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# ANALYSIS OF FACTORS AFFECTING THE BACKLOG CLOSE-OUT PROJECT AND ITS IMPLICATIONS ON THE PERFORMANCE OF NON-FINANCIAL ENGINEERING DEPARTMENTS IN PETROCHEMICAL COMPANIES

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**Abstract**

The purpose of this research is to analyze the influence of Detail Engineering Design (DED), field work, as built drawings, and backlog close out projects to ESD non-financial performance of Petrochemical companies. The method used is quantitative. Data collection technique by means of purposive sampling. The data obtained were then processed using SEM-PLS. **Findings:** The results showed that Detailed engineering design has no effect on the backlog close-out project on ESD non-financial, Field work has a positive and significant effect to the backlog of close-out projects, as-built drawings have a positive and significant effect on the backlog of close-out projects, Detailed engineering design has a positive and insignificant effect on ESD non-financial performance, Fieldwork has a significant negative effect on ESD non-financial performance, and the close-out project backlog variable has a positive and significant effect on ESD non-financial performance at Petrochemical companies. The r-square value indicates that the Detail Engineering Design, field work, and as-built drawings are able to explain the variability of the backlog close-out project construct by 68.1%, and the remaining 31.9% is explained by other constructs outside studied in this research. While the Detail Engineering Design, fieldwork, as-built drawings, and close-out backlogs are able to explain the variability to ESD non-financial performance constructs of 98.7%, and the remaining 1.3% is explained by other constructs outside those examined in this research.

**Keywords**: As Built Drawings, Backlog Close Out Projects, Detail Engineering Design, Fieldwork, Non-Financial Performance.

## INTRODUCTION

The phenomenon of the performance of the Engineering and Construction Dept. Petrochemical companies have recently been getting worse, in line with the number of modification projects, both minor and capex, which are always increasing from year to year, and have an impact on the project backlog which continues to increase every year. This certainly has an impact on the performance of the Engineering and Construction Dept. which is not good. Backlog of work that has not been done backlog close-out project is a backlog of work that must be completed (backlog), as presented in table 1 below:

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**Table 1: Frequency Project, Backlog and WBS 2020 – 2022 Period**

| Backlog Project Status | 2020 | | 2021 | | 2022 | |
|---|---|---|---|---|---|---|
| | **Backlog No.** | **Percentage** | **Backlog No.** | **Percentage** | **Backlog No.** | **Percentage** |
| Total Completed Project | 7485 | 72,8% | 8124 | 72,9% | 9254 | 73,9% |
| Total Backlog Project | 2786 | 27,2% | 3016 | 27,1% | 3255 | 26,1% |
| Total WBS Released | 10271 | 100% | 11140 | 100% | 12509 | 100% |

Source: Primary data processed (2023)

Based on the data in Table 1 above, which was obtained from the system analysis program (SAP) system, it shows an increasing frequency that by December 2020, the total project modification backlog had reached 2786 of the 10271 total WBS released which had a completion rate of only 72.8%. As of December 2021, the total project modification backlog has reached 8124 out of 11140 total WBS released which has a completion rate of only 72.9%. And in December 2022, the total project modification backlog has reached 3255 out of 12509 total WBS released which has a completion rate of only 73.9%.

Meanwhile, the Key Performance Indicator (KPI) that has been set by the company must have a completion rate of at least 90%, which means that a maximum of 10% of the WBS backlog is permitted. Based on these data, the ESD Dept. only able to complete 73% of the total WBS and the remaining 27%. Backlog close-out project performance which is also one of the factors causing ESD's recent poor performance. The close-out project backlog table is presented in the table below:

**Table 2: Backlog Clouse-out Project Performance 2020 – 2022 Period**

| **Step project melibatkan as-built drawings** | **Number of Modification Projects MINOR and CAPEX** | | |
|---|---|---|---|
| | **2020** | **2021** | **2022** |
| New Project | 39 | 40 | 44 |
| Approved | 51 | 54 | 61 |
| JIR Issued | 65 | 68 | 78 |
| JIR Pending | 82 | 72 | 81 |
| Close-out Issued | 94 | 81 | 80 |
| Close-out Pending | 97 | 87 | 92 |
| As buit Issued | 105 | 93 | 97 |
| As buit Pending | 114 | 103 | 105 |
| Punch list Pending | 119 | 118 | 114 |

Source: Primary data processed (2023)

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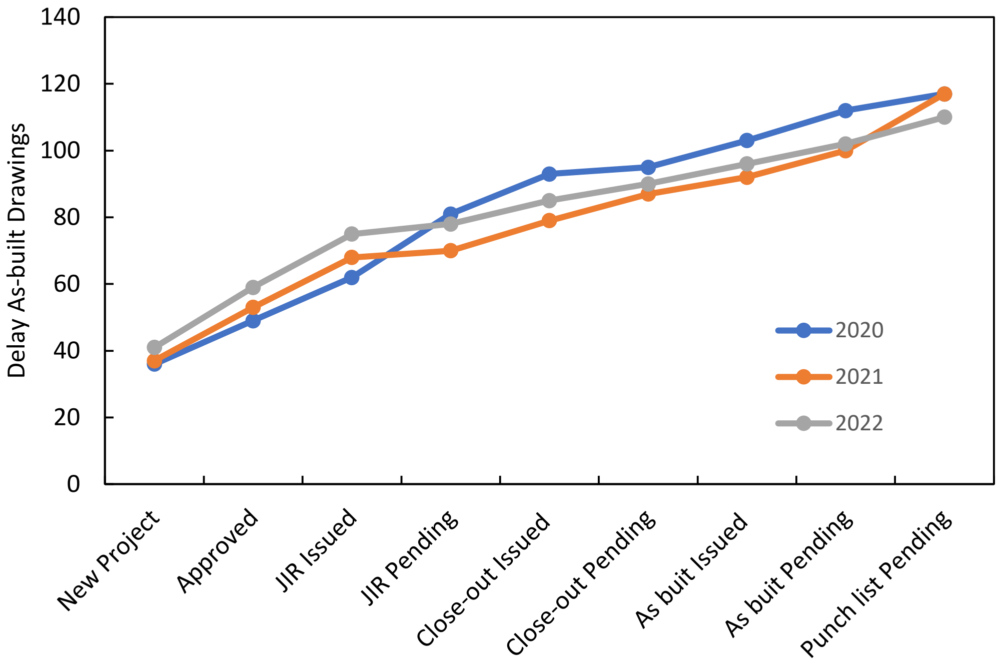


**Figure 1: Modified Plant Graph for 2020 – 2022**

Source: Primary data processed (2023)

Figure 1. above shows that, the increase in modification projects every year continues to increase, so that it has an impact on the modification project backlog which has unfavorable implications for the Engineering and Construction Department's non-financial performance.

According to Abeele and Denis, (2012), The pipeline route can be easily imported, or constructed through a user-friendly and straightforward graphical interface. In general, the image of the equipment in question is equipment that is connected by pipes between one and another, such as pressure tanks, heat exchangers, compressors, pumps and others. Detailed Engineering Design (DED) is a planning product (detailed working drawings) made by a planning consultant for work to be used as a guide in project implementation (Kurniawan et al., 2017; and Michael, et al, 2020). DED in Construction Work can be interpreted as a product of a planning consultant, which is commonly used in making a plan (Wibisono and Despa, 2021).

The phenomenon of as-built drawings that are slow in working on them is that it makes close-out projects also become neglected and are increasing. As-built drawings are a revised set of documents, data sheets and drawings relating to the work submitted by the contractor after completing a particular project or work in the field. As-built drawings reflect all changes made in specifications and working drawings during the construction process, and show the exact dimensions, geometry and location of all work elements completed in accordance with the

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works contract. As-built drawings are made by the contractor based on the results of field implementation which include changes to work during construction. As-built drawings are used as documentation or as concrete evidence if something happens and as a feasibility study for planning future developments and as an archive for the owner.

The successful completion of expansion or modification projects has contributed to the growth of the Petrochemical industry (Ahzan, 2014). Referring to Armstrong (2017), the backlog is a list of all work that has been scheduled and will eventually be completed. In the modern era, there is an interest in measuring non-financial indicators. Non-financial indicators are used as performance measures to achieve effectiveness throughout the organization (Abdelraheem and Hussein, 2022). A close-out project is an important final stage in a project, but sometimes it is often overlooked and even has the potential to bring bad project credibility if it is not managed properly, because the close-out project is still unfinished.

Based on the background of the problems described above, the formulation of the problem in this study is formulated in the form of questions below:

1. How does the detailed engineering design variable affect the backlog of close-out projects in Petrochemical companies?
2. How does the field work variable affect the backlog of close-out projects in Petrochemical companies?
3. How does the variable as-built drawings affect the backlog of close-out projects in Petrochemical companies?
4. How does the detailed engineering design variable affect performance in the Engineering and Construction Dept. non-financial in Petrochemical companies?
5. How does the field work variable affect performance in the Engineering and Construction Dept. non-financial in Petrochemical companies?
6. How does the as-built drawings affect the performance of the Engineering and Construction Dept. non-financial in Petrochemical companies?
7. How does the backlog close-out project affect the performance of the Engineering and Construction Dept. non-financial in a Petrochemical Company?

This research consists of 3 (three) independent variables consisting of Detail Engineering Design (DED), field work, and as-built drawings, 1 (one) intervening variable, namely the backlog close-out project, and the dependent variable is performance on Engineering and Construction Dept. non-financial. The scope of this research is limited to the Engineering and Construction Dept. non-financial in Petrochemical companies.

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## LITERATURE REVIEW

### Background Theory

Agency theory explains the relationship between the agent as the party managing the company and the principal or provider of capital as the company's owner, both of which are bound by a contract (Jensen and Meckling, 1976). In its implementation, the principal or the owner of capital authorizes management as an agent (agency relationship), but after that, different interests occur. These different interests can cause information gaps from agents to principals (Pepall et al. (2014: 452); Aljana and Purwanto, 2018).

Agency theory also implies an information gap between managers as agents and company owners as principals. Based on this view, the company is designed to generate appropriate incentives when the various parties involved in the production process have different and personal information (Jensen and Meckling, 2010; Pepall et al. (2014: 452). According to Pepall et al. (2014: 452), Agency theory has produced beneficial insights into the types of contracts that can address information problems and provide appropriate incentives for both parties to fulfill their contractual obligations.

### Detail Engineering Design (DED) and Backlog Close-out Project

The design process or Detail Engineering Design (DED) according to Kurniawan et al., (2017) defines that, DED is a planning product (detailed working drawings) made by a planning consultant for work to be used as a guide in project implementation. Factors in investment tender documents and basic design factors in the process of validating detailed engineering design documents that are inaccurate resulting in changes in planning and specifications (Adhi et al., 2020). DED can have a significant effect on increasing the cost and duration of the project and can cause engineering failures, which can result in accidents (Love et al., 2017). Process design errors can significantly reduce project performance by resulting in rework, requiring additional time and wasting resources (Han et al., 2013). Dewantoro et al., (2020) stated that design process errors led to repairs or re-disassembly, which resulted in project delays (close-out projects).

### Field Work and Backlog Close-out Project

Between the initial plan and the completed project, all construction work underwent changes and modifications. As the name implies, as-built drawings are illustrations that reflect how a project is actually built, after the many revisions that usually occur during the construction process. The opinion of Rauzana and Usni (2020) states that changes in the scope of field work have an effect on low performance on construction projects which have an impact on project delays. Poor site management, financial difficulties, inaccurate estimates, inappropriate construction methods, inexperienced subcontractors and errors during construction are the causes of delays in the completion of construction projects, including close-out projects (Le-Hoai , et al., 2008; Sesmiwati et al., 2017; Adhiputra and Rambe, 2018).

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### As-built Drawings and Backlog Close-out Projects

As-built drawings include any and all matters and other changes made during the project construction phase which include modifications, field changes, shop drawing changes, design changes, and extra work. As-built surveys to make as-built drawings easier to produce, due to the greater level of detail recorded from each stage of the project. Alrizal, et al. (2020) states that the causes of quality failure are lack of knowledge about work, lack of discipline and expertise, insufficient materials, delivery of materials is sometimes late, materials that do not comply with specifications, poor quality equipment. This has an impact on delays in as-built drawings.

### Detailed Engineering Design (DED) and ESD Non-Financial Performance

Detailed Engineering Design (DED) is a planning product (detailed working drawings) made by planning consultants for construction work such as factory buildings, apartment buildings, highways, bridges, dams and other construction works. Nazaruddin (2017) states that the need for non-financial performance measurement can spur companies to make improvements more quickly and can drive value towards long-term financial and competitive performance. The unfavorable impact arising from design errors is that the results cannot be used optimally, the operation is disrupted, and the need for additional costs and time for repairs.

### Field Work and ESD Non-Financial Performance

Work in the field is not uncommon in the implementation of construction projects both at the beginning of the project, in the middle and at the end of the project. Rauzana and Usni (2020) state that changes in the field (work scope) have an impact on low performance in construction projects. In implementing construction projects, the objective of project management is to obtain optimal cost, effective time, and good quality. The causes of project quality failure are lack of work knowledge, insufficient material, late delivery of materials, materials not in accordance with specifications (Adhiputra and Rambe, 2018; Nyoman, 2019). Changes to work in the field can be in the form of adding, subtracting, and or even replacing materials, specs or work items that have been mutually agreed upon in the initial work contract.

### As-Built Drawings and ESD Non-Financial Performance

Alrizal, et al. (2020) states that the causes of quality failure are lack of knowledge about work, lack of discipline and expertise, insufficient materials, delivery of materials is sometimes late, materials that do not comply with specifications, poor quality equipment. This has an impact on delays in as-built drawings. Changes in design, poor labor productivity, lack of maturity in planning, and scarcity of materials are factors causing delays in project completion (Guszak and Lesniak, 2015). Many small and large contractors in recent years have voiced their concern over the difficulty of dealing with delays, and the main reason is that contractors do not have the ability to identify the important causes of delays that occur during the construction process (Aziz and Hakam, 2016).

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**Backlog of Close-out Projects and ESD Non-Financial Performance**

Changes in design, poor labor productivity, lack of maturity in planning, and scarcity of materials are factors that cause delays in project completion (Guszak and Lesniak, 2015; Adhi et al, 2020). Many small and large contractors in recent years have raised concerns about the difficulty of dealing with delays, and the main reason is that contractors do not have the ability to identify the important causes of delays that occur during the construction process (Aziz and Hakam, 2016). Statement by Wang, et al. (2015) that delays in project completion are situations where construction work is hampered without stopping completely. Hassan et al (2018) argues that, a project is delayed if it cannot be handed over by the facilitator to the service user on the predetermined first handover date. So it can be stated that the project is late if it has passed the time or duration specified in the construction contract. A project is delayed if it cannot be handed over by the facilitator to the service user on the first work handover date set by Adhi et al, 2020).

## METHODOLOGY

The thinking model is a guideline or procedure and technique in planning a research that has the aim of developing strategies that are useful for building strategies that deliver results of a research model or blueprint. With a good research model, researchers and interested parties have a clear picture of the relationship between the variables in the research and what the researcher wants to do in carrying out the research (Sugiyono, 2018: 23). As a construction within the framework of a thought, a model will show: (1) the number of variables to be studied, (2) predictions about the pattern of relationships between variables, (3) description of the relationship between variables, and (4) the number of parameters estimated (Muhidin et al., 2011).

In order for the objectives of a study to be achieved properly, the population and sample taken must be appropriate. The sample taken must be representative or able to represent the population. The population is a generalization area consisting of objects or subjects that have certain characteristics and quantities determined by the researcher to be studied which then draws a conclusion (Arikunto, 2016). According to Arikunto (2016), the population is the overall research subject. Meanwhile, Sugiyono (2019) defines the population as a generalization area consisting of objects or subjects that have certain characteristics and qualities set by the researcher to be studied, which then draws a conclusion. To synthesize the solutions and problems reviewed in this study, a framework model was formed. The framework of thought in this study can be described in the form of a flowchart as follows below:

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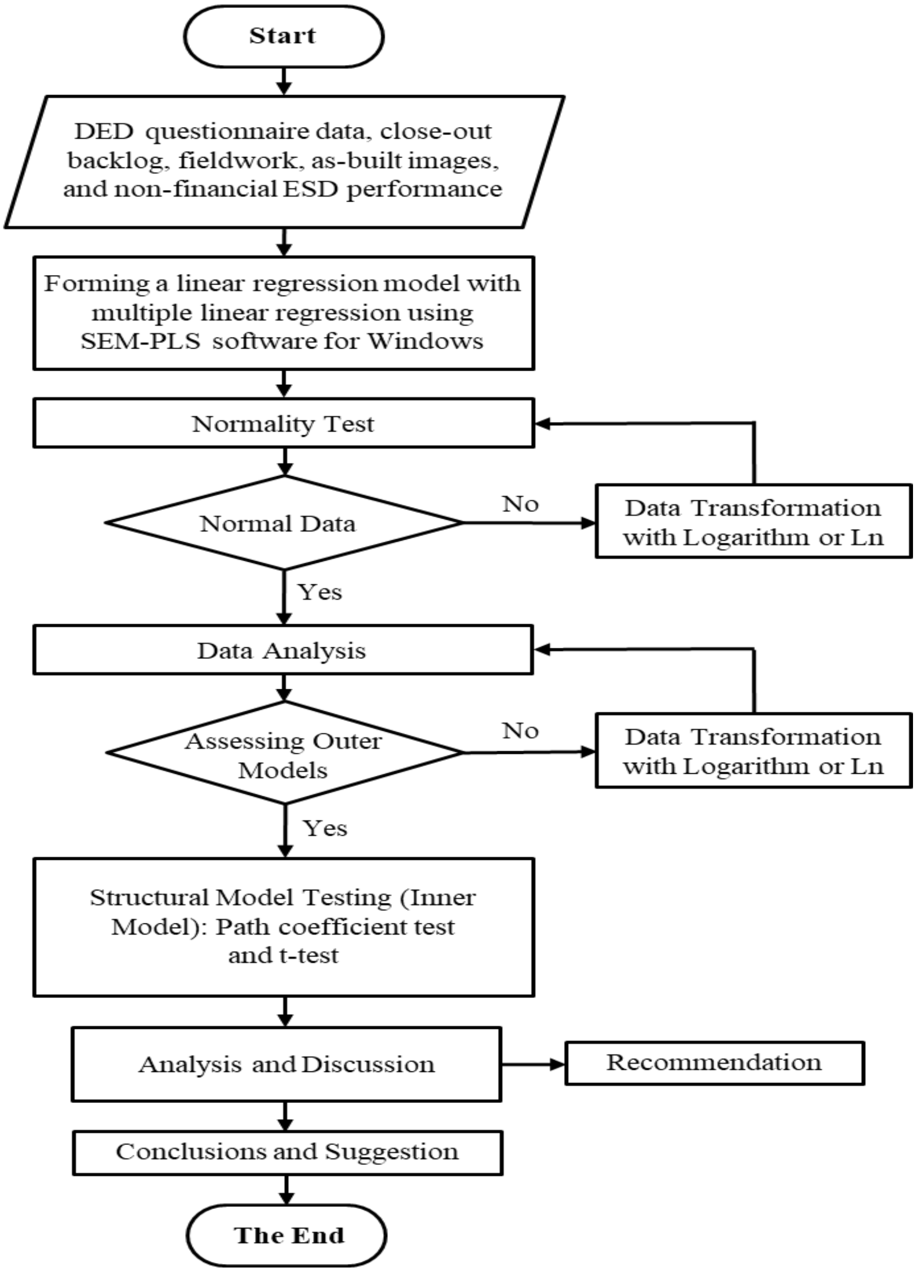


**Figure 2: Researcher Thought Flowchart**

### Methods Used

The method used in this research is Structural Equation Modeling (SEM). SEM is a multivariate statistical technique which is a combination of factor analysis and regression (correlation) analysis, which aims to examine the relationships between variables in a model, both between indicators and constructs, or relationships between constructs. By using Partial Least Square (PLS) to reduce indicators and see the relationship between the dimensions of

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Detail Engineering Design (DED), field work, as-built drawings, and backlog close-out projects on ESD non-financial performance. The interaction between indicators in the aim of improving ESD non-financial performance can be seen using both qualitative and quantitative approaches (Castaneda et al. (2018); Pradhan et al. (2017); Nilsson et al. (2016). This research method uses quantitative data, because in this case it focuses more on testing the theory through research variables in the form of numeric and conducting data analysis through statistical procedures and mathematical modeling.

With a good research model, researchers and interested parties have a clear picture of the relationship between the variables in the research and what the researchers want to do in carrying out the research (Noor, 2017; Sugiyono, 2019). As a construction within the framework of a thought, a model will show: (1) the number of variables to be studied, (2) predictions about the pattern of relationships between variables, (3) the decomposition of the relationship between variables, and (4) the number of estimated parameters (Muhidin et al., 2011).

**Population and Sample**

The population is a generalization area consisting of objects or subjects that have certain characteristics and quantities determined by the researcher to be studied which then draws a conclusion (Arikunto, 2016). According to Arikunto (2016), the population is the overall research subject. Meanwhile, Sugiyono (2019) defines the population as a generalization area consisting of objects or subjects that have certain characteristics and qualities set by the researcher to be studied, which then draws a conclusion. The population in this study are all contractor employees and permanent employees in the Engineering Services Dept. in a Petrochemical company consisting of several contactors with a total of 182 employees.

The sampling technique used is Non Probability Sampling. According to Sugiyono (2019) Non Probability Sampling is a sampling technique that provides equal opportunities or opportunities for each member or element of the population to be selected as a sample. In this study the respondents were asked to tick a five-point Likert scale. Data was obtained by sending an online survey questionnaire email to 127 Petrochemical company employees. Respondents were asked to tick a five-point Likert scale (1 to 5).

Researchers make provisions in taking samples by setting specific criteria with the aim that it is expected to be able to provide answers to problems in this study. Sugiyono (2019: 90) argues that, the appropriate sample size in this study is between 30 and 500. The specific criteria for inclusion in determining the sampling used in this study are as follows: (a) This research focuses more on the performance of the Engineering Services Dept. (ESD) non-financial. (b) Permanent employees and long term contracts. (c) Complete the questionnaire completely.

**Hypothesis**

The hypothesis is a temporary answer, the reason given is still based more on what is relevant to the research question. The provisional answer is not yet based on empirical facts obtained through data collection. The following are the model hypotheses in this research:

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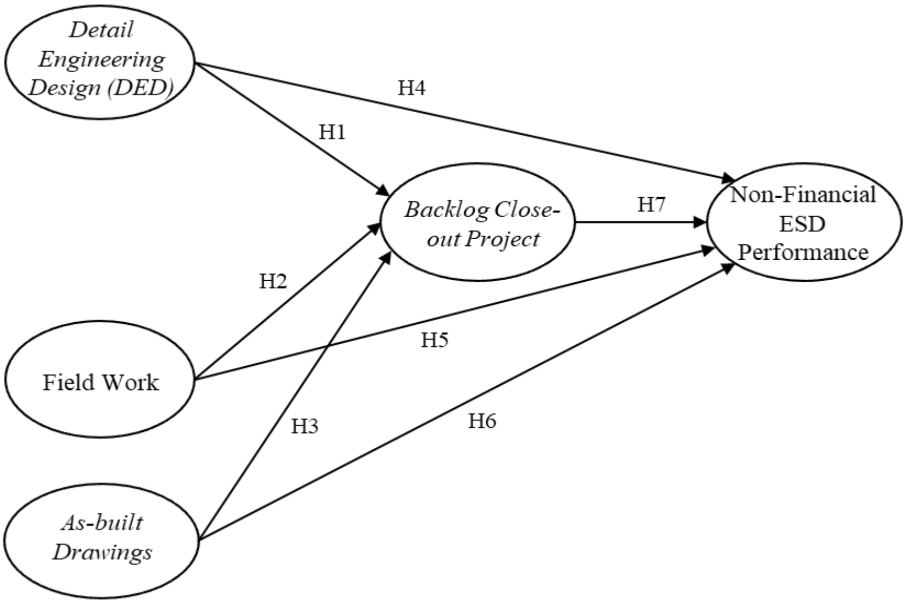


**Figure 3: Research Model Hypothesis**

Based on the theoretical basis and empirical evidence from the results of previous research, and the researcher's framework, the research model hypotheses that can be developed and built, can be formulated in this study as follows:

**H1:** The detailed engineering design variable is thought to have a partial effect on the backlog of close-out projects at Petrochemical Companies.

**H2:** The field work variable is thought to have a partial effect on the backlog of close-out projects at Petrochemical Companies.

**H3:** The as-built drawings variable is thought to have a partial effect on the backlog of close-out projects at Petrochemical Companies.

**H4:** The detailed engineering design variable is thought to have a partial effect on ESD non-financial performance in Petrochemical Companies.

**H5:** The field work variable is thought to have a partial effect on ESD non-financial performance in Petrochemical Companies.

**H6:** The as-built drawings variable is thought to have a partial effect on ESD non-financial performance at Petrochemical Companies.

**H7:** The backlog close-out project variable is thought to have a partial effect on ESD non-financial performance in Petrochemical Companies.

**Analysis Method**

Analysis of the data used in this research is multiple linear regression using the SEM-PLS program. Before performing multiple linear regression analysis and hypotheses, validity and

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reliability tests, descriptive statistics and classical assumption tests were first performed. The research data that has been collected from the instrument is then tested for validity and reliability first so that the data obtained is truly valid and reliable.

Partial Significant Test or T-Test is aimed at knowing the effect of each independent variable in a research on the dependent variable. According to Ghozali (2018), the criteria for making decisions from the results of this test are if the p value < 0.05, then the result is $H_a$ is accepted. However, on the contrary, if the p value > 0.05, then the result is $H_a$ is rejected. The decision-making criteria in this research are:

a. If $t_{count} < t_{table}$ or p-value > 0.05, then the independent variable partially has no effect on the dependent variable.

b. If $t_{count} > t_{table}$ or p-value < 0.05, then the independent variable partially affects the dependent variable.

The coefficient of determination ($R^2$) is basically a measure of how far the model's ability to explain variations in the dependent variable is. The value of $R^2$ which is small or close to zero means that the ability of the independent variable in explaining the dependent variables is very limited. Overall, the results obtained for the k-variable case are as follows:

$$R^2 = \frac{\hat{\beta}_2 \sum y_i x_{2i} + \hat{\beta}_3 \sum y_i x_{3i} + \ \dots \ + \hat{\beta}_k \sum y_i x_{ki}}{\sum y_i^2}$$

The decision-making criteria in this research are:

a. If the value of the Determinant Coefficient ($R^2$) is equal to 0, it means that the variation of the dependent variable cannot be explained by the independent variables at all.

b. If the value of the Determinant Coefficient ($R^2$) is equal to 1, it means that the variation of the dependent variable as a whole can be explained by the independent variables.

## RESULTS AND ANALYSIS

Respondents in this research were respondents who had filled out and returned questionnaires which were distributed to employees of the ESD department of Petrochemical companies, namely 127 questionnaires distributed and 127 questionnaires which had been returned. Where the respondents in this study were as many as 127 respondents. The number of respondents in terms of gender in the Petrochemical company employee respondents is presented in the table below.

**Table 3: Number of Respondents Based on Gender**

| No | Gender | Total | Percentage |
|---|---|---|---|
| 1 | Male | 121 | 95% |
| 2 | Female | 6 | 5% |
| | Total | 127 | 100% |

Source: Primary data processed (2023)

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From Table 3. it can be seen that there were 6 female respondents or 5% of the total respondents, while 121 male respondents or 95% of the total respondents studied. The average respondent is male. The age range in this study was divided into 4 sections, namely, 21 - 30 years, 31 - 40 years, 41 - 50 years, and 51 - and above. The number of respondents seen from the age of the Petrochemical company respondents is explained in the table below.

**Table 4: Number of Respondents Based on Age**

| No | Age | Total | Percentage |
|---|---|---|---|
| 1 | 21 - 30 tahun | 48 | 37,8% |
| 2 | 31 - 40 tahun | 46 | 36,2% |
| 3 | 41 - 50 tahun | 22 | 17,3% |
| 4 | 51 tahun keatas | 11 | 8,7% |
| | Total | 127 | 100% |

Source: Primary data processed (2023)

From Table 3 it can be seen that the long term Petrochemical company contractor employees are 21-30 years old, namely 48 people or 37.8% of the total respondents, respondents aged 31-40 years are 46 people or 36.2% of the total respondents, respondents aged 41-50 years were 22 people or 17.2% of the total respondents and respondents aged 51 years and over were 11 people or 8.7% of the total respondents. Of the total respondents studied, the average respondent was aged 21-30 years old.

The number of respondents was seen from the length of work for long term contractor employee respondents for Petrochemical companies in this study divided into 4 parts, namely, 3 – 6 years, 7 – 10 years, 11 – 13 years, and 14 years and over as explained in the table below:

**Table 5: Number of Respondents Based on Length of work**

| No | Length of work | Total | Percentage |
|---|---|---|---|
| 1 | 3 – 6 tahun | 5 | 3,9% |
| 2 | 7 – 10 tahun | 25 | 19,7% |
| 3 | 11 – 13 tahun | 67 | 52,8% |
| 4 | 14 tahun keatas | 30 | 23,6% |
| | Total | 127 | 100% |

Source: Primary data processed (2023)

From Table 4 it can be seen that the long term contractor employees of Petrochemical companies who have worked for 3-6 years, namely 5 people or 3.9% of the total respondents, have worked for 7-10 years, namely 25 people or 19.7% of the total respondents. total respondents, working time 11-13 years, namely as many as 67 people or 52.8% of the total respondents, working time 14 years and over as many as 30 people or 23.6% of the total respondents. The average respondent is 11-13 years.

**Data analysis**

Data processing techniques using the Partial Least Square (PLS)-based SEM method require 2 stages to assess the Fit Model of a research model (Ghozali, 2018). These stages are assessing

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the outer model or measurement model and composite reliability and Average Variance Extracted (AVE). This section describes the results of the research and analysis of the data that has been collected through distributing questionnaires. The results of data processing are information that will later indicate whether the hypothesis that has been formulated can be accepted or rejected. The model that has been designed according to the formulation of the problem can be seen in below the figure:

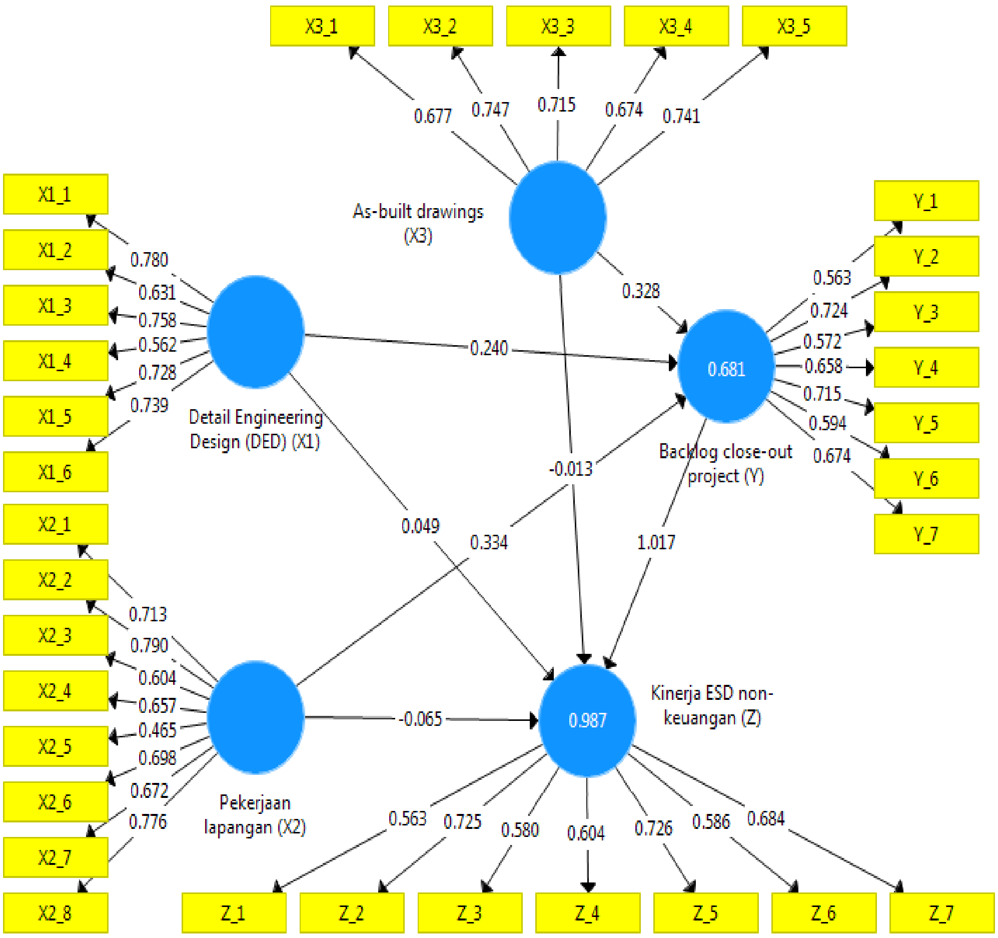


**Figure 4: Structural Design Model**

**Convergent Validity**

Convergent validity of the measurement model with reflexive indicators is assessed based on the correlation between the item score or component score estimated with the PLS Software. The individual reflexive measure is said to be high if it correlates more than 0.70 with the construct being measured.

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**Table 6: Outer Loadings (Measurement Model) Initial Model**

| | Detail Engineering Design (DED) (X1) | Pekerjaan lapangan (X2) | As-built drawings (X3) | Backlog close-out project (Y) | ESD non-financial performance (Z) |
|---|---|---|---|---|---|
| X1_1 | 0.780 | | | | |
| X1_2 | 0.631 | | | | |
| X1_3 | 0.758 | | | | |
| X1_4 | 0.562 | | | | |
| X1_5 | 0.728 | | | | |
| X1_6 | 0.739 | | | | |
| X2_1 | | 0.713 | | | |
| X2_2 | | 0.790 | | | |
| X2_3 | | 0.604 | | | |
| X2_4 | | 0.657 | | | |
| X2_5 | | 0.465 | | | |
| X2_6 | | 0.698 | | | |
| X2_7 | | 0.672 | | | |
| X2_8 | | 0.776 | | | |
| X3_1 | | | 0.677 | | |
| X3_2 | | | 0.747 | | |
| X3_3 | | | 0.715 | | |
| X3_4 | | | 0.674 | | |
| X3_5 | | | 0.741 | | |
| Y_1 | | | | 0.563 | |
| Y_2 | | | | 0.724 | |
| Y_3 | | | | 0.572 | |
| Y_4 | | | | 0.658 | |
| Y_5 | | | | 0.715 | |
| Y_6 | | | | 0.594 | |
| Y_7 | | | | 0.674 | |
| Z_1 | | | | | 0.563 |
| Z_2 | | | | | 0.725 |
| Z_3 | | | | | 0.580 |
| Z_4 | | | | | 0.679 |
| Z_5 | | | | | 0.726 |
| Z_6 | | | | | 0.586 |
| Z_7 | | | | | 0.684 |

Source: Primary data processed (2023)

Based on Table 6 above, it shows that, the results of processing using SmartPLS Software can be seen that, the outer model or correlation between constructs and variables initially did not meet convergent validity, because there are still quite a number of indicators that have a loading factor value of less than 0.70. The next step is to reconstruct the path diagram that was previously made by removing invalid indicators.

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**Table 7: Outer Loadings (Measurement Model) Modified Model**

| | Detail Engineering Design (DED) (X1) | Pekerjaan lapangan (X2) | As-built drawings (X3) | Backlog close-out project (Y) | ESD non- financial performance (Z) |
|---|---|---|---|---|---|
| X1_1 | 0.817 | | | | |
| X1_3 | 0.815 | | | | |
| X1_5 | 0.754 | | | | |
| X1_6 | 0.738 | | | | |
| X2_1 | | 0.717 | | | |
| X2_2 | | 0.853 | | | |
| X2_8 | | 0.865 | | | |
| X3_2 | | | 0.806 | | |
| X3_3 | | | 0.723 | | |
| X3_5 | | | 0.818 | | |
| Y_2 | | | | 0.862 | |
| Y_5 | | | | 0.864 | |
| Z_2 | | | | | 0.869 |
| Z_5 | | | | | 0.864 |

Source: Primary data processed (2023)

Based on Table 7. above shows that, the re-estimation results show that all the loading values of each reflex construct produce a loading value greater than 0.70, thus this modified model meets the convergent validity well criteria.

**Composite Reliability and Average Variance Extracted (AVE)**

The validity and reliability criteria can also be seen from the reliability value of a construct and the Average Variance Extracted (AVE) value of each construct. The construct is said to have high reliability if the value is 0.70 and the AVE is above 0.50. Table 4.6 presents the Composite Reliability and AVE values for all variables.

**Table 8: Discriminant Validity Value (Cross Loading)**

| | Composite Reliability | Average Variance Extracted (AVE) |
|---|---|---|
| Detail Engineering Design (X1) | 0.862 | 0.611 |
| Filed work (X2) | 0.855 | 0.664 |
| As-built drawings (X3) | 0.826 | 0.614 |
| Backlog close-out project (Y) | 0.854 | 0.745 |
| ESD non-financial performance (Z) | 0.858 | 0.751 |

Source: Primary data processed (2023)

**Test Results for the Coefficient of Determination (R-Square Test)**

The results of the determination test (R-Square) can be seen from the value of the coefficient of determination in this study presented in the table below:

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**Table 9: R-Square Value**

| | R Square | R Square Adjusted |
|---|---|---|
| Backlog close-out project (Y) | 0.681 | 0.673 |
| Kinerja ESD non-keuangan (Z) | 0.987 | 0.987 |

Source: Primary data processed (2023)

Based on Table 9 above, the r-square value indicates that the Detail Engineering Design, field work, and as-built drawings are able to explain the variability of the backlog close-out project construct by 68.1%, and the remaining 31.9% is explained by other constructs outside studied in this study. While the Detail Engineering Design, fiel dwork, as-built drawings, and close-out backlogs are able to explain the variability to ESD non-financial performance constructs of 98.7%, and the remaining 1.3% is explained by other constructs outside those examined in this research.

### Structural Model Testing (Inner Model)

Testing the inner model or structural model is carried out to see the relationship between the constructs, the significance value and the R-square of the research model. The structural model was evaluated using the R-square for the t-test dependent construct and the significance of the structural path parameter coefficients. The structural model test in SmartPLS was carried out using the bootstrapping resampling method with the resulting output model presented in below the figure:

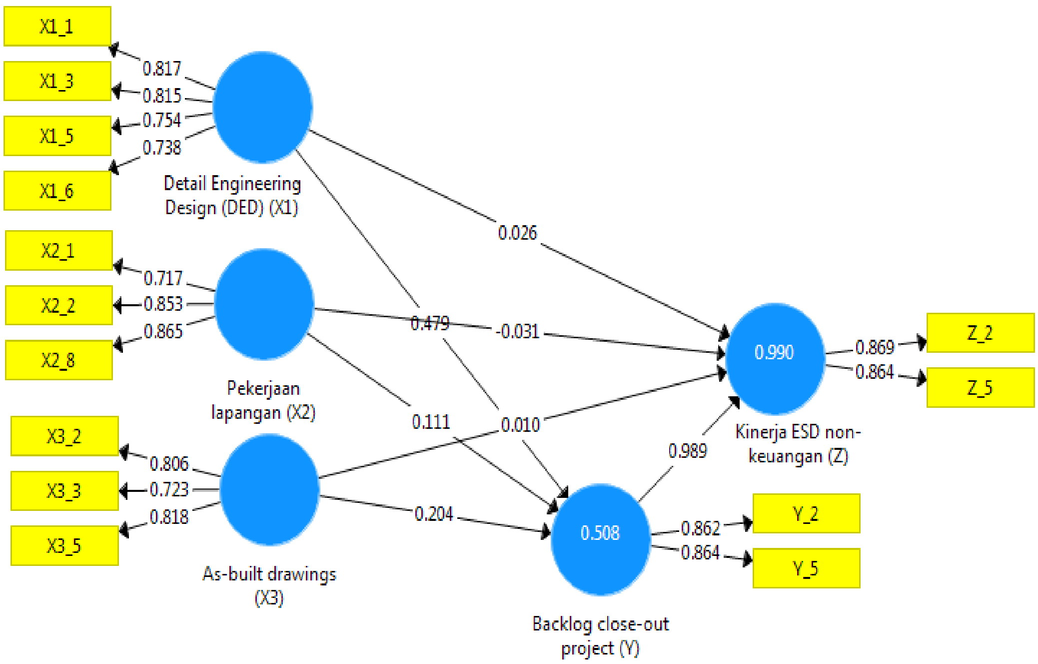


**Figure 5: Structural Models**

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The structural model test consists of 3 (three) tests, namely: r-square or determination test, path coefficient, and t-test (significance). The r-square test was conducted to see how much influence the independent variables had, namely: Detailed Engineering Design, field work, as-built drawings, backlog close-out project in influencing the dependent variable, namely SD non-financial performance in the research.

**Path coefficient test and t-test (significance)**

The path coefficient test and t-test (significance) were carried out to test whether the hypotheses that have been built in this study are proven or not. The t statistical test basically shows how far the influence of one independent variable is partially in explaining the variation of the dependent variable. This study uses a significance level of 0.05 ($\alpha$ = 5%) for Detailed Engineering Design, fieldwork, as-built drawings, and close-out backlogs on ESD non-financial performance. If tcount < $t_{table}$, then the independent variable partially has no effect on the dependent variable (hypothesis is rejected). Meanwhile, if $t_{count} > t_{table}$, then the independent variable partially affects the dependent variable (the hypothesis is accepted). The results of the t-test in this study are presented in the table below:

**Table 10: Inner Model Test Results**

| | Original Sample (O) | Sample Mean (M) | Standard Deviation (STDEV) | T Statistics (O/STDEV) | P Values |
|---|---|---|---|---|---|
| Detail Engineering Design (X1) → Backlog close-out project (Y) | 0.240 | 0.241 | 0.138 | 1.741 | 0.084 |
| Filed work (X2) → Backlog close-out project (Y) | 0.334 | 0.347 | 0.163 | 2.043 | 0.043 |
| As-built drawings (X3) → Backlog close-out project (Y) | 0.328 | 0.318 | 0.093 | 3.537 | 0.001 |
| Detail Engineering Design (DED) (X1) → ESD non- financial performance (Z) | 0.049 | 0.047 | 0.037 | 1.312 | 0.192 |
| Field work (X2) → ESD non- financial performance (Z) | -0.065 | -0.064 | 0.032 | 2.000 | 0.048 |
| As-built drawings (X3) → ESD non-financial performance (Z) | -0.013 | -0.017 | 0.025 | 0.541 | 0.590 |
| Backlog close-out project (Y) → ESD non-financial performance (Z) | 1.017 | 1.020 | 0.018 | 57.307 | 0.000 |

Source: Primary data processed (2023)

Based on Table 10 above, in SmartPLS statistical testing of each hypothesized relationship is carried out using a simulation. In this case, the bootstrap method was carried out on the research sample. Testing with bootstrap is also intended to minimize the problem of abnormal research data.

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## DISCUSSION

### Detail Engineering Design to Backlog close-out project

The test results show that the relationship between the detailed engineering design variable and the backlog close out project shows a path coefficient value of 0.240 with a t value of 1.741. This value is smaller than the t table of 1.96 and the P value is greater than 0.05. This means that the detailed engineering design has a positive but not significant effect on the backlog close-out project, which means that the detailed engineering design can be changed according to the conditions in the field because it adjusts to the conditions in the field and has no effect on the backlog close-out project because a red mark-up has been made in the field.

These results are in accordance with the results of research by Nasir et al. (2016) design errors can adjust to the field and have no effect on as-built drawings, because as-built close-out drawings can be in line with ongoing fabrication projects. This is in line with the results of research from (Han et al., 2013). Dewantoro et al., (2020) stated that the design process does not impact or continue in the next design process and in the next project stages. Nasir et al. (2016) changes in the field can adjust to field conditions and have no effect on as-built close-out images, because as-built close-out images can simultaneously be fabricated.

### Field work to backlog close-out projects

The test results show that the relationship between the field work variable and the close-out project backlog shows a path coefficient value of 0.334 with a t value of 2.043. This value is greater than the t table of 1.96 and the P value is less than 0.05. So it can be concluded that field work has a positive and significant effect on the close-out project backlog, meaning that when the field work has been completed, the as-built red mark-up is immediately updated according to the field, so that no backlog close-out projects occur.

These results are in accordance with the results of research by Rauzana and Usni (2020) which state that work in the field has an influence on low performance in petrochemical area projects. Sesmiwati et al. (2017) stated that the causes of delays in the completion of construction projects also included close-out as-built drawings. Therefore, changes in the field in construction fabrication projects in the petrochemical area affect the close-out of the project. The designer's inaccuracy in identifying various problems that may arise when the project is running will have an impact on work in the field.

### As-built drawing to Backlog close-out project

The test results show that the relationship between the as-built drawings variable and the close-out project backlog shows a path coefficient value of 0.334 with a t value of 3.537. This value is greater than the t table of 1.96 and the P value is less than 0.05. So it can be concluded that as-built drawings have a positive and significant effect on the backlog of close-out projects, which means that as-built drawings are documents that must be updated according to conditions in the field which will become a reference in the future for maintenance. Therefore, the drawing must be up to date.

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These results are in accordance with the results of Aziz and Hakam's research (2016), in working on as-built drawings on expansion project modifications in the petrochemical area and its surroundings which occurred during the construction process had an unfavorable impact and affected the delay in project completion. This is in line with the findings of Dewantoro, et al., 2020 stating that the work on as-built drawings which was later discovered resulted in a backlog of closed-out projects.

**Detail Engineering Design to ESD non-financial performance**

The test results show that the relationship between detailed engineering design variables and ESD non-financial performance shows a path coefficient value of 0.049 with a t value of 1.312. This value is smaller than the t table of 1.96 and the P value is greater than 0.05. So it can be concluded that detailed engineering design has a positive and insignificant effect on ESD non-financial performance, which means that detailed engineering designs can be made using hand sketches which can be directly executed in the field according to field conditions, and do not provide added value to the department.

These results are consistent with the results of research on road construction in the Nasir et al. petrochemical industrial complex. (2016) errors in design can adjust the field and have no effect on performance, because the design can be in line with the ongoing fabrication project. This is in line with Nasir et al. (2016), late design errors can be prevented by preparing them in stages, so they do not affect the performance of the engineering department.

**Field work to ESD non-financial performance**

The test results show that the relationship between field work and ESD non-financial performance shows a path coefficient value of -0.065 with a t value of 2.000. This value is greater than the t table of 1.96 and the P value is less than 0.05. So it is concluded that field work has a significant negative effect on ESD non-financial performance, which means that field work is a reflection of ESD non-financial performance, because it has an impact on decreasing performance.

These results are consistent with the results of research by Dewantoro et al., (2020) that fieldwork refers to drawings that are later known to result in repairs and rework in construction which in turn decreases the company's performance. On-site manufacturing errors but can affect activities in the field directly and can be corrected without disrupting the course of construction activities. In line with that, working in a hurry can cause errors to occur which can result in rework. Mboy et al., (2021) that field work on construction projects affects project performance, due to a lack of understanding in project implementation.

**As-built drawings to ESD non-financial performance**

The test results show that the relationship between the as-built drawings variable and ESD non-financial performance shows a path coefficient value of -0.013 with a t value of 0.541. This value is smaller than the t table of 1.96 and the P value is greater than 0.05. So it can be concluded that as-built drawings have no negative and significant effect on ESD non-financial performance, which means that as-built drawings can be done during construction and do not

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have to wait for the fabrication to finish, then as-built drawings are done so that ESD non-financial performance is not too bad.

This result is in accordance with the results of research by Sesmiwati et al. (2017) the causes of delays in the completion of construction projects are also included in the as-built drawings. Therefore, as-built drawings caused by changes in the field in construction fabrication projects in the petrochemical area affect the company's performance. Rauzana and Usni (2020) state that changes in the scope of work that have been as-built have had an impact on low performance in petrochemical area projects.

**Close-out project backlog to ESD non-financial performance**

The test results show that the relationship between the backlog close-out project variable and ESD non-financial performance shows a path coefficient value of 1.017 with a t value of 57.307. This value is greater than the t table of 1.96 and the P value is less than 0.05. So it can be concluded that the backlog close-out project has a positive and significant effect on ESD non-financial performance, which means that if the backlog close-out project variable increases, then the ESD non-financial performance variable will increase.

## CONCLUSION

Based on the results of the analysis of the effect of detailed engineering design, fieldwork, as-built drawings, and backlog close-out projects on ESD non-financial performance of Petrochemical Companies, this is the answer to the research questions based on the formulation of the problem in this study, and achieves research purposes, the results of the conclusions are as follows:

1. Detailed engineering design has no effect on the backlog close-out project on ESD non-financial in Petrochemical companies, it is concluded that the detailed engineering design can be changed according to field conditions because it adjusts to field conditions and does not affect the backlog close-out project because the red mark-up has been removed in the field.
2. Field work has a positive and significant effect on the backlog of close-out projects, meaning that when field work has been completed, the as-built red mark-up is immediately updated according to the field, so that there is no backlog of close-out projects.
3. As-built drawings have a positive and significant effect on the backlog of close-out projects, which means that as-built drawings are documents that must be updated according to conditions in the field which will become a reference in the future for maintenance. Therefore, the drawing must be up to date.
4. Detailed engineering design has a positive and insignificant effect on ESD non-financial performance, which means that detailed engineering designs can be made using hand sketches which can be directly executed in the field according to field conditions, and do not provide added value to the department.

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5. Field work has a significant negative effect on ESD non-financial performance, which means that field work is a reflection of ESD non-financial performance, because it has an impact on decreasing performance.
6. As-built drawings can be done during construction and do not have to wait for the fabrication to be completed, then as-built drawings can be done so that ESD non-financial performance is not too bad.
7. The close-out project backlog variable has a positive and significant effect on ESD non-financial performance at Petrochemical companies. It can be concluded that if the close-out project backlog variable increases, ESD non-financial performance variable will increase.

## RECOMMENDATION

Recommendations in the form of policies and system design to improve the performance of the non-financial Engineering Service Dept. in Petrochemical companies. The final result of this research is a conclusion as an answer to the researcher's question as described in the research problem formulation. And provide suggestions for future researchers, so that further research is sustainable.

Petrochemical company management pays attention to the work that must be completed according to the deadline. For example, by the way the company provides a longer deadline or the company provides complete information or data about the work to be completed so that employees can easily complete the work.

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