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Designing Risk Reduction Strategies to Improve Construction Performance Project Solid Waste Disposal

(Case Study: 2 x 1000MW Steam Power Plant Project)

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Abstract:- The construction project of a coal-fired steam power plant, of course, takes into account the problemof waste (coal ash), therefore it is necessary to plan for a place to store solid waste remaining from combustion (Solid Waste Disposal). Disposal of solid waste is a useful waste storage area to prevent pollution to the surrounding environment. The construction of solid waste disposal consists of embankments and ponds, in its construction it is necessary to consider the risks that will occur, so asto minimize the impact that will be caused, in terms of cost, time and quality. This study aims to determine the extent to which risk management is applied in the implementation of solid waste disposal development projects. The survey was conducted through interviews using a likert scale (1- 5) questionnaire. The population and study sample taken are contractors and subcontractors who work on solid waste disposal projects, and already had long experience with soil works. The respondents consisted of project managers, construction managers, supervisors, surveyors, quality controls, engineers, and staff involved in them. A combination of propotional and purposive sampling method was used. SEM (Smart PLS) was used to test the validity and reability of the model as the data analysis technique. The research conludes that the performomance project of solid waste disposal were influenced by resouces, which influenced by managerial aspect, that that the management of manpower and materials has a major role in improving performance is key mainly.

Keywords:- *Risk Management, Solid Waste Disposal Project, SEM-PLS, Performance.*

I. INTRODUCTION

The construction industry contributes to the Indonesian economy in fourth place, 10.56 percent of the Gross Domestic Product (GDP) in the second quarter of 2020. The Central Bureau of Statistics (BPS) monitors construction developments through the Quarterly Construction Company Survey (SKTR) conducted on companies medium and large scale construction in Indonesia [7]. With this sizable contribution, the construction industry is required to be able to manage the risks that have the potential to occur in the implementation of construction in order to provide positive output in accordance with the planned implementation schedule and budget. Definition of construction industry risks in general are events that affect project objectives both in terms of cost, time and product quality. And at each stage of the project is inseparable from the risk of uncertain conditions that can affect both in terms of quality and quantity [24]). Risk is the possibility of something unexpected happening beforehand, which is detrimental and can affect the completion of the project as a whole with regard to time, cost and quality [25].

Various types of projects have risks that will certainly be faced, including the solid waste disposal project in a steam power plant (PLTU). SWD is a construction in the form of a pond surrounded by an embankment which functions to accommodate solid waste left over from the PLTU's coal combustion and is useful to prevent waste material from spilling over and contaminating the surrounding area. SWD construction requires a solid design to prevent failure and damage in the future. Lack of preparation in construction design that does not consider and pay attention to the characteristics of the soil in the building area will result in a decrease in the quality of the construction and require a repair process that takes a long time and costs. For SWD construction, which has a fairly large area of approximately 25 hectares, of course, it requires a very large budget and a long process. In the construction of ashpond construction, the subgrade or subgrade is the most important part, because this part is the surface for the position of the pavement parts. Besides.that strength and durability construction and pavement depends on the characteristics bearing capacity of the soil. Soilfoundation.also will become the foundation or the entire construction of the SWD development, because the strength of the subgrade will determine how thick the soil layer is [8] With such a large construction area, the materials and equipment needed are also the same. a lot. Moreover, the land for embankment must have good criteria. The construction of this ash pond requires a large amountof land and if good quality soil is not available in the nearest location, then the cost of building the ash pond becomes very high[8]

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Departing from this case, there is an urgency to carry out research and studies on the coal ash waste storage pond development project to find out the potential risks that will occur, so that risks that have a negative impact can be prevented, so that the target schedule for completion and costs can be in accordance with the plan. . This research is not only to find out how the influence of risk among the supporting aspects (variables) of construction implementation but how strategies need to be done to improve project performance. Risk is one aspect of uncertainty. Risk is an uncertain event or condition which, if it occurs, has a positive or negative effect on one or more project objectives. Negative risks are called threats, and positive risks are called opportunities. that risk is an effect of target uncertainty, this effect is a deviation that has negative and positive characteristics[5]. All projects have risks because they are unique endeavors with varying degrees of uncertainty. Project team members must proactively identify risks throughout the project to avoid or minimize the impact of threats and trigger or maximize the impact of opportunities.

Both threats and opportunities have a set of possible response strategies that can be planned to be implemented if the risk occurs. Project Risk Management includes the process of carrying out risk management planning, identification, analysis, response planning, response implementation, and monitoring of risks in a project. The objective of project risk management is to increase the likelihood and/or impact of positive risks and to reduce the likelihood and/or negative impact of risks, in order to optimize the chances of project success. [1]. All projects are risky because they are unique ventures of varying degrees of complexity aimed at delivering benefits. It does this within the context of constraints and assumptions, while responding to stakeholder expectations that may conflict and change. Organizations must choose to take project risks in a controlled and deliberate way to create value while balancing risk and reward.

II. MATERIALS AND METHODS

A. *Modelling*

This research model is based on several theories and previous research that is used as a reference is the research by Huda M, [18],Fandopa[15], Anggi et al[16]), Lisananda AA[21]), Fandopa's research points to several risky aspects affecting project quality performance. Huda M's research concluded that the company's resource competence and strategic decisions have a strong influence on the performance and competitive advantage of the company and the company's performance is indirectly influenced by project management capacity.

From several studies that raise risk management in several projects which broadly consist of several aspects that play an important role in project implementation, and will be referred to as latent variables which are items of the conceptual model formed including managerial aspects which are denoted as MG, resource aspects which are denoted as SD, design and documentation aspects which are denoted as DD, environmental aspects which are denoted as LS, and aspects of methods and equipment which are denoted as MA, then by adopting the research model in Huda M (2013), which raises research on performance sustainability strategies and competitiveness of construction companies. By referring to several risk events in the SWD work project which has several aspects as variables and several risk events as indicators, the conceptual model can be formulated with several indicators which are denoted as shown in table 1.

By adjusting to the SWD project work item which is a job that is limited by time (target) by not considering aspects of sustainability interests and company competitiveness, the conceptual model does not provide an assessment of the sustainability and competitiveness aspects of the company.

B. *Definition of Variable and Indicator,*

- *Managerial,*

Managerial in projects or commonly referred to as project management is the application of knowledge, skills, tools and techniques or methods in project activities to achieve the requirements/needs of stakeholders from a project[15]. The aim is to execute project so that the results can meet the scope of requirements on budget, schedule, acceptable risk, quality and level of safety [17].

- *Resources,*

Human resources are the most important part in limited project activities. The resource management of a project has a major impact on the success and performance of the project itself [15]. If the specifications of the available human resources are not sufficient in number or specification, personnel capacity building will be increased by conducting training or recruiting from outside the company so that the required specifications and number of personnel are met (Rania Al-Maghraby, 2008). Materials are the largest component in project implementation in terms of cost, the cost of procuring materials on projects reaches 50% or even more of the total project cost. Errors in material procurement will greatly affect overall project performance. Material management is a management system that integrates the purchasing area, expediting and controlling progress from vendors. It is an important part of project management and can be integrated with engineering to provide an end product that meets client requirements and is cost effective (Damodara U. Kini, 1999).

- *Design,*

Design is the prosess of creating the description of new facilitu, usually represented by detailed plans and specification [11],design change and rework are inevitable in construction project,and performance of construction project in much impacted by design change[2].

- *Method,*

The method of carrying out the work or what is commonly abbreviated, CM (Construction Method). Is a sequence of logical and technical execution of work in relation to the availability of the required resources and the

conditions of the work field or environment, in order to obtain an effective and efficient implementation methods [20].

➢ *Environment,*

Environment With the consideration that each implementation of a construction project is unique because it is inseparable from the influence of geographical factors that exist in the project location environment, both technical and non-technical in nature. Problems related to technical matters, for example in determining the foundation structure in relation to local soil conditions and structures. While matters related to non-technical issues, for example: regulations and permits, habitat conditions, climate and weather [13]

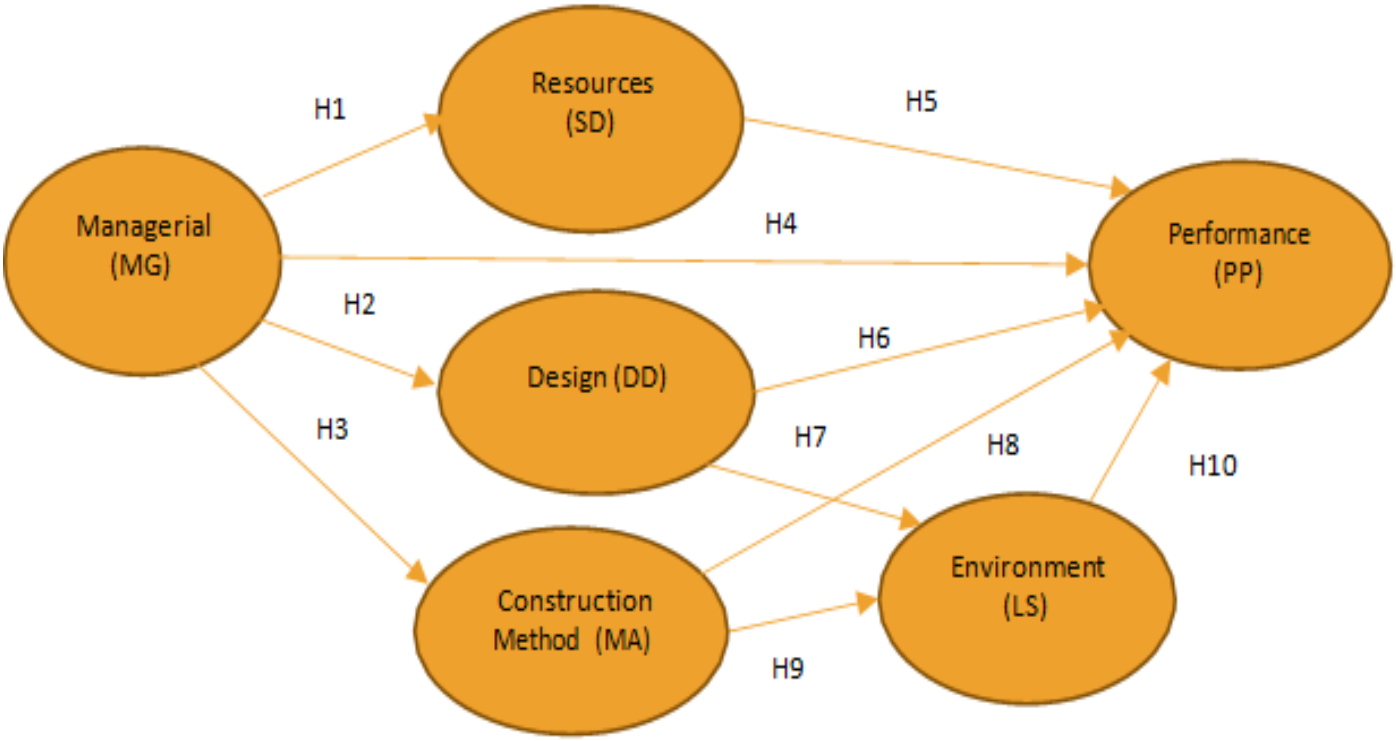

Fig 1 Research Conceptual model and Hypotesis

➢ *Performance,*

Performance Can be interpreted as a description of the successful construction of financial aspects, customer satisfaction, business processes within the company, as well as learning activities and company growth to improve the company's financial performance in the future [18]

Table 1 Variables and Indicator that Occur in the Solid Waste Disposal Project to be Studied

Variable	Indicator	Reference
Managerial(MG)	Decisions mistake, (MG.1), Inaccurate project scheduling (MG.2), Unclear division of tasks (MG.3), The flow of coordination between parties is not clear (MG.4)	Anggi EF, Agus I, dan Adi S(2019), Fandopa (2012)
Resources(SD)	Shortage of manpower(SD.1), shortage of labor(SD.2), Lack of ability/skill of workforce(SD.3), Materials used are not in accordance with specifications (SD.4), Materials used are insufficient of needs (SD.5), the material used isdamaged (SD.6)	Fandopa (2012), Anggi EF,Agus I, dan Adi, S(2019), Huda M, Wibowo MA. (2013), Darvik Lisa, LarissonJulia (2010)"
Design (DD)	Design mistake (DD.1), Unclear specifications /working drawings (DD.2), Changes in design and scope of work (DD.3), Incompatibility of working drawings and actual conditions at the project site (DD.4)	Anggi EF, Agus I, dan Adi,S(2019), Fandopa (2012) Abdul Rahman H et al(2017)
Method (MA)	Improper implementation method (MA.1), Equipment used is damaged/less than needed (MA.2)	Anggi EF, Agus I, dan Adi S(2019), Aldesra Azri L (2021), Fandopa (2012)
Environment (LS)	Air pollution occurs during construction (LS.1),Landslides occurred during the execution of works (LS.2), Difficult field conditions(LS.3), Social problems/ demonstrations (LS.4)	Aldesra Azri L (2021), Fandopa (2012), NohaAhmed, et al (2021)
Project Permormance(PP)	Delay in completion of work (PP.1), Less thanoptimal quality (PP2)	Fandopa (2012), Takim R,AkintoyenA (2002)

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- *From the conceptual model, the hypothesis that will be developed is as follows:*

✓ H1 = Managerial Variables in the project are significantly influences resources. The hypothesis supported by the research Huda M,[17], other supporting references related by risk project management which consist risk indicators : Wrong decisions, Inaccurate project scheduling Uncleardivision of tasks, Unclear flow of coordination between parties [14,15,18]
✓ H2 = Managerial Variables in the project are significantly influences Design. The hypothesis supported by the research Fandopa R [15], Fahlevi et al[16]
✓ H3 = Managerial variables in the project are significantly influence on the method The hypothesis supported by the research Fandopa,[15],Fahlevi et al[16]
✓ H4 = Managerial Variables in the project are significantly influences performance. The hypothesis supported by the research Fandopa R [15],Huda M ,[18],
✓ H5 = Resources variables are have a significant influence on performance in construction implementation. The hypothesis supported by the research Darvik L, Larisson J[12] other supporting references related by reseach Huda M ,[18],
✓ H6 = Design variables are significantly affect the performance during construction. The hypothesis supported by the research Abdul Rahman H, et al [2] other supporting references related by risk design which consist risk indicators: wrong design, Unclear specifications / working drawings, Changes in design and scope of work, Discrepancies in working drawings and actual conditions at the project site[15.16]
✓ H7 = Design variable having an impact on the environment in the construction process. The hypothesis supported by in the research of Noha Ahhmed, et al [24] that the construction sector is one of the most significant, where the sector has a real impact on the environment with large amountsof emissions into the atmosphere.
✓ H8 = The construction method variables are have an influence on environment in construction implementation. The hypothesis supported by the research I Wayan Jawat, [20], The implementation method used if it is not appropriate will have an effect directly to the quality of work. The selection of the implementation method is determined at the design ang planning stage by considering many aspects, including field conditions Fandofa, R [15].
✓ H9 = Environmental variables are have an influence on performance in construction implementation. The hypothesis supported by the research Akanni PO et al [4]

C. Materials and Methods

Based on the research model in figure 1 above, six constructs were developed to measure the latent variable “Managerial”, “Resources”, Design and drawing”, “Construction Method”, “Environment”,and ” Performance”. Survey method were by distributing likert scale (1-5) based questionnaire which consisted of question about variables which can measure latent variables. Every questionwas associated with variable described in the previous section. The survey was conducted by face to face interview to stakeholder project; project managers, construction managers, engineers, supervisors, quality control, surveyors.and distributing questionnaires were be given by link on line to 100 respondents who were workers involved in the SWD project, The determination of the sample was taken by proportional sampling to employees who were involved in the SWD project and had experience.

From 100 questionaires distributed to employees 78 viable analyzed answers obtained answere via link google from, from the results of the questionnaire on employees who have worked for less than 10 years by 53 percent, between 10 and 20 years by 32 percent, and more than 20 years by 12 percent. Majority of respondents had bachelor degree (S1), which is as much as 85.9 % of totalrespondet; ranked second was the group of respondent with senior high school as much 11.5% and tehe rest were with master degree (S2).

Research instrument validity test was performed by Validity test is used to ensure the items/indicators in the measurement of variables in this study are really the right parameters. And the validity test can be done with the convergent validity method with the help of smart PLS software. this is done by connecting all the constructs or variables in the research method, then from the resultsof the correlation a loading factor value, a critical ratio (CR) value, and the p-value of the output regression weight will be obtained. The output value is used as a criterion whether the items or indicators used in the study meet the specified validity criteria or not. The expected output value is a loading factor value of more than 0.7 (Heir et al. 2011 on Ab Hamid MR, et al [3]), and a loadingfactor value of 0.5 – 0.6 is considered sufficient (Chin, 1998). from the algorithm analysis results PLS obtained that the loading factor values for all items used in this study are in accordance with thecut of value recommended by Hair et al (2011) on Ab Hamid MR, et al [3], which is greater than 0.7. this means that the items used in variable measurement are appropriate or have met the validitycriteria. Ffor factor loading the results of the PLS analysis algorithm can be seen in Tabel 2 and Figure.2

The reliability test is used to test the consistency of the research instrument. And the method used to test the reliability in this study is the composite reliability method. Composite reliability testing is used to show the consistency of an indicator in latent variables, usually the value of composite reliability tends to be greater than Cronbach's alpha (Fornell and Lackerm 1981). It is considered reliable if the composite reliability value is greater than 0.7 (Nunnally and Berstein, 1994 on Ab Hamid MR, et al [3]). The following is a summary of the results of the PLS algorithm analysis in theform of a composite reliability value in table3. Based on table3, that is, each variable has a value greater than 0.7, and the AVE value is greater than 0.5,

which means that the research instrument has met the required reliability, or It can be said that the research instrument has good consistency.

Table 2 Summary of validity test with loading factor criteria

No.	Indicator	Design	Environment	Managerial	Method	Perofrmance	Resources	Criteria
1	DD2	0,728						Valid
2	DD3	0,747						Valid
3	DD4	0,828						Valid
4	LS1		0,826					Valid
5	LS2		0,653					Valid
6	LS3		0,779					Valid
7	LS4		0,777					Valid
8	MA1				0,831			Valid
9	MA2				0,846			Valid
10	MG1			0,790				Valid
11	MG2			0,778				Valid
12	MG3			0,884				Valid
13	MG4			0,684				Valid
14	PP1			0,871				Valid
15	PP2			0,900				Valid
16	SD1			0,693				Valid
17	SD3			0,812				Valid
18	SD4			0,866				Valid
19	SD5			0,781				Valid
20	SD6			0,788				Valid

Table 3 Summary of Realibility test

	Cronbach'sAlpha	Rho A	CompositeReliability	Average Variance Extracted (AVE)
Design	0,663	0,688	0,812	0,592
Environment	0,759	0,778	0,846	0,580
Managerial	0,792	0,800	0,866	0,620
Method	0,577	0,578	0,825	0,703
Performance	0,726	0,733	0,879	0,785
Resources	0,848	0,860	0,892	0,624

Source : Data Processed by Researche

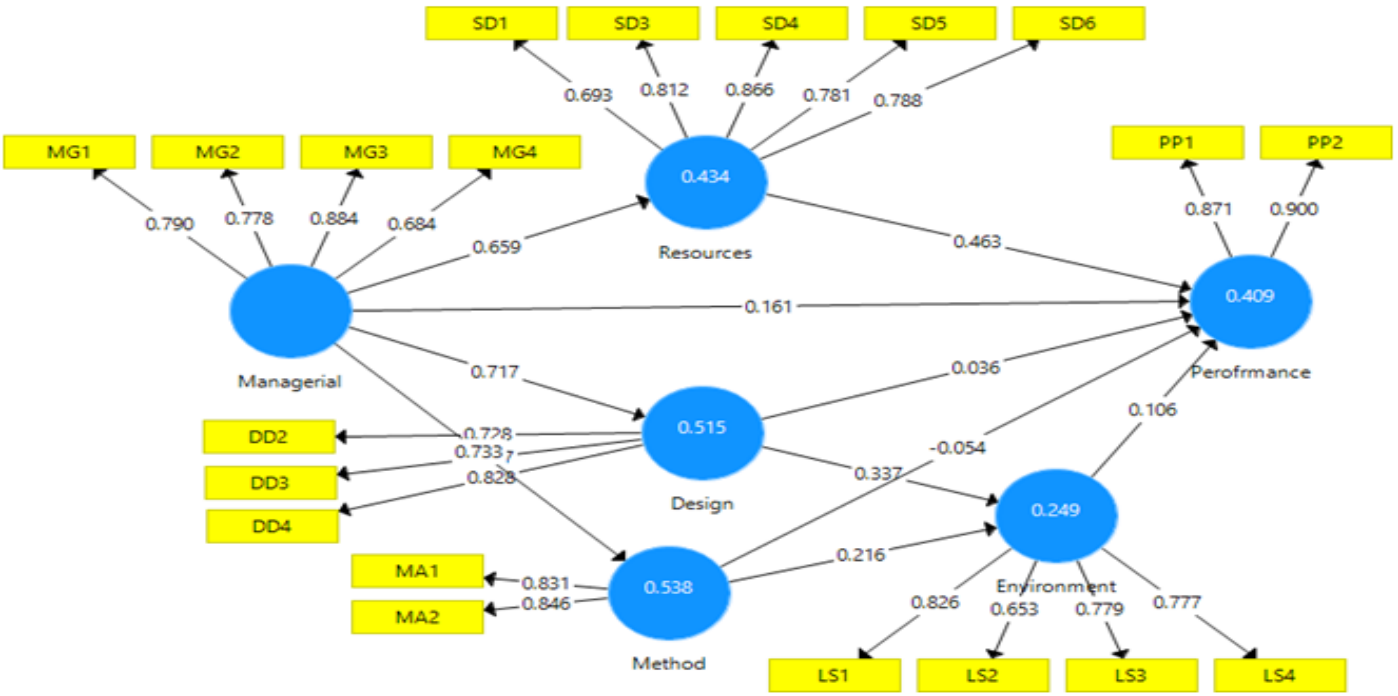

Fig 2 Validity Test with PLS Algorithm
Source: Data Processed by Researcher

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➢ *Hypotheses:*

The use of Structural Equational Modeling is in the context of testing the assumptions of causality between variables. SEM analysis output is displayed in the form of images and tables. Pictures to show the research model in visual form while the table contains a summary of the results of the data in the form of numbers as a basis for determining hypothesis testing. Following are the results of SEM analysis in the form of C.R values and P-values displayed to assess whether the proposed hypothesis is accepted or rejected. The expected value to accept the hypothesis is C.R greater than 1.96 and p-value less than 0.05. Conversely, if the C.R value is less than 1.96 and the p- value is greater than 0.05, Details can be seen in Figure 3 and Table 4.Hypotheses testing is done by comparing the t-value of each latent variable with t-table (1.96), which is said to be significant if thet-test value of the latent variable is greater than t-table (t-count> 1.96). based on the loading factor value (figure 2) and the results of the T test (Figure 3), the significance criteria for each hypothesis can be seen in table 3 below

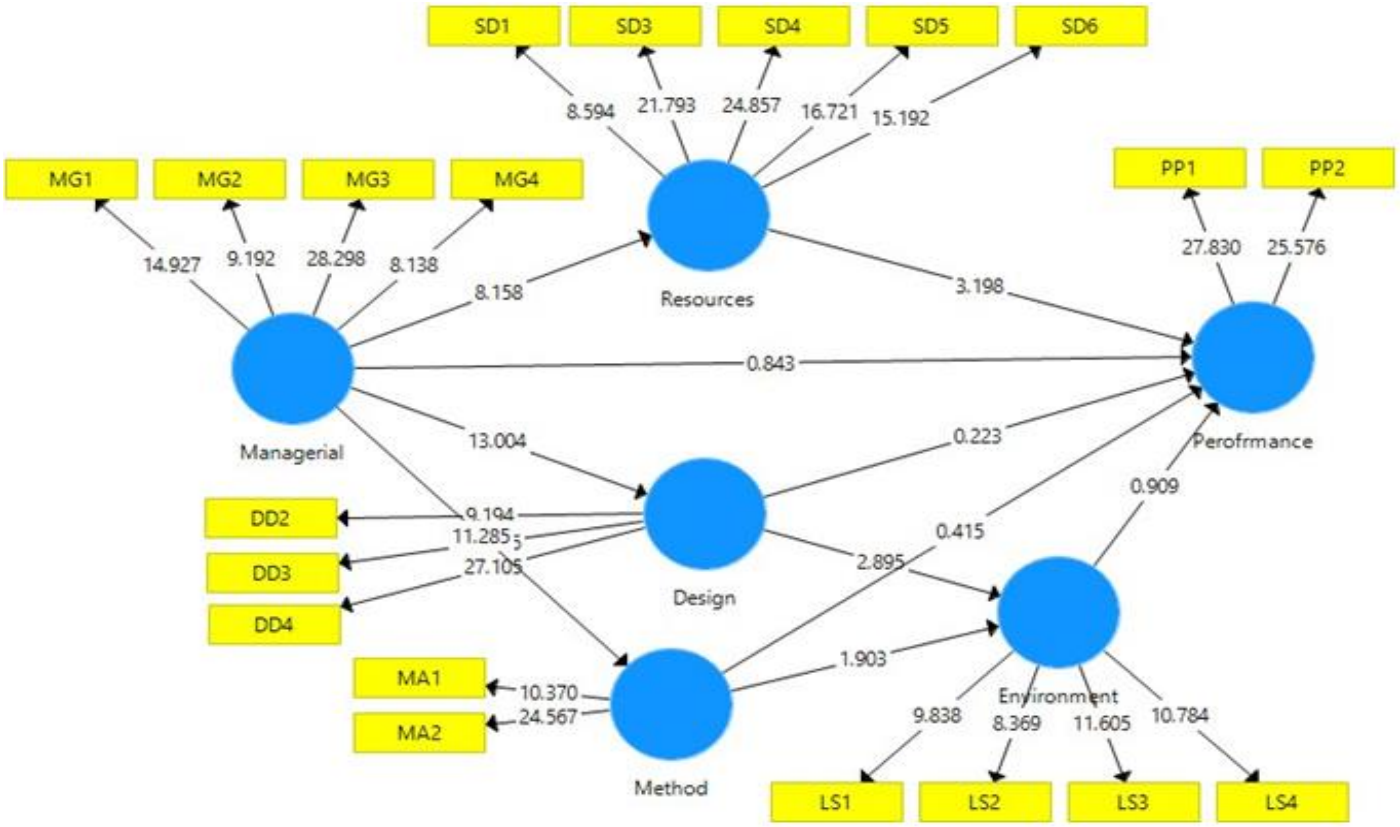

Fig 3 Hypothesis Testing (t-test) with Bootstrapping
Source: Data Processed by Researcher

Table 4 The Influence of Latent Variables

Independet Variable	Dependent Variable	Original Sample(O)	Sample Mean(M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Criteria tcount>t-table (1.96)
Managerial (MG)	Resources (SD)	0,659	0,664	0,081	8,158	0,000	Significant
Managerial (MG)	Design (DD)	0,717	0,721	0,055	13,004	0,000	Significant
Managerial (MG)	Method (MA)	0,733	0,745	0,065	11,285	0,000	Significant
Managerial (MG)	Performance (PP)	0,161	0,138	0,191	0,843	0,400	Not Significant
Resources (SD)	Performance (PP)	0,463	0,466	0,145	3,198	0,001	Significant
Design (DD)	Performance (PP)	0,036	0,049	0,163	0,2223	0,823	Not Significant
Design (DD)	Environment (LS)	0,337	0,343	0,117	2,895	0,004	Significant
Method (MA)	Environment (LS)	0,216	0,225	0,113	1,903	0,058	Not Significant
Method (MA)	Performance (PP)	-0,054	-0,047	0,129	0,415	0,678	Not Significant
Environment (LS)	Performance (PP)	0,106	0,115	0,117	0,909	0,364	Not Significant

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III. RESULT AND DISCUSSION

Based on Table 4 it can be seen that the T-Statistic value of the influence on Resources, Design, and Method is exceeds 1.96 and p-value is below 0.05 positive so that managerial has a positive effect on resources, design and method. The same for statistic value of the influence on performance and environment has exceed 1.96 and p-value is below 0.05 positive that resources effect on performance, design and method has effect positive on environment..

- *Effect of Managerial on Resources, Drawing and Method*

This study confirms the first hypothesis that managerial has a significant effect on resources. That managerial in projects or commonly referred to as project management is the application of knowledge, skills, tools and techniques or methods in project activities to achieve the requirements/needs of stakeholders from a project[15]. This means that several managerial aspects in determining the allocation and need for resources in the SWD construction process need support and fulfillment of their needs, and management and regulation are needed, so that excess or shortagedoes not occur. The division of labor tasks (job descriptions) in executing a job also requires proportional and appropriate management so that performance and performance will be obtained properly. Coordination of labor and team is also very necessary so that it can run on a track that is inaccordance with the stages of work. Besides that, effect of managerial on design and drawings that in project design (managerial decision makers) have an important role in determining the design/design as well as supporting items to be used in construction implementation. Including changes to the design and size in the field is a managerial responsibility.

In carrying out and executing a job, especially in SWD, strategies and methods are needed for its implementation. That the role of the managerial (decision maker) is very important, what method will be used to carry out the work and the allocation of equipment according to needs.

From the results of hypothesis testing with PLS it produces t-statistics exceed of 1.96 and a p value <0.05 meaning that Ho is accepted, that Managerial has a significant effect on resources, design andmethod.

- *Effect of Managerial on Performance*

The fourth hypothesis that managerial has a significant effect on performance in the construction process. This means that the accuracy in making decisions greatly influences project performance, besides that appropriate and timely project scheduling has a significant impact on project performance. This is supported by research Huda, et al [18] that management has an important influence on project performance. However it is contrary to the case for SWD project that managerial has less influence on performance. The T-Statistic of managerial influence on performance is 0.757with a p-value of 0.449. The T-Statistic and p-value for managerial variables on performance do notmatch the cut of value specified, namely the T-Statistic is less than 1.96 while the p-value >0.05 above of . This means that managerial in SWD projects, how the project is managed and the decision- making process does not directly affect performance.

- *Effect of Resources on Performance*

This study confirms the fourth hypothesis that resources have a significant effect on performance in the SWD construction process. This means that the procurement of a number of skilled workers as well as engineer staff and executors in the field greatly influences project performance, besides that the accuracy of material procurement, both specifications and arrival schedules, also has an important effect on project performance, meaning that to make a construction the role of executor and materials is key mainly. That resources are the most important part in limited project activities. The resource management of a project has a major impact on the success and failure of the project itself [15]. If the specifications of the available human resources are not sufficient in number or specification, personnel capacity building will be increased by conducting training or recruiting from outside the company so that the required specifications and number of personnel are met. In accordance with the results of the analysis simulation with PLS, it gives a value showing the result of the value of p <0.05, meaning that Ho is accepted, that resources have a significant effect on performance.

- *Effect of Design and Drawings on the Environment and Performamnce*

This study confirms the sixth hypothesis that construction design has a significant effect on the environment, in the SWD construction process there are various construction activities that generate pollution both from earthwork activities, be it excavation or embankment. As stated in the research of Noha Ahhmed, et al [23] that the construction sector is one of the most significant, where the sector has a real impact on the environment with large amounts of emissions into the atmosphere. Besides that, construction design that does not pay attention to the characteristics and carrying capacity of the soil will have an impact on the environment itself. In accordance with the results of the analysis ith PLS giving a value showing the results of the value of p <0.05 meaning that Ho is accepted, that the design has a significant effect on the environment.

But different for the results of the PLS analysis, the hypothesis for the influence of design on projectperformance SWD gives a minimum value of the part coefficient limit significant. However, in the case of the SWD project, the PLS analysis yields a value of p> 0.05, meaning that Ho is rejected, that design has no effect on project performance. For this project is contrary with research that performance of construction project in much impacted by design change [2]

- *Effect of Methods on the Environment and Performance*

This study confirms the seventh hypothesis that method has a significant effect on the environment in the SWD construction process. This is according to what is said by I Wayan Jawat, [20]. That a sequence of logical and

technical execution of work in relation to the availability of the required resources and the conditions of the work field or environment, in order to obtain an effective and efficient implementation method. Besides that, construction method that does not pay attention to the characteristics and carrying capacity of the soil will have an impact on the environment itself. The implementation method used if it is not appropriate will have an effect directly to the quality ofwork. The selection of the implementation method is determined at the planning stage (planning) by considering many aspects, including field conditions [14]. From the results of the analysis with the PLS, the result is a p value <0.05, meaning that Ho is accepted, that the method and equipment have a significant effect on the environment.

IV. CONCLUSIONS

➢ *Based on the results of the analysis and discussion, it can be seen that the risk events that affect the solid waste disposal development activities are as follows:*

- From the results of the hypothesis, it is obtained that the aspect that greatly influences performanceis the resource aspect with several parameters and managerial factors which of course have a role in managing design resources and methods. It is natural that resources are the main factor in determining performance because resources, especially labor, are the ones who carry out the work. As long as resources are given more attention then performance will increase.
- To improve project performance based on risk management there are several aspects that need to be considered for attention and management of risk occurrence so that it can anticipate it. It is necessary to manage aspects of the design and working drawings by minimizing design errors, minimizing discrepancies in data and measurements in the field, minimizing drawings discrepancies with actual conditions and minimizing changes drawings. Then in the managerial aspect it is necessary to minimize mistakes in making decisions, clear division of work tasks, make coordination and communication within the team, and make the right implementation schedule. In the resource aspect, good management is also needed, including procuring a number of implementing staff according to needs, procuring a sufficient number of project engineers, procuring a sufficient number of skilled workers/skills, procuring materials according to specifications in the purchasing and storage process, importing material according to the arrival schedule so that it is fulfilled accordingto the needs and users.

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