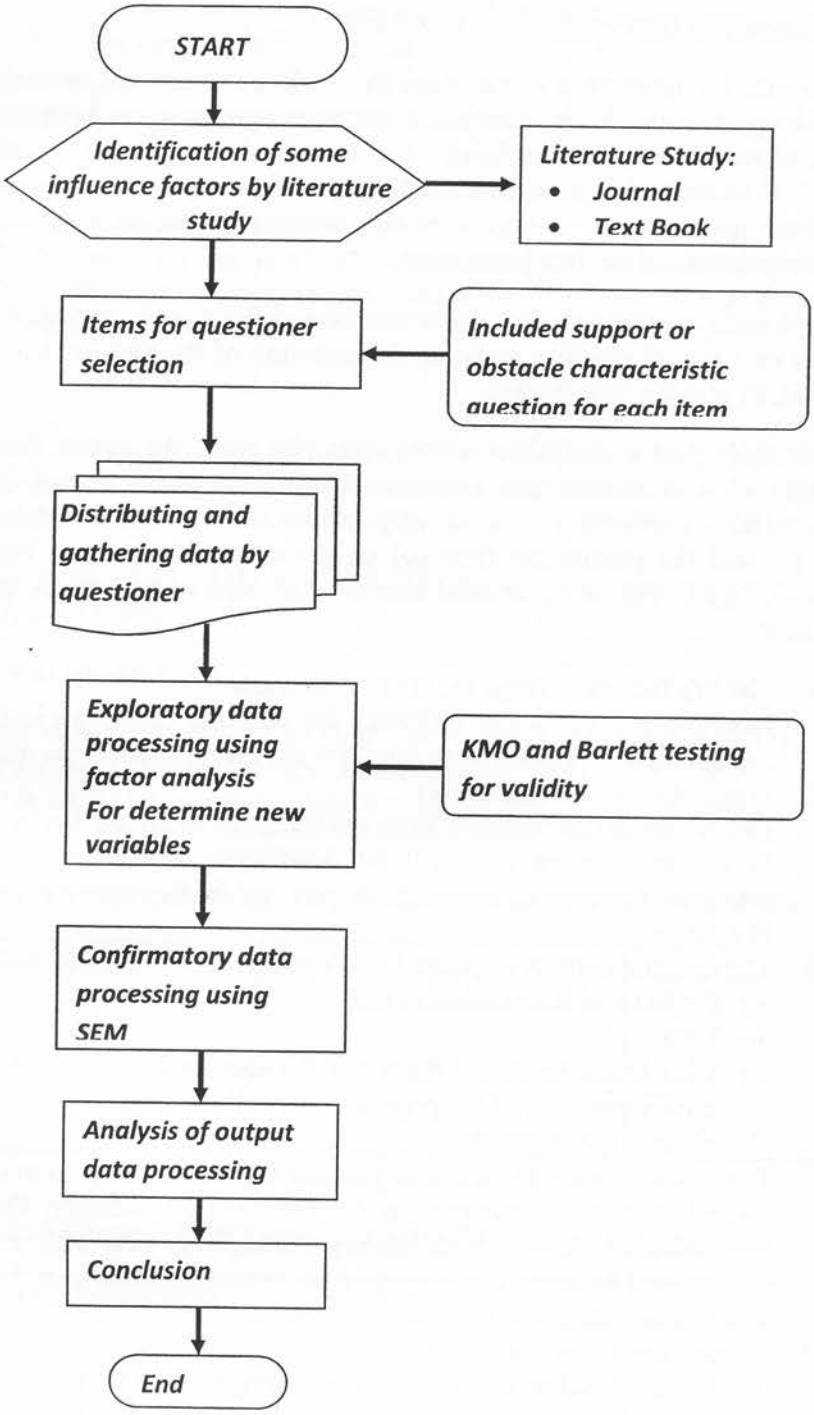


Figure 2. Research methodology Algorithm

The purpose of factor analysis is as follows:

1. Reducing the number of variables smaller number than origin variable.
2. Using the correlation coefficient test to identifying the relationship between the new variables with form factor
3. Explore and confirm test the validity and reliability of the instrument.
4. Perform data validation to determine whether the results of the factor analysis can be generalized into the population.

In exploratory factor analysis, the researchers did not or do not have the knowledge or theory or a hypothesis that make up the structure of the factors that will be formed or formed, so that the new theory.

In this study, factor analysis conducted into two parts, the factors that support duration (optimistic) and factors that become obstacles in the calculation of the duration (pessimistic). Furthermore, the identify factors can be used to establish the optimistic time (a) and the pessimistic time (b) on a construction project. For that reason, the methodology in this study divided into several steps as part of the process to find the factors are:

1. Identify factors through the study of literature
   Identification of factors influence the duration of the project is obtained from journals and textbooks as an input for the preparation of the questionnaire.
2. Preparation of questionnaires
   Factors influence obtained from the literature study further arranged in the form of a questionnaire that will be distributed to the relevant parties with an estimated duration of construction projects, in this case the construction project in Jakarta.
3. The questionnaire is organized into three parts:
   a) Project and Respondents Data.
   b) Data inputs
   c) Data characteristics which are the factors that support or constraints the implementation of the project.
4. Distributing questionnaires
   Respondents were the resource persons as well as a depiction of the performance targets of human resources in the construction industry. On the basis of the respondents selected from among managerial who was responsible for his educational background, has expertise, both theoretically and skill capabilities to manage the estimated duration.
5. Respondents may consist of:
   a) Project Leader, as the person most responsible for the estimated duration of the project management. In general, a project leader selected based on his experience in managing the overall project.
   b) Site manager or site engineer, as a person of interest directly with the duration of the project.
   c) Estimator, a direct person that calculate duration prediction of a project.
6. The division of the factors
   The data divided into 2 groups that support the implementation of the project and data constraints of the project. The purpose of the division is to clarify the

influence of factors that support the optimistic duration and influencing factors that cause obstacles causing pessimistic duration.

7. Processing Data with Factor Analysis Method
   The next stage after the questionnaire data collection, the data will be processed by multivariate statistical technique of factor analysis. The goal is to reduce and categorize variables into new variables that have been identified better.
8. Conclusion Withdrawal
   The results of the factor analysis will be concluded to be a new indicator as a source of information in the next stage of research is the basis for calculating the duration of probabilistic.

Case Study

Factor identification carried out with 68 source either text book or scientific journal. This identification gives 54 factors on questionnaire. The study conducted in Jakarta with 62 respondents

Data processing is using SPSS 17.00 as a tool. The results of processing output data with SPSS 17:00 is seen below.

Test the adequacy of the data

Adequacy of sample data can be identified by the value of Kaiser-Meyer-Olkin (KMO). Data can be said to meet the sufficiency of the data or assumptions deserve to be factored if the value of KMO is greater than 0.5. KMO data processing results are as follows:

Table 1. SPSS Output: KMO test for the data that supports the duration

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.866
Bartlett's Test of Sphericity	Approx. Chi-Square	1612.906
	Df	435
	Sig.	.000

Table 2. SPSS Output: KMO test data is an obstacle for the duration

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.799
Bartlett's Test of Sphericity	Approx. Chi-Square	415.865
	Df	105
	Sig.	.000

From Table 1 and Table 2 above obtained value of KMO> 0.5 so that the factor analysis conducted showed the sample is feasible to be factored and the factors can be analyzed further. Factor group is a collection of variables that have a value greater than 0.55

correlation to the formation of a new factor with dimensions of constituent factors are as follows:

After 18 iteration of anti image rotated matrix, supporting factors that influence the optimistic duration get six groups of factors as new variable:

Table 3. SPSS output for dimension supporting factors duration indicators

Items	Component					
	1	2	3	4	5	6
Recording duration of previous	**.803**	.142	.288	.078	-.011	.173
Project organization	**.784**	.261	.047	.240	.152	.072
The learning curve	**.730**	.115	.162	.261	.205	.202
Experience	**.703**	.139	.112	.068	.262	.051
Learning time	**.582**	.224	.469	.083	.206	.354
Unit of time	.524	.235	.411	.153	.129	.399
Teamwork	.122	**.688**	-.088	.434	-.064	.287
Use of appropriate human resources	.125	**.671**	.450	.132	.309	.239
The company's policy	.455	**.657**	.127	.206	.125	.085
Human Resource management	.150	**.648**	.497	.283	.071	.193
Responsibility	.205	**.625**	.202	.391	.297	.262
Discipline employees	.444	.543	.285	.045	.400	-.060
Management tools	.110	.142	**.716**	.202	.396	.184
Labor productivity	.350	.237	**.646**	.174	.130	.086
Skill workers	.222	.221	**.628**	.362	.206	.228
Resource Availability	.329	.049	**.577**	.425	.295	-.043
Flow of information	.378	.433	.485	.146	.066	.175
Acceleration strategy	.206	.239	.051	**.725**	.380	.087
Decision-making	.124	.174	.299	**.707**	.184	.065
Understanding the condition of the project	.118	.378	.240	**.687**	.186	-.002
Relations project work	.530	.078	.277	**.568**	.086	.181
A positive attitude	.306	.407	.332	.488	-.008	.343
Participants	.276	.378	.204	.398	.102	.382
Consistency teamwork	.325	.006	.224	.259	**.730**	.124
Use of technology	.101	.292	.281	.450	**.595**	.098
Acceleration events	.166	.404	.345	.399	.511	.042
Implementation of Construction Methods	.185	.440	.368	.188	.509	.137
Effectiveness of the work	.155	.269	.239	.041	.062	**.825**
Education workers	.282	.107	-.009	.103	.528	**.680**
Law applicable	.432	.140	.450	.364	-.226	.466
Prerequisites workers						

Iteration for obstacles factors gives 4 groups of factors as a new variable that influence the pessimistic duration:

Table 4. SPSS Output for dimensional constraint length composer factor indicators

Items	Component			
	1	2	3	4
Managerial uncertain	**.884**	.055	.104	.092
Genesis unexpected	**.773**	.181	.219	.096
Working hours are not sure	**.755**	.238	.069	.307
Scheduling error	.195	**.805**	-.023	.188
The waiting time booking	-.008	**.728**	.355	.150
Drawing is less clear	.170	**.699**	.287	.326
Changes in material production	.464	.536	.462	-.162
Holiday	-.008	.219	**.748**	.345
Political changes	.560	.001	**.669**	.075
Weather	.361	.419	**.611**	.134
Changes in SD	.367	.425	.452	.302
Estimated illogic	.253	.048	.319	**.792**
Dependence subcon	.010	.244	.203	**.744**
Construction failures	.351	.454	-.188	**.644**

Interpretation of Integrated new variables (Indicators)

Based on the dimensions of drafting formations above factors, six variables occur as new variables that influence the optimistic duration and four other more occur as new variables/indicators that influence the pessimistic duration. Each influence variable/ indicator in both optimistic and pessimistic duration group needs a proper nomenclature that will use for further function. Naming the variables should refer to the origin variable source/ sources.

After trace back the literature source. a propose of new variable/ Indicator name in this case study shown in Table 7 for influence indicator for optimistic duration. and shown in table 8 for influence indicator for pessimistic duration. These new ten variables were occurred base on number of data. A different number of data could give a different number of new groups. In that case, naming a new indicator should be conducted carefully to get a proper name. Thus, literature sources have to be keeping along the process.

Table 5. Indicators for the duration optimistic

Factor	Variable	Indicator
A	1. Recording duration of previous 2. Project Organization 3. Learning curve 4. Experience 5. Learning time	Experience of project performance
B	1. Teamwork 2. The use of appropriate human resources 3. The company's policy 4. Human Resource management 5. Responsibility	Management of human resources
C	1. Management tools 2. Labour productivity 3. Skilled workers 4. Availability of resources	The quality of human resources
D	1. Acceleration strategy 2. Decision-making 3. Understanding the condition of the project 4. Relations project work	Management decision-making
E	1. Use of technology 2. Acceleration events	Use of technology
F	1. Education workers 2. Legislation in force	Regulation

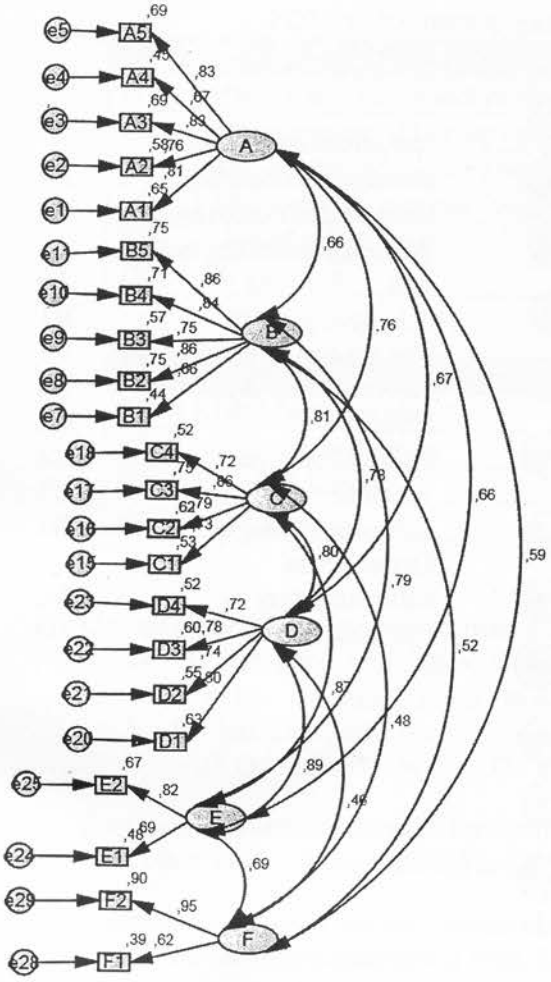
Table 6. Indicators for the duration pessimistic

Factor	Variable	Indicator
A	1. Managerial uncertain 2. Unexpected occurrence 3. Working hours are not sure	Risk Management
B	1. Scheduling error 2. The waiting time booking 3. Drawing is less clear	Information systems
C	1. Holiday 2. Political changes 3. Weather	External factors
D	1. Estimated illogic 2. Dependence subcontractors 3. Construction failures	Estimation

Confirmatory Analysis for Intergrated New Variables

Based on the results of previous exploratory analysis, confirmatory was conducted to show the form of new variable that consists of several constituent indicators.

Furthermore, the AMOS program make chart that shows relationships between factors formations formed by the indicators forming.



Specification Notation:

Recording duration of previous	A1
Project Organization	A2
Learning curve	A3
Experience	A4
Learning time	A5
Teamwork	B1
The use of appropriate human resources	B2
The company's policy	B3
Human Resource management	B4
Responsibility	B5
Management tools	C1
Labor productivity	C2
Skilled workers	C3
Availability of resources	C4
Acceleration strategy	D1
Decision making	D2
Understanding the condition of the project	D3
Relations project work	D4
Use of technology	E1
Acceleration events	E2
Education workers	F1
Legislation in force	F2

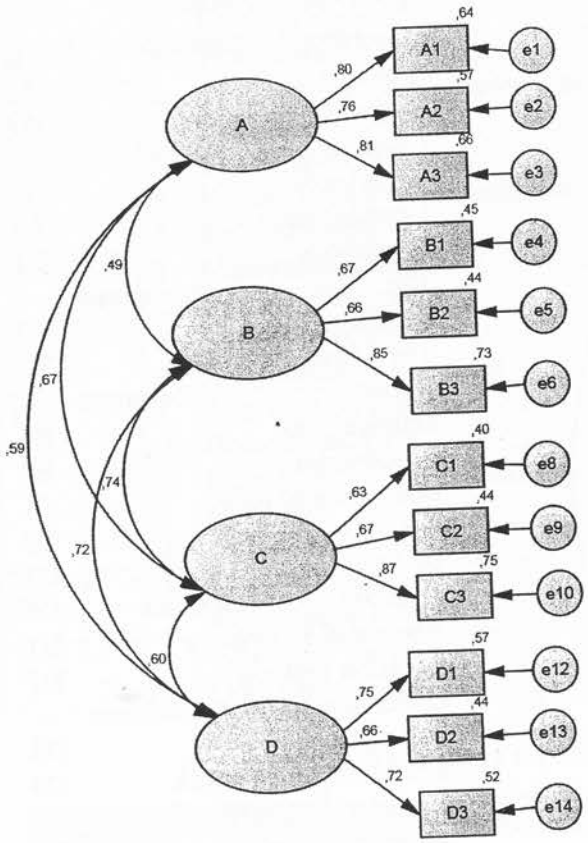
Figure 3. AMOS Output of SEM Diagram for Optimistic duration

Based on SEM diagram for the optimistic duration above can be summarized as follows:

- The experience of the project's performance is affected by the variable learning curve and learning time ($\lambda = 0.83$)
- The human resource management are most influenced by the proper use of human resources and responsibilities ($\lambda = 0.86$)
- The quality of human resources are most affected by the skills of workers ($\lambda = 0.86$)
- The management decision-making strategies that were most affected by the acceleration ($\lambda = 0.80$)
- The use of technology most affected by the acceleration of activity ($\lambda = 0.82$)

- The external regulations most affected by the legislation in force ($\lambda = 0.95$)
- The correlation between the indicators for the most optimistic duration occurred between indicators of management decision-making with the use of technology ($\lambda = 0.89$)

Furthermore, here is a diagram for the duration pessimistic AMOS:



Specification Notation:

Managerial uncertain	A1
Unexpected occurrence	A2
Working hours are not sure	A3
Scheduling error	B1
The waiting time booking	B2
Picture is less clear	B3
Holiday	C1
Political changes	C2
Weather	C3
Estimated unlogic	D1
Dependence subcontractors	D2
Construction failures	D3

Figure 4. AMOS Output of SEM Diagram for Pessimistic duration

Based on SEM pessimistic duration diagram above can be summarized as follows:

- The risk management is most affected by the uncertain working hours ($\lambda = 0.81$) as well as the managerial uncertainty ($\lambda = 0.80$).
- The information system is most affected by the picture is less clear ($\lambda = 0.85$).
- The external factors most influenced by the weather ($\lambda = 0.75$).
- The estimates are most influenced by expectations unlogic ($\lambda = 0.57$).
- The correlation between the indicators for the most pessimistic duration is between indicators of information systems with external factors ($\Psi = 0.74$).

CONCLUSION

1. Data processing result gives six new influent indicators for optimistic duration and four indicators for pessimistic duration which are:

Influent Indicators to Optimistic Duration	
O1	Experience of project performance
O2	Management of human resources
O3	The quality of human resources
O4	Management decision-making
O5	Use of technology
O6	Regulation

Influent Indicators to Pessimistic Duration	
P1	Risk Management
P2	information systems
P3	External factors
P4	Estimation

2. Optimistic duration has correlation characteristic:
   a) O1 has good correlation with A5 as also O2 with B4. O3 with C3. O4 with D1. O5 with E2 and O6 with F2.
   b) O1 has also good correlation to O3. as also O2 with O3. O4 and O5. O3 with O4 and O5. O4 with O5 and O6.

   Any new influence indicator for optimistic duration that has a good correlation with other new indicator should not be used together in any purpose.

3. Pessimistic duration has correlation characteristic:
   c) P1 has good correlation with A3 as also P2 with B3. P3 with C3. P4 with D1.
   d) P2 has also good correlation to P3 and P4.

   Any new influence indicator for pessimistic duration that has a good correlation with other new indicator should not be used together in any purpose.

4. Lesson learning shows that number of data influences the output on number of group.

5. Further study on quantification the range of uncertainty could be generated base on this preliminary study.

REFERENCES

Ahuja, H.N. (1976). *Project Management: Techniques in Planning and Controlling Construction Project.*

Ammar Mohammad, A. (2011). *Optimization of Project Time-Cost Trade-Off Problem with Discounted Cash Flows.* ASCE, January.

Anderson Stuart, Shane. Jennifer S., Schexnayder. C. (2011) *Strategies for Planne Project Acceleration.* ASCE, May.

Anondho. Basuki. (2011). *Hubungan Faktor - Faktor Eksternal Latent dengan Kinerja Estimasi Proyek Konstruksi Bangunan Gedung di Indonesia.* Lembaga Penelitian dan Publikasi Ilmiah Universitas Tarumanagara, Jakarta.

Anondho. Basuki. (2009). *Hubungan Indikator Ekonomi Terhadap Estimasi Biaya Pelaksanaan Proyek Konstruksi.* Lembaga Penelitian dan Publikasi Ilmiah Universitas Tarumanagara, Jakarta.

Anondho Basuki, Yusianto Yusi, Suparman. Meiske Y., Soeleiman Lydiawati. *Laporan Akhir Staranas Tahap I: Kajian Rentang Koefisien Produktivitas Indisti Jasa Konstruksi Nasional untuk Pengingkatan Daya Saing*, DITJEN DIKTI DEPDIKNAS.

Asian Development Bank. (1986). *Handbook On Management Of Project Implementation.* Asian Development Bank.

Drucker. Peter F.*The New Realities. (2003).* Transaction Publisher.

Ervianto. Wulfram I. *Teori - Aplikasi Manajemen Proyek Konstruksi.* Yogyakarta; 2004.

Gabriel A. Barraza, W. Edward Back, Fernando Mata.(2004). *Probabilistic Forecasting of Project Performance Using Stochastic S Curves.* ASCE Journal of Construction Engineering and Management. January/February Edition, p.25.

G. Bush. Vincent. (1994). *Manajemen Konstruksi.* Jakarta.

G. Clifford, L. Erik. (2007). *Manajemen Proyek Proses Manajerial Edisi 3.* Yogyakarta.

Kerzner Harold. (1989). *Project Management A System Approach to Planning Scheduling and Controlling.* Van Nostrand Reinhold Company.

Lin Gogbo, Shen Qiping Geofrey, Sun Ming, Kelly John. (2011). *Identifications of Key Performance Indicators for Measuring The Performance of Value Management Studies in Constructions.* ASCE / September.

Meredith Jack R., Mantel Samuel J. JR. (1995). *Project Management: A Managerial Approach.* John Wiley & Sons. Inc, Canada.

Porter Michael. (1993). *Competitive Advantage.* Collier Macmillan Publishers.

Schuette Stephen D., Liska Roger W. (1994). *Building Construction Estimating.* McGraw-Hill, Inc., Singapore.

Soeharto Imam. (1997). *Manajemen Proyek: Dari Konseptual sampai Operasional.* Penerbit Erlangga, Jakarta.