Key Success Factors of Line of Balance (LOB) And M-PERT Integration on The Development of Wastewater Treatment Plant

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Abstract: The construction of a wastewater treatment plant in Indonesia to overcome domestic wastewater discharges has experienced many delays so that people are threatened not to enjoy development facilities that can protect them from the dangers of environmental pollution. The purpose of this paper is to analyze the application of the LOB and M-PERT scheduling methods by identifying the factors that influence the application of the two scheduling methods and how the results of the analysis are implemented A total of 40 questionnaires were distributed to consultant planners and supervisors of wastewater treatment plant and with the RII (Relative Importance Index) statistical analysis method it was found that the most influential factors were analysis of M-PERT activities in the form of combining activities in one group and on alternative pathways, and calculating reset PERT. Analysis of LOB implementation is in the form of optimizing project time, relationship logic activities, analysis of buffer time determination, and duration of work units. Schedule in the form of land ownership, inability to acquire required permission, and the influence of local custom and religious events. Based on these findings, the speakers recommend the following: 1) The planning consultant can socialize the application of the LOB and M-PERT methods to all stakeholders involved starting from contractors, field supervisors, and the local City Government; 2) Encouraging local City Government to be able to increase the number of wastewater treatment plant facilities built; 3) Increase the number of city residents who are protected from the dangers of environmental pollution with the wider scope of services provided.

Index Terms: wastewater treatment plant, LOB, M-PERT, RII

I. INTRODUCTION

Along with the increase in population, the threat of decreasing water quality due to wastewater discharge remains a global problem. Improvement of wastewater access services in developing countries continues with efforts to treat wastewater.

Current trends related to urban and industrial wastewater treatment plant problems illustrate that on average in new high-income countries it is able to treat 70% of wastewater, while middle to upper-income countries (including Indonesia) is around 38%, and middle-income countries to down about 28%, the last low-income country is only 8% in urban and industrial wastewater [1].

One of the factors that cause low urban and industrial wastewater treatment capacity as a whole is a delay in the implementation of the construction of waste water treatment plants, where many factors are influenced by shortages of labor, project location, weather, competency of project implementers, large investment costs treatment plant and others [2],[3].

On average, the construction of waste water treatment plants has a delay of mostly 20% and can be seen in Figure 1 five World Bank and ADB projects[4],[5]. The average delay in the construction of waste water treatment plants in Indonesia in 2018 is 36% as 20% and shown in Figure 1.

To overcome the delay in the construction of a wastewater treatment plant, it is necessary to use the Line of Balance *(LOB)* scheduling method because the construction of a waste water treatment plant is carried out in many places and repeated with the same building construction design [6]-[9]. While the use of the M-PERT scheduling method is intended to obtain the accuracy of the completion time of construction [10].

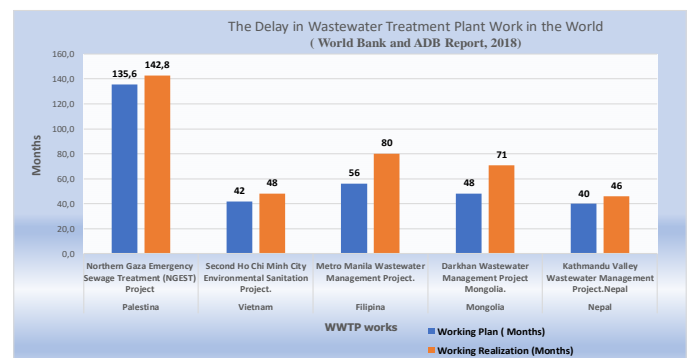**Figure 1. Delay in wastewater treatment plant work In the world**

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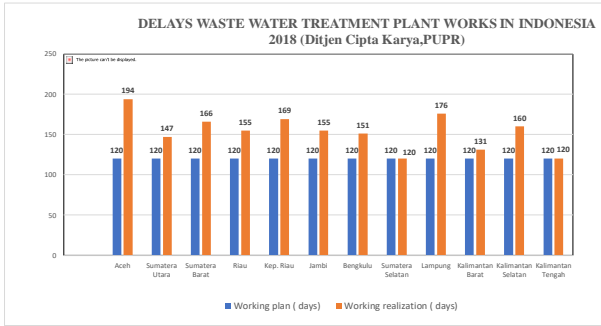*& Sciences Publication*

Figure 2. Delay in wastewater treatment plant work in Indonesia

Figures for the Environmental Performance Index (EPI) provide information on environmental management performance ratings in the world which include indicators of air pollution, water, and sanitation which include wastewater, forestry, agriculture, and others and Indonesia's position is still ranked 133 out of 180 countries in the world with EPI 46.92. Switzerland's highest EPI number reaching 87.42 and the lowest in Burundi is 27.43 as shown in figure 1.3, with dark blue having numbers 50 - 100 and light blue at numbers 0 – 50 as seen in figure 3 below [11].
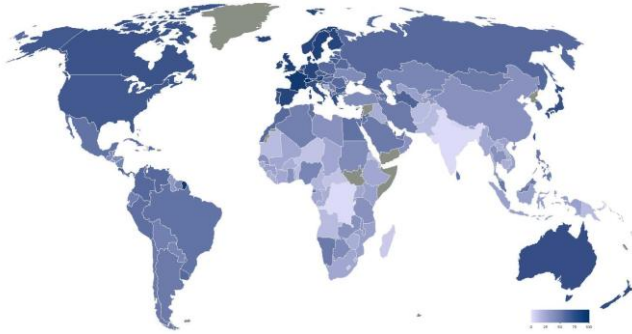

**Figure 3.
Environmental Performance Index (EPI) Score in the world**

II. IMPLEMENTATION OF LOB AND M-PERT METHOD INTEGRATION

The construction of a wastewater treatment plant in cities built in bulk through the 2018 state budget funding has been built by 41 units in 13 provinces of Sumatra and Kalimantan, but it has been slow, even though the planning design is the same, which is not achieved. For this reason, the integration of LOB and M-PERT scheduling methods is carried out in order to help optimize the timing of the construction of a wastewater treatment plant that is carried out repeatedly in several locations and to achieve accurate completion time due to limited financing time from the APBN [12]-[14]. The application of the integration of the LOB and M-PERT scheduling methods will help the City Government in meeting the target number of wastewater treatment plant facilities that must be built within a budget year. And next year the City Government can plan to build more wastewater treatment plant facilities so that the target that all residents can get adequate access to wastewater treatment plant facilities can be met in stages.

III. RESEARCH METHODOLOGY

The design of the study begins with the following steps: 1) Work begins with gathering literature studies and identifying problems with delays in waste water treatment plant projects from international journals and national journals; 2) From the literature study and identification of problems, the title of the research can be obtained and continued by conducting a research gap to ensure research gaps are available; 3) Arranging State of the Arts in order to ensure there are no similar studies and avoid plagiarism in this study; 4) Formulate the problem (Research Question) about the application of the Line of Balance (LOB) and M-PERT methods and set research goals (Research Aim) to answer the Research Question and compile the research hypothesis; 5) Compile research methods that include the process of construction work, identification of variables, data collection and compiling testing models and hypotheses; 6) Collect primary and secondary data and qualitative and quantitative data on the construction of waste water treatment plants in 2018; 7) Continued by validating the data process with statistical analysis using the *RII (Relative Importance Index)* method, where this method has been used throughout the world in research; 10) From all the steps above, conclusions and suggestions can be drawn for the next step of the research. A detailed description of the research design can be seen in figure 4 below [15].
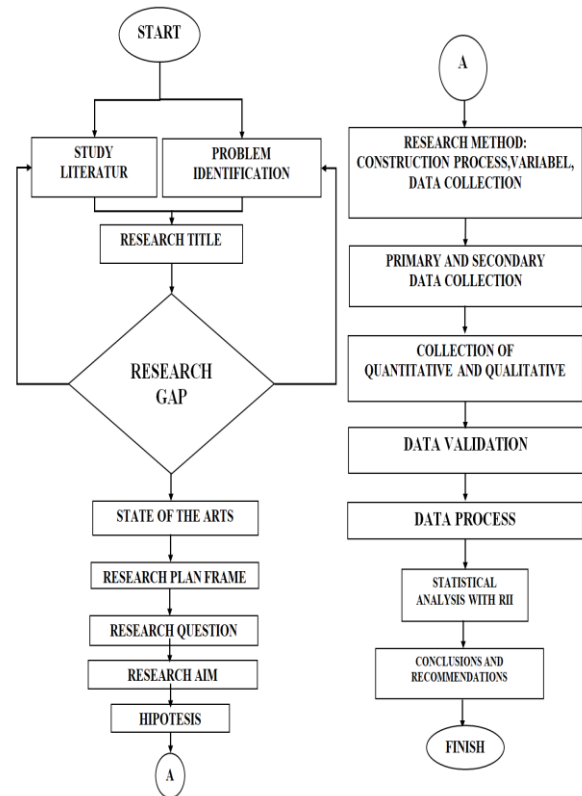

Figure 4. Research Methodology

This questionnaire survey is used to obtain any factors that influence the application of LOB and M-PERT scheduling methods in the construction of a wastewater treatment plant. 40 Respondents from the site engineer, site manager, and project manager were asked to respond to 44 sub-factors identified using numbers 1 - 5 on a Likert scale,

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where 1 is not considered influential, 2 is considered as having no effect, 3 is considered as influential enough, 4 is considered as influential and 5 is very influential based on the experience they face every day. The questionnaire before being distributed has been limited to those who understand and understand the LOB and M-PERT methods so that later the respondents will be able to understand in completing the questionnaire.

The results of data collection from all respondents illustrate that the questionnaire data sent by the author of 45 pieces and who returned 40 the number of questionnaires has met the minimum requirements for use in research by following the minimum number of respondents. The details of the return of the questionnaire are as follows:

Tabel 1. Data Collection

Questionnaire	Sent	Returned	Percentage (%)
Hardcopy	45	40	89

Profile of respondents in the study had sex dominated by men by 70% and women only 30% with the number of details of respondents can be seen in the Figure 5 below.
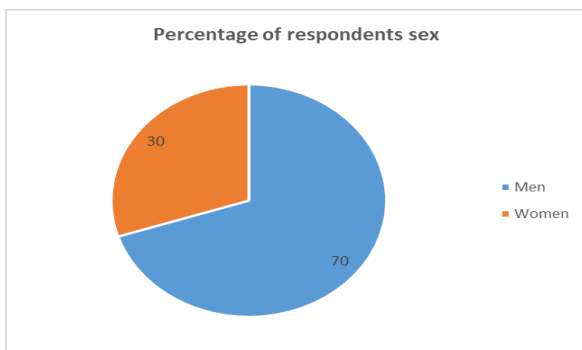

Figure 5. Percentage of respondents sex

Distribution of respondents by age was dominated by age> 51 years and the smallest respondents were <30 years old and 31 - 40 years old as shown in the Figure 6 below.
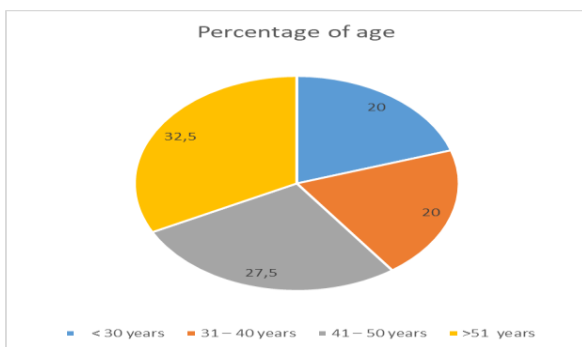

Figure 6. Percentage of age

Whereas the education level of the respondents is dominated by civil engineering and environmental engineering scholars with a bachelor 85% and the lowest Diploma 3 of 5% as can be seen in the Figure 7 below.
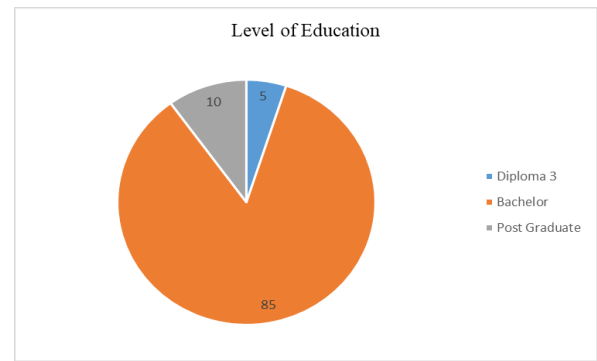

Figure 7. Level Education respondents

Most of the respondents' positions in the research target are Project Managers of 70% and the smallest as site managers and site engineers of 5% as can be seen in the Figure 8 below.
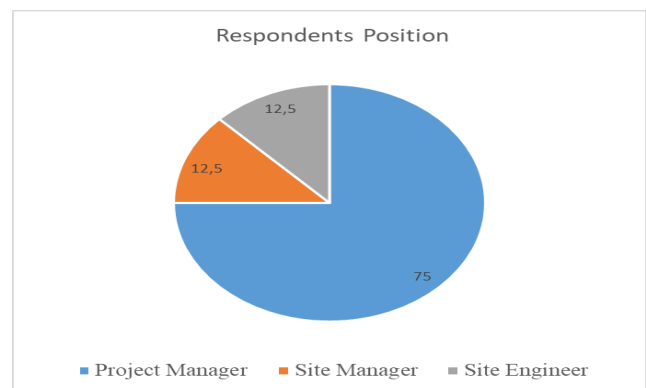

Figure 8. Respondents position

Respondent's work experience is dominated by over 15 years working period of 57.5%, then 20% of respondents have a working period of 5 - 10 years, 10 years - 15 years work period of 17.5% and the smallest 5% with <5 years work experience. Respondent's work experience can be seen in the Figure 9 below.
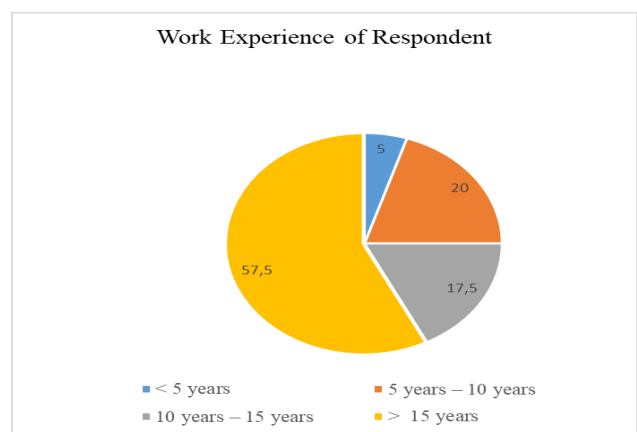

Figure 9. Work experience of the respondent

The type of work carried out by respondents was dominated by wastewater treatment construction work of 55%, followed by the construction of buildings equipped with STP (Sewage Treatment Plant) of 45% as can be seen in Figure 10 below.
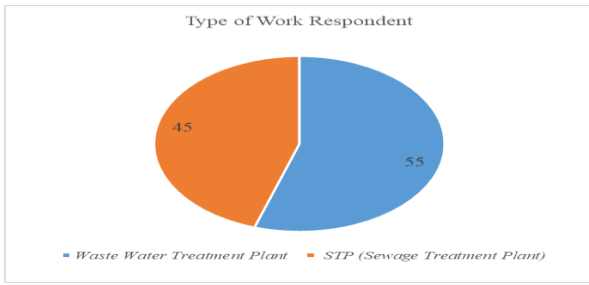
Figure 10. Type of work respondents

44 of these sub-factors come from 9 main factors based on literature studies [4],[15],[10]. The main factor consists of the Line of Balance method in the aspects of scheduling, planning, implementing, and analyzing implementation. The theory of M- PERT (Manual PERT), this method is a development of PERT. Not done computerized, but manually as stated by the inventor of this theory. [16]. Preparation of research instruments by using a questionnaire to the stages of preparation, namely by identifying variables, the main factors, and sub-factors, classify and search the most important factor, prepare statements in the points corresponding questions variables and compile qualitative respondents with multilevel [17].While the data processing method uses a scheme as shown in the Figure 11 below.
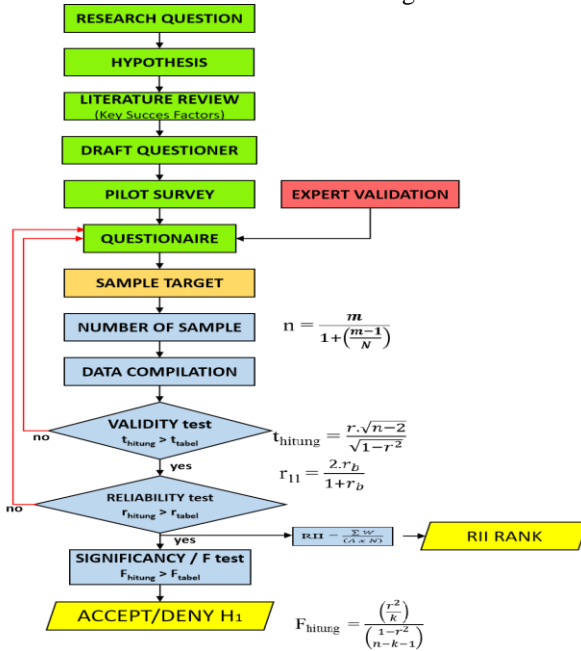

Figure 11. Data Processing Method

The statistical analysis method in this study uses the Relative Importance Index (RII) method based on equation 1 below [18],[19].

$$RII = (\sum W / A \times N)$$ (1)

Note :
RII: *Relative Importance Index*
W: *Weight (range $1 - 5$)*
A: Highest weight, 5
N: Total respondent

IV. RESULT AND DISCUSSION

The results of statistical analysis with the RII method on 10 sub-factors, where the highest score of RII is 0.995 and the lowest is 0.950 can be seen in Table 2 below

Table 2. The Most Influential Variable

Rank	Sub Factor	RII Score
1	Combining 1 group activities	0,995
2	Merging of alternative lane activities	0,990
3	Recalculating PERT	0,985
4	Project time Optimization	0,980
5	Relationship logic activities	0,975
6	Analysis of buffer time determination	0,970
7	Duration of work unit	0,965
8	Land ownership	0,960
9	Inability to acquire required permission	0,955
10	Effect of local custom & religious events	0,950

Table 2 showed the top 10 most influential sub-factors in applying the LOB and M-PERT scheduling method based on the choice of respondents has a high RII number in the range between 0.950 - 0.995, where the sub-factor of the M-PERT main factor is like combining one group activity, combining activities on alternative paths and recalculating PERT. Sub factors of the LOB method such as optimization of project time, relationship logic activities, and analysis of buffer time determination and duration of work units. Whereas the land ownership sub-factor, inability to acquire required permission and the influence of local custom and religious events is the main factor of the schedule of the wastewater treatment plant work.

V. CONCLUSION

1. There is a significant influence of LOB and M-PERT integration utilization to the final duration of the wastewater treatment plant construction project.
2. The 10 most influential factors of the utilization of the line of balance and M-PERT scheduling method integration consists of combining 1 group activities, merging of alternative lane activities, recalculating PERT, project time optimization, relationship logic activities, analysis of buffer time determination, duration of work unit, land ownership, the inability to acquire required permission, and the effect of local custom & religious events.
3. The resulting 10 most influential factors could be used by planning consultant on wastewater treatment plant construction project activity scheduling to reach higher efficiency and effectivity.

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