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# Analysis of Factors Affecting Delays in Construction Projects in the Upstream Oil and Gas Industry of South Sumatra

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**ABSTRACT**

Upstream oil and gas construction projects in South Sumatra face significant delays due to geographic, technical, and social complexities. This study analyzes factors causing these delays and proposes context-specific mitigation strategies using Partial Least Squares–Structural Equation Modeling (PLS-SEM) with data from 186 project owners and practitioners. Findings reveal that material shortages have the most direct impact on project delays, followed by planning and design issues. The contractor factor mediates the effects of labor, financial and economic, and external variables. Key delay indicators include material shortages, inadequate site investigations, design mismatches, inaccurate price negotiations, and low safety awareness. The Focus Group Discussion (FGD) supports these quantitative results, emphasizing the need for field data–based design validation, thorough site investigations, and strengthening local contractor capabilities. It also highlights social conflicts resulting from limited legal awareness and moral responsibility within communities, further contributing to delays. Recommended strategies involve conducting comprehensive subsurface, geotechnical, and social investigations, engaging contractors early, adopting digital project management approaches, and managing social risks through Corporate Social Responsibility (CSR) and stakeholder engagement. This integrated approach offers practical contributions to improving the efficiency of upstream oil and gas projects in complex regions like South Sumatra.

***KEYWORDS*** Project Delay, upstream oil and gas, PLS-SEM, delay factors, South Sumatra



## INTRODUCTION

Indonesia has an abundant wealth of natural resources, including the oil and gas sector which plays a strategic role in the national economy and energy security. Stability of energy supply is the main requirement for sustainable economic development amid increasing demand due to population and industrial growth (Zhao et al., 2017). Although global instability and geopolitical conflicts such as the Russia-Ukraine war have affected the direction of world energy investment, Indonesia has shown a positive trend with an increase in upstream oil and gas investment in 2023 of US$13.7 billion, an increase of 13% from the previous year, surpassing the global growth estimated at only 6.5%. This achievement is the highest record since 2016, indicating strong recovery and confidence in the national oil and gas sector after the pandemic.

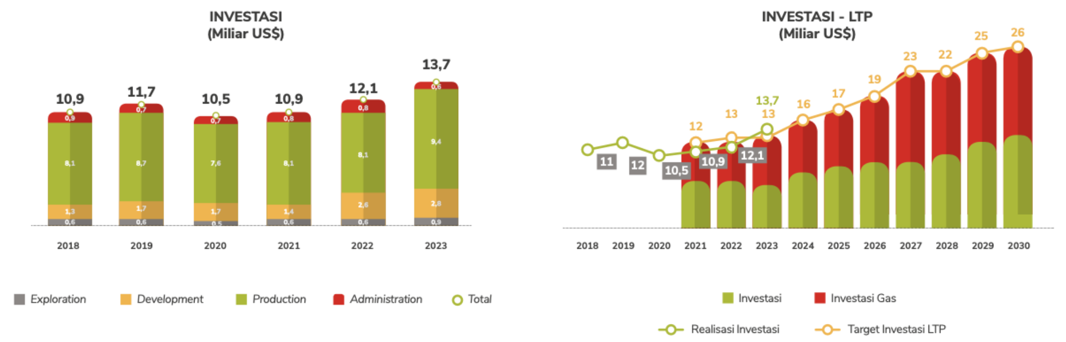



Figure **Error! No text of specified style in document.**. Indonesia's Upstream Oil and Gas Investment Trends 2018-2023
Source. SKK Migas Annual Report (2023) .

The management of the oil and gas sector in Indonesia faces various challenges such as the uncertainty of world oil prices, technical and regulatory constraints, and the dominance of investment in production activities compared to the exploration of new reserves. One of the main problems is the delay in projects in the upstream oil and gas sector, which hinders exploration, facility development, and production, resulting in the low realization of the national oil and gas lifting target and disrupting energy security. The upstream oil and gas industry in South Sumatra is also facing similar problems, where 52% of the projects constrained by 2024 are in the construction phase. This delay is caused by various internal factors such as immature planning and weak coordination, as well as external factors such as licensing, extreme weather, and social conflicts. This complexity demands an analytical approach to identify the root of the problem thoroughly and strategically (Priamoko, 2017; Purnomo, 2018).

Success in overcoming delays in upstream oil and gas projects will have a wide positive impact. Projects completed on time will ensure a stable domestic energy supply, minimizing dependence on energy imports (Kharina & Sambowo, 2019; Matin, 2016). In addition, this success will support national efforts in building an independent, competitive, and sustainable energy sector. Therefore, steps to understand and overcome delays in upstream oil and gas projects are priorities that are not only relevant for companies but also crucial for national development (Al-Mhdawi et al., 2024; Alsharif & Karatas, 2016).

Despite extensive research on construction project delays globally, significant research gaps remain in understanding the specific dynamics of upstream oil and gas projects in geographically and socially complex regions like South Sumatra. Previous studies on project delays have predominantly employed either purely quantitative approaches (Doloi et al., 2012) or purely qualitative methods (Fallahnejad, 2013; Sweis et al., 2019), limiting their ability to capture both the statistical relationships between delay factors and the contextual nuances that influence project execution. Furthermore, existing research on oil and gas project delays has largely focused on Middle Eastern contexts (Al-Sabah et al., 2014; Bin Seddeeq et al., 2019; Kassem et al., 2021) or general construction sectors (Yap et al., 2021), with limited attention to the unique challenges posed by Indonesia’s upstream oil and gas industry, particularly in regions characterized by challenging terrain (swamplands, peatlands), complex social dynamics (community conflicts, limited legal awareness), and infrastructure constraints.

The novelty of this study manifests in three critical dimensions that distinguish it from previous research. First, methodologically, this research integrates PLS-SEM quantitative analysis with FGD qualitative validation, creating a comprehensive framework that not only identifies statistical relationships between delay factors but also validates these findings through practitioner insights and contextual understanding (Hasibuan et al., 2013; Kamaruzzaman, 2012; Kaming et al., 2019). This mixed-method approach addresses the limitations of single-method studies by providing both predictive validity and explanatory depth. Second, contextually, this study focuses specifically on South Sumatra's upstream oil and gas sector, a region with unique geographical challenges (seasonal flooding, swamplands), socio-cultural complexities (local community engagement issues, limited legal awareness), and infrastructure limitations that differ significantly from contexts examined in existing literature. Third, practically, this research goes beyond identifying delay factors to formulate context-specific, empirically validated mitigation strategies that integrate technical, social, and managerial dimensions, providing actionable recommendations for project owners, contractors, and policymakers operating in high-complexity environments.

This study aims to analyze the influence of factors such as contractors, planning and design, financial and economic, labor, materials, and external factors on the time performance of construction projects in the Upstream Oil and Gas Industry in South Sumatra from the perspective of the project owner. In addition, this study examines the dominant indicators of each variable that contribute to project delays and develops mitigation strategies based on the results of the Partial Least Squares – Structural Equation Modeling (PLS-SEM) analysis and focus group discussions that can be applied by project owners and contractors. This research is expected to provide benefits in the form of data-based recommendations in addressing the causes of project delays, supporting the formulation of more effective mitigation strategies, and serving as a guide for stakeholders in improving the management of upstream oil and gas construction projects to minimize potential delays.

## METHOD

This research used a quantitative approach with the Partial Least Squares - Structural Equation Modeling (PLS-SEM) technique to analyze the factors causing delays in construction projects in the upstream oil and gas industry in South Sumatra. The study began with the identification of problems through literature review and field observations, followed by the preparation of a conceptual framework, hypothesis formulation, and development of an instrument in the form of a questionnaire based on a 5-point Likert scale. Data were collected through a survey of 186 respondents selected using purposive sampling based on their experience and involvement in upstream oil and gas projects. Data analysis was carried out in two stages: the Outer Model (validity and reliability) and the Inner Model (relationships between variables). To validate the quantitative results and formulate mitigation strategies, a Focus Group Discussion (FGD) was conducted with project actors. This approach allowed the identification of dominant factors and causal relationships between variables, as well as provided strategic recommendations to reduce project delays.

## RESULT AND DISCUSSION

### Outer Model Evaluation

### Convergent Validity Assessment

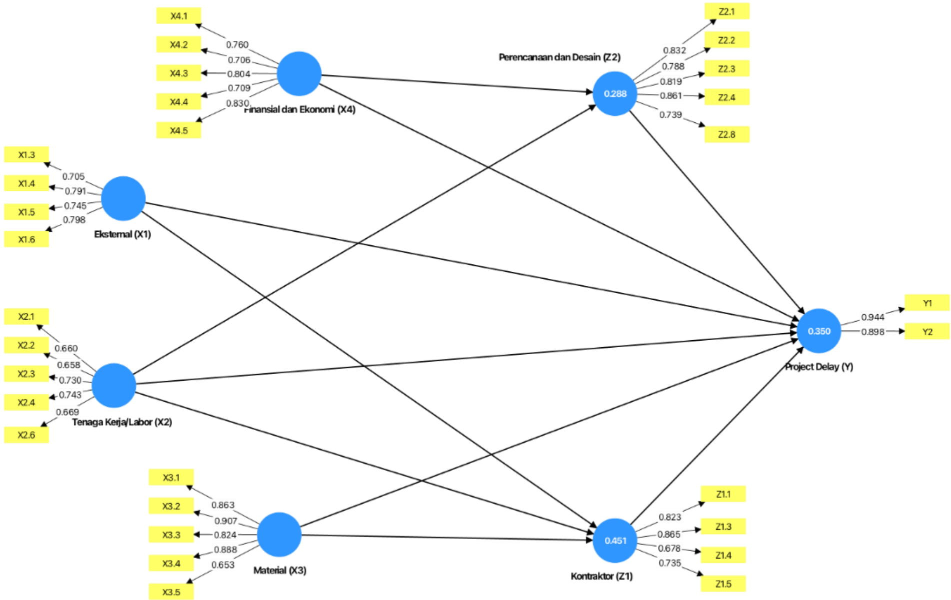



Figure 2. Structural models after the removal of indicators
(Researcher's Processed Results, 2025)

The model in Figure 2 shows the relationship structure between latent variables and the indicators that have been adjusted after the elimination process. This model provides a more focused and accurate picture of the variables that truly reflect the construct being studied. All indicators maintained after the removal process have met the convergent validity criteria with an Outer Loading value above 0.60. This shows that these indicators have a strong correlation with the latent variables they represent, making them suitable for use in measurement models. Especially in the Project Delay variable, the two remaining indicators have a very high Outer Loading value, reflecting the reliability of the construct. Thus, the structure of this revised model is considered valid and can be used for the next stage of analysis.

### Discriminant Validity Assessment

Table 1. Value Cross Loading

| | External (X1) | Finance and Economics (X4) | Contractor (Z1) | Material (X3) | Planning and Design (Z2) | Project Delay (Y) | Labor (X2) |
|---|---|---|---|---|---|---|---|
| **X1.3** | **0.705** | 0.039 | 0.201 | 0.153 | -0.018 | 0.147 | 0.193 |
| **X1.4** | **0.791** | -0.134 | 0.211 | 0.215 | -0.098 | 0.096 | 0.090 |
| **X1.5** | **0.745** | -0.083 | 0.109 | 0.053 | 0.013 | 0.045 | 0.029 |
| **X1.6** | **0.798** | 0.098 | 0.172 | 0.061 | 0.301 | 0.135 | 0.098 |
| **X2.1** | 0.166 | -0.019 | 0.219 | 0.200 | 0.251 | 0.316 | **0.660** |
| **X2.2** | -0.038 | 0.115 | 0.260 | 0.257 | 0.327 | 0.205 | **0.658** |
| **X2.3** | 0.132 | 0.291 | 0.307 | 0.357 | 0.349 | 0.043 | **0.730** |
| **X2.4** | 0.047 | 0.168 | 0.450 | 0.506 | 0.241 | 0.036 | **0.743** |
| **X2.6** | 0.237 | 0.130 | 0.353 | 0.522 | 0.156 | 0.207 | **0.669** |
| **X3.1** | 0.196 | 0.391 | 0.579 | **0.863** | 0.307 | 0.370 | 0.465 |

| | External (X1) | Finance and Economics (X4) | Contractor (Z1) | Material (X3) | Planning and Design (Z2) | Project Delay (Y) | Labor (X2) |
|---|---|---|---|---|---|---|---|
| **X3.2** | 0.238 | 0.529 | 0.680 | **0.907** | 0.263 | 0.435 | 0.334 |
| **X3.3** | -0.081 | 0.439 | 0.474 | **0.824** | 0.206 | 0.256 | 0.624 |
| **X3.4** | 0.027 | 0.478 | 0.469 | **0.888** | 0.165 | 0.351 | 0.538 |
| **X3.5** | 0.277 | 0.240 | 0.426 | **0.653** | 0.044 | 0.420 | 0.317 |
| **X4.1** | -0.037 | **0.760** | 0.450 | 0.588 | 0.471 | 0.332 | 0.324 |
| **X4.2** | 0.068 | **0.706** | 0.231 | 0.416 | 0.242 | 0.153 | 0.275 |
| **X4.3** | -0.135 | **0.804** | 0.123 | 0.308 | 0.252 | 0.172 | 0.025 |
| **X4.4** | -0.016 | **0.709** | 0.205 | 0.129 | 0.281 | 0.154 | -0.029 |
| **X4.5** | 0.084 | **0.830** | 0.173 | 0.331 | 0.330 | 0.077 | 0.043 |
| **Z1.1** | 0.173 | 0.308 | **0.823** | 0.491 | 0.467 | 0.407 | 0.444 |
| **Z1.3** | 0.177 | 0.374 | **0.865** | 0.536 | 0.551 | 0.459 | 0.293 |
| **Z1.4** | 0.306 | 0.111 | **0.678** | 0.542 | 0.205 | 0.301 | 0.462 |
| **Z1.5** | 0.079 | 0.294 | **0.735** | 0.431 | 0.443 | 0.404 | 0.226 |
| **Z2.1** | 0.004 | 0.397 | 0.461 | 0.265 | **0.832** | 0.256 | 0.536 |
| **Z2.2** | 0.056 | 0.513 | 0.440 | 0.240 | **0.788** | 0.293 | 0.138 |
| **Z2.3** | 0.073 | 0.376 | 0.402 | 0.117 | **0.819** | 0.295 | 0.179 |
| **Z2.4** | 0.097 | 0.272 | 0.432 | 0.113 | **0.861** | 0.268 | 0.423 |
| **Z2.8** | 0.045 | 0.241 | 0.421 | 0.227 | **0.739** | 0.573 | 0.233 |
| **Y1** | 0.057 | 0.272 | 0.533 | 0.485 | 0.437 | **0.944** | 0.267 |
| **Y2** | 0.249 | 0.202 | 0.380 | 0.319 | 0.331 | **0.898** | 0.134 |

Source : Researcher's Processed Results (2025)

Based on Table 1, it is known that the Outer Loading value of each indicator against its latent variable is higher than the value against other latent variables. This indicates that most of the indicators have met the Discriminant Validity criteria. However, there is one exception to the Contractor variable, namely the Z1.4 indicator (Contractor project management is ineffective), which shows a higher cross loading value for other variables compared to the original construct. According to Hair et al. (2014), these differences need to be further analyzed, both statistically and contextually, to determine whether the indicator can still be maintained in the model or needs to be removed.

Table 2. Discriminant Validity Fonell-Larcker

| | External (X1) | Finance and Economics (X4) | Contractor (Z1) | Material (X3) | Planning and Design (Z2) | Project Delay (Y) | Labor (X2) |
|---|---|---|---|---|---|---|---|
| **External (X1)** | **0.761** | | | | | | |
| **Finance and Economics (X4)** | -0.015 | **0.764** | | | | | |
| **Contractor (Z1)** | 0.241 | 0.350 | **0.779** | | | | |

| | External (X1) | Finance and Economics (X4) | Contractor (Z1) | Material (X3) | Planning and Design (Z2) | Project Delay (Y) | Labor (X2) |
|---|---|---|---|---|---|---|---|
| **Material (X3)** | 0.173 | 0.507 | 0.646 | **0.832** | | | |
| **Planning and Design (Z2)** | 0.065 | 0.445 | 0.537 | 0.245 | **0.809** | | |
| **Labor (X2)** | 0.151 | 0.262 | 0.506 | 0.448 | 0.423 | **0.693** | |
| **Project Delay (Y)** | 0.151 | 0.201 | 0.462 | 0.534 | 0.384 | 0.227 | **0.921** |

Source : Researcher's Processed Results (2025)

Table 3. Heterotrait-monotrait ratio (HTMT)

| | Heterotrait-monotrait ratio (HTMT) |
|---|---|
| **Finance and Economics (X4) <-> External (X1)** | 0.259 |
| **Contractor (Z1) <-> External (X1)** | 0.301 |
| **Contractor (Z1) <-> Financial and Economic (X4)** | 0.438 |
| **Material (X3) <-> External (X1)** | 0.286 |
| **Material (X3) <-> Financial and Economics (X4)** | 0.546 |
| **Materials (X3) <-> Contractor (Z1)** | 0.761 |
| **Planning and Design (Z2) <-> External (X1)** | 0.221 |
| **Planning and Design (Z2) <-> Financial and Economics (X4)** | 0.485 |
| **Planning and Design (Z2) <-> Contractor (Z1)** | 0.649 |
| **Planning and Design (Z2) <-> Materials (X3)** | 0.277 |
| **Project Delay (Y) <-> External (X1)** | 0.195 |
| **Project Delay (Y) <-> Financial and Economic (X4)** | 0.278 |
| **Project Delay (Y) <-> Contractor (Z1)** | 0.618 |
| **Project Delay (Y) <-> Material (X3)** | 0.503 |
| **Project Delay (Y) <-> Planning and Design (Z2)** | 0.484 |
| **Labor (X2) <-> External (X1)** | 0.271 |
| **Labor (X2) <-> Financial and Economic (X4)** | 0.354 |
| **Labor (X2) <-> Contractor (Z1)** | 0.619 |
| **Labor (X2) <-> Material (X3)** | 0.683 |
| **Labor (X2) <-> Planning and Design (Z2)** | 0.473 |
| **Labor (X2) <-> Project Delay (Y)** | 0.322 |

Source : Researcher's Processed Results (2025)

### Inner Model Evaluation
### Coefficient Determination (R2)

Table **Error! No text of specified style in document.**. Value R-Square ($R^2$)

| Variable endogenous | R-Square | Information |
|---|---|---|
| **Contractor (Z1)** | 0.451 | Moderate |
| **Planning and Design (Z2)** | 0.288 | Weak |
| **Project Delay (Y)** | 0.350 | Moderate |

Source : Researcher's Processed Results (2025)

Based on Table 4, the R-Square value of the Contractor variable (Z1) is 0.451 which is included in the moderate category. This shows that exogenous variables that affect the contractor variable are able to explain 45.1% of the variation that occurs in these variables. Meanwhile, the Planning and Design variable (Z2) has an R-Square value of 0.288 which is in the weak category, indicating that the constructs that affect it only explain about 28.8% of its variability. The Project Delay variable (Y) has an R-Square value of 0.350, which is also moderate, so it can be concluded that the model has a moderate ability to explain project delays based on the constructs tested in this study.

### Variable Effects f-square (f2)

Table 5. Value F-Square

| Variable Relationships | The value of f-square | Information |
|---|---|---|
| **External (X1) → Contractor (Z1)** | 0.027 | Small Effects |
| **External (X1) → Project Delay (Y)** | 0.003 | No Effect |
| **Finance and Economics (X4) → Planning and Design (Z2)** | 0.198 | Moderate Effects |
| **Finance and Economics (X4) → Project Delay (Y)** | 0.013 | No Effect |
| **Contractor (Z1) → Project Delay (Y)** | 0.019 | No Effect |
| **Material (X3) → Contractor (Z1)** | 0.379 | Big Effects |
| **Material (X3) → Project Delay (Y)** | 0.088 | Small Effects |
| **Planning and Design (Z2) → Project Delay (Y)** | 0.098 | Small Effects |
| **Labor (X2) → Contractor (Z1)** | 0.031 | Small Effects |
| **Labor (X2) → Planning and Design (Z2)** | 0.127 | Small Effects |
| **Labor (X2) → Project Delay (Y)** | 0.033 | Small Effects |

Source : Researcher's Processed Results (2025)

Based on Table 5, it can be concluded that not all exogenous variables exert a significant influence on endogenous variables. Some variables show small effects, such as the variables External (X1) against the Contractor (Z1), and Labor (X2) against the Contractor (Z1), Planning and Design (Z2), and Project Delay (Y). Moderate effects were only shown by the Financial and Economic variable (X4) on Planning and Design (Z2), while large effects were found on the Material variable (X3) on Contractors (Z1), which means that material availability and quality greatly affected the contractor's performance. Meanwhile, some relationships, such as External (X1) to Project Delay (Y), Financial and Economic (X4) to Project Delay (Y), and Contractor (Z1) to Project Delay (Y), did not have a significant effect due to the very low f-square value, which was below 0.02. These findings show that in the context of upstream oil and gas construction projects, the greatest influence on project delays comes from material management and indirect relationships through other variables, rather than from direct external or financial factors.

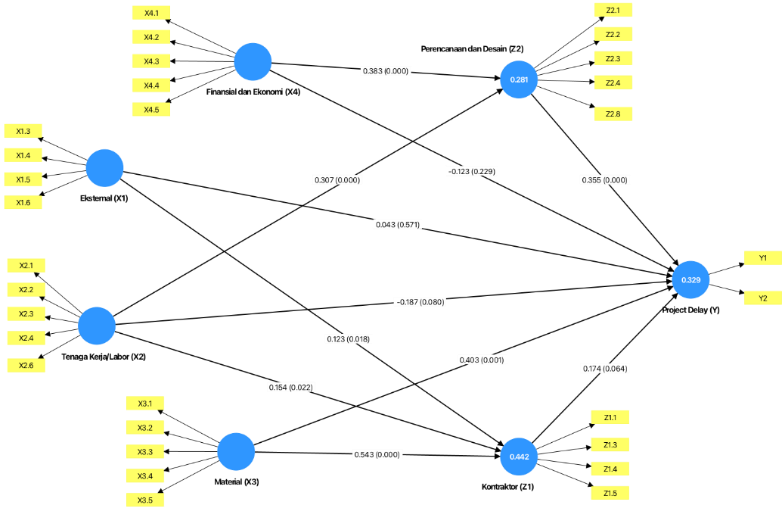


Figure 3. *Bootstrapping Model*

Figure 3 presents a visualization of the bootstrapping model that illustrates the relationship between latent variables along with the Path Coefficient value and t-statistic resulting from the bootstrapping process using the SmartPLS application. This model shows the direction and strength of the influence of each exogenous variable on the endogenous variable in this study. Furthermore, the numerical value details of the test can be seen in more detail in Table 6, which contains the Path Coefficient and t-statistic values of each relationship path between the latent variables tested.

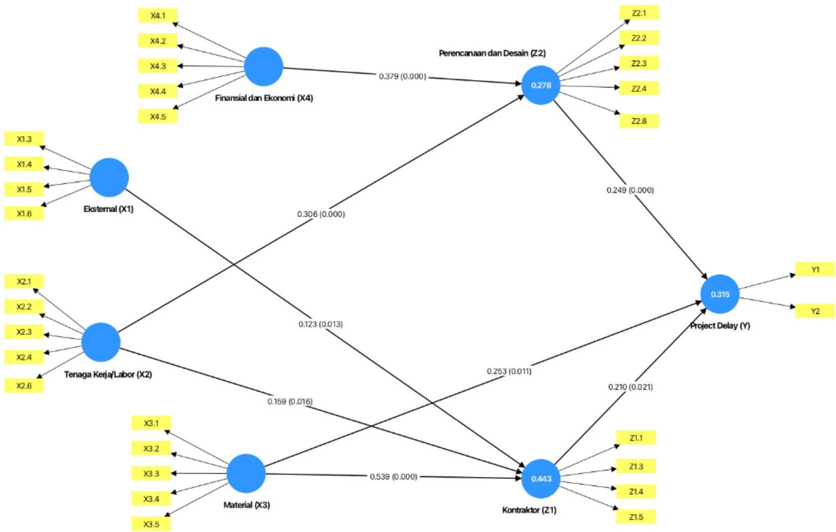
Table 6. Value Path Cofficient

| **Variable Relationships** | **Hipotesis** | **Path Coefficient** | **T statistics** | **P values** | **Information** |
|---|---|---|---|---|---|
| **External (X1) → Project Delay (Y)** | H1 | 0.043 | 0.580 | 0.571 | Insignificant |
| **Labor (X2) → Project Delay (Y)** | H2 | -0.187 | 1.732 | 0.080 | Significant |
| **Material (X3) → Project Delay (Y)** | H3 | 0.403 | 3.374 | 0.001 | Significant |
| **Finance and Economics (X4) → Project Delay (Y)** | H4 | -0.123 | 1.194 | 0.229 | Insignificant |
| **Contractor (Z1) → Project Delay (Y)** | H5 | 0.174 | 1.885 | 0.064 | Significant |
| **Planning and Design (Z2) → Project Delay (Y)** | H6 | 0.355 | 3.828 | 0.000 | Significant |
| **Finance and Economics (X4) → Planning and Design (Z2)** | H7 | 0.383 | 6.528 | 0.000 | Significant |
| **External (X1) → Contractor (Z1)** | H8 | 0.123 | 2.369 | 0.018 | Significant |
| **Labor (X2) → Planning and Design (Z2)** | H9 | 0.307 | 4.021 | 0.000 | Significant |
| **Labor (X2) → Contractor (Z1)** | H10 | 0.154 | 2.329 | 0.022 | Significant |
| **Material (X3) → Contractor (Z1)** | H11 | 0.543 | 10.085 | 0.000 | Significant |

Source : Researcher's Processed Results (2025)

Based on Table 6, the results of hypothesis testing can be known through analysis Path Coefficient and the value t-statistic. Of the eleven relationship pathways tested, there were two pathways that did not show a significant influence on the variables Project Delay, namely Hypothesis 1 (X1 → Y), and Hypothesis 4 (X4 → Y). These two hypotheses have value p-value above 0.10, which means that the relationship between these variables and project delays is not statistically significant at a 90% confidence level. Therefore, the direct influence of these two variables cannot be used as a basis in explaining the delay in upstream oil and gas construction projects directly.

Based on the results of the initial Path Coefficient test, there are two relationships between latent variables that are not statistically significant, namely in Hypothesis 1 and Hypothesis 4. Therefore, these paths are omitted to construct a final structural model that reflects only significant relationships. This simplification aims to obtain a more accurate and parsimonious model in explaining the factors that affect Project Delay in upstream oil and gas construction projects. The following Figure 4 presents a visualization of the simplified structural model, while Table 7 shows a summary of the Path Coefficient, t-statistic, and p-value values of the significant paths in the final model.




Picture **Error! No text of specified style in document.**. Diagram Path Coefficient Model Final

Figure 4 shows a path coefficient model that has been adjusted based on the results of previous tests, eliminating statistically insignificant relationships. This final model shows the structure of the relationship between latent variables that have a direct influence on the delay of upstream oil and gas construction projects. Furthermore, the details of the path coefficient values for the final model are presented in Table 7 below, which contains information on the Path Coefficient, t-statistic, and p-value values of each hypothesis that are declared significant.

Table 7. Test Results Path Coefficient Final

| Variable Relationships | Hipotesis | *Path Coefficient* | T statistics | P values | Information |
|---|---|---|---|---|---|
| **Material (X3) → *Project Delay* (Y)** | H3 | 0.253 | 2.536 | 0.011 | Significant |
| **Contractor (Z1) → *Project Delay* (Y)** | H5 | 0.210 | 2.303 | 0.021 | Significant |

| Variable Relationships | Hipotesis | *Path Coefficient* | T statistics | P values | Information |
|---|---|---|---|---|---|
| **Planning and Design (Z2) → *Project Delay* (Y)** | H6 | 0.249 | 3.706 | 0.000 | Significant |
| **Finance and Economics (X4) → Planning and Design (Z2)** | H7 | 0.379 | 6.307 | 0.000 | Significant |
| **External (X1) → Contractor (Z1)** | H8 | 0.123 | 2.477 | 0.013 | Significant |
| **Labor (X2) → Planning and Design (Z2)** | H9 | 0.306 | 3.975 | 0.000 | Significant |
| **Labor (X2) → Contractor (Z1)** | H10 | 0.159 | 2.412 | 0.016 | Significant |
| **Material (X3) → Contractor (Z1)** | H11 | 0.539 | 9.814 | 0.000 | Significant |

Source : Researcher's Processed Results (2025)

Based on Table 7, all relationships between the remaining latent variables in the final model showed statistically significant results, indicated by a p-value below 0.100 and a t-statistical value above 1.96. This indicates that the delay in the project (Y) is a consequence of the interaction of various factors. Material Variable (X3) has been proven to have a significant influence both directly and through the role of the Contractor (Z1). These findings are supported by studies that identify material factors as one of the main causes of construction project delays (Bakhtiyar, Soehardjono, & Hasyim, 2012). Similarly, Planning and Design (Z2), as the initial foundation of projects, shows a substantial contribution to Project Delay (Y), in line with research highlighting the importance of effective planning in minimizing project delays.

Furthermore, the Labor variable (X2) was shown to significantly affect the intermediate variables, namely Contractor (Z1) and Planning and Design (Z2), consistent with the finding that labor issues have an impact on project performance. Similarly, External factors (X1) have also been shown to affect Contractors (Z1) and Planning and Design (Z2), in line with research that identifies external risks as triggers for delays in the oil and gas sector (Kassem, Khoiry, & Hamzah, 2021). Effective project management must consider the complex interdependencies between internal and external factors to mitigate the risk of delays, confirming the validity of the relationship paths identified in the model as a strong predictor of project time performance in the upstream oil and gas construction sector.

Table 8. Path Coefficient Indirect Influence

| Variable Relationships | Path Coefficient | T statistics | P values | Information |
|---|---|---|---|---|
| **Finance and Economics (X4) → Planning and Design (Z2) → Project Delay (Y)** | 0.095 | 3.043 | 0.002 | Significant |
| **External (X1) → Contractor (Z1) → Project Delay (Y)** | 0.025 | 1.489 | 0.136 | Insignificant |
| **Material (X3) → Contractor (Z1) → Project Delay (Y)** | 0.113 | 2.095 | 0.036 | Significant |
| **Labor (X2) → Planning and Design (Z2) → Project Delay (Y)** | 0.076 | 2.729 | 0.006 | Significant |
| **Labor (X2) → Contractor (Z1) → Project Delay (Y)** | 0.018 | 1.836 | 0.066 | Significant |

Source : Researcher's Processed Results (2025)

Based on Table 8, the results of the analysis of indirect pathways show that four out of five relationship pathways have a significant influence on project delays, namely the pathways from Financial and Economic, Material, and Labor variables through the mediation variables of Planning and Design and Contractors. This indicates that these factors contribute significantly to explaining project delays through indirect channels. Although the path from the External variable through the Contractor is not statistically significant (P-value 0.136), this path is maintained in the model due to theoretical justification, contextual relevance in the study area, and the support of the PLS-SEM methodological approach that prioritizes the power of prediction and exploration.

In the context of South Sumatra, external factors such as social conflicts, external interventions, and local political tensions have the potential to affect the performance of contractors practically even if they are not statistically significant. The decision to maintain this pathway is supported by literature such as Hair et al. (2017) and Sarstedt et al. (2022), which emphasize the importance of theoretical and predictive relevance in the PLS-SEM model. In addition, the External construct is still considered feasible because it has valid and reliable indicators (Outer Loading > 0.7, Composite Reliability > 0.7, AVE > 0.5). Thus, maintaining the External construct in the model aims to keep the research results reflective of the social complexities in the field and can serve as a solid basis for strategic decision-making in project risk management.

**Result of Focus Group Discussion (FGD)**

This study combines the quantitative analysis of PLS-SEM with the qualitative Focus Group Discussion (FGD) method to understand in depth the factors causing delays in upstream oil and gas projects in South Sumatra. The results of the FGD show that the Planning and Design variables, especially engineering design that is not in accordance with field conditions, are the main cause of delays, in line with the findings of Du et al. (2016) and Shen et al. (2017) regarding the importance of cross-functional collaboration from the beginning. Other findings highlight the indirect influence of the Material variable on delays through the Contractor variable, with problems such as procurement delays and inappropriate specifications exacerbating the performance of project implementers (Kraidi et al., 2019; Behboud et al., 2023). The recommended strategies include the preparation of a Material Management Plan, vendor diversification, and early procurement in accordance with the PTK 007 SKK Migas Guidelines. In addition, the active involvement of project owners (KKKS) in procurement supervision is considered crucial (Shen et al., 2017). External risks such as thuggery and social pressure are also significant barriers (Kassem et al., 2021), while low occupational safety awareness among local workers demands systematic and culturally based training interventions (Sodangi & Salman, 2023). Other factors such as price negotiation are inaccurate (Hair et al., 2022), minimal location surveys (Fallahnejad, 2013), and high logistical dependencies reinforce the need for more adaptive and structured procurement and design systems. Thus, the success of upstream oil and gas projects is highly determined by cross-functional integration from the planning stage, careful supply chain risk management, and local capacity strengthening in all aspects of project implementation.

**The Influence of Each Variable on Project Delays**

***Material Effects on Project Delays***

The results of the structural model analysis with the SmartPLS approach show that material factors are the most dominant variable in explaining the delay of upstream oil and gas construction projects, either directly through a very statistically significant relationship, or indirectly through a decrease in contractor performance in the field. The high f-square value of the contractor confirms a substantial causal influence, supported by the strength of indicators such as material shortages, non-conforming specifications, and procurement delays (Bin Seddeeq et al., 2019; Daoud et al., 2023). These findings are consistent with the studies of Dehdasht et al. (2017) and Behboud et al. (2023) which placed material procurement risk as the main cause of time deviation in oil and gas EPC projects. The results of the FGD also show that the weak buffer stock system, dependence on one vendor, and the lack of synchronization of procurement with the implementation schedule cause projects to often stall in the middle of the road. Therefore, strategies such as the preparation of a Material Management Plan, vendor diversification, Material Requirement Planning (MRP) integration, and the use of national e-procurement are very important to be implemented. In the context of South Sumatra facing logistical and infrastructure challenges, strengthening cross-regional coordination and the development of a national oil and gas logistics center are strategic recommendations to ensure smooth procurement of materials and reduce the risk of systemic project delays.

***Contractor's Influence on Project Delays***

The results of the structural model analysis using the PLS-SEM approach show that contractor factors have a substantial influence on the delay of upstream oil and gas construction projects, both directly and as mediators of other variables such as materials, labor, and financial-economics. Although its direct influence is only marginally significant (90% confidence level), its contribution remains practically and structurally strong. Indicators such as inadequate site investigations, lack of contractor experience, and weak internal monitoring systems have high Outer Loading and t-statistic values, indicating that the technical and managerial aspects of the contractor are the main source of project time deviations. These findings are supported by research by Ruqaishi & Bashir (2015), Al-Sabah et al. (2014), and Behboud et al. (2023) which identified that weak planning, supervision, and contractor experience are the main causes of delays in large-scale oil and gas projects. The results of the FGD also emphasized the importance of collaborative field validation, initial technical audits, and KPI-based reporting systems as mitigation measures. Therefore, the handling strategy should be focused on improving the quality of contractor management, strengthening the digital supervision system, and fostering local contractors through joint operations and technical training (Hair et al., 2022). This approach is important to ensure the timeliness and efficiency of the implementation of strategic projects in the national energy sector.

***The Influence of Planning and Design on Project Delays***

The results of SmartPLS analysis showed that planning and design were the most significant factors affecting the delay of upstream oil and gas construction projects, with Path Coefficient values and p-values indicating high significance and moderate f-square, indicating substantial effect strength. This construct is supported by strong indicators such as engineering design inconsistencies, immature planning, and changes in scope of work that reflect weak cross-team coordination and poor initial project documentation. These findings are in line with various previous studies that emphasized that failures in planning and finalizing designs are the main cause of time and cost deviations in oil and gas projects. The results of the Focus Group Discussion (FGD) strengthened this analysis by revealing that the design process was often rushed, there was little involvement of field functions, and did not consider the actual conditions of the project such as topography, geotechnics, and logistics, thus triggering revisions in the middle of implementation. The strategic proposals from the FGD include the implementation of cross-functional design validation meetings, constructability reviews by the implementation team, and the implementation of value engineering from the beginning. Therefore, this variable must be the main focus of managerial intervention through strengthening design audits, digitizing collaboration systems, and stricter control of design changes to prevent systemic delays in upstream oil and gas projects.

***External Influences on Project Delays***

The results of the structural model analysis with SmartPLS show that external factors have an indirect influence on the delay of the project through the contractor, although it is not statistically significant at the 95% confidence level, but the positive relationship direction and the strength of the indicator indicate a potential practical relationship that is worth paying attention to. Factors such as local community conflicts, licensing uncertainty, and security disturbances have proven to hamper contractors' performance, especially in the context of upstream oil and gas projects in South Sumatra which are socially vulnerable (Derakhshanalavijeh & Teixeira, 2017; Du et al., 2016). These findings are strengthened by the results of the FGD which revealed that the lack of community involvement from the beginning, delays in environmental permits, and lack of coordination with local governments often trigger significant delays. Therefore, approaches such as community engagement, stakeholder mapping, and contractor engagement from the planning stage are considered important to develop a more applicable external risk mitigation strategy. Although the direct influence has not been significant, the PLS-SEM approach allows these variables to be maintained in the model based on construct validity and conceptual support. Cross-actor collaborative strategies and adaptive responses to local socio-political dynamics are key in reducing the risk of project delays due to complex and often unpredictable external factors.

***The Influence of Labor Factors on Project Delays***

The results of the SmartPLS analysis show that labor has a significant indirect influence on the delay of upstream oil and gas construction projects through contractor variables, with strong construct validity and significant contributions from indicators such as low occupational safety awareness and productivity. Although it has no direct effect, the limitation of technical competence, the lack of training, and the weak discipline of HSSE among workers, especially in remote areas such as South Sumatra, significantly reduce contractor performance and trigger project delays through rework and operational disruptions. These findings are reinforced by various international studies and FGD results, where project actors emphasized the importance of structured training, regular performance evaluations, and collaboration with local vocational institutions. Therefore, workforce management based on certified technical training, integration of safety aspects, and improvement of the quality of local labor is an important strategy to reduce the risk of systemic delays in complex and high-standard upstream oil and gas projects.

***Financial and Economic Impact on Project Delays***

The results of SmartPLS analysis show that financial and economic variables do not have a significant direct influence on the delay of upstream oil and gas construction projects, but provide a significant indirect influence through contractor variables. This means that financial constraints do not necessarily cause delays, but reduce the performance of contractors in the procurement and implementation of projects. Key indicators such as inaccurate price negotiations and unstable contractors' financial conditions indicate that financial risk remains a major concern in project management. These findings are strengthened by previous studies and FGD results which revealed that delays in disbursement of funds, exchange rate fluctuations, and limited working capital of local contractors are operational obstacles in the field. In addition, the financial reporting system that is not yet digital and the slow budget approval process make the situation worse. Therefore, although not a direct cause, the financial aspect has a systemic impact on the smooth running of the project, so it needs to be managed through realistic budget planning, strict financial evaluation of contractors, and digitalization of the financial system to increase efficiency and visibility in the implementation of upstream oil and gas projects.

***Direct Influence of Variables Affecting Upstream Oil and Gas Project Delays in South Sumatra***

The results of the analysis show that planning and design are the most significant variables directly in influencing the delay of upstream oil and gas construction projects, followed by contractor factors. Immature design quality, lack of geotechnical and hydrological data, and weak cross-functional coordination are the main causes of time deviation in the field, especially in projects in South Sumatra that have high geographical and social challenges. Delays are also exacerbated by the low capabilities of contractors in terms of time management, logistics, and technical risk mitigation, especially among local or national contractors with minimal experience on complex projects. The findings of the FGD show that designs are often released before final field conditions are identified, resulting in technical modifications during construction. Thus, increasing the effectiveness of cross-functional planning and the selection of contractors based on technical performance are crucial strategies in reducing the risk of delays in oil and gas projects in this region.

***Indirect Influence of Variables Affecting Delays in Upstream Oil and Gas Projects in South Sumatra***

The results of the study show that the delay in upstream oil and gas projects in South Sumatra is not only influenced by the direct paths of the Planning and Design (Z2) and Contractor (Z1) variables, but also significantly by the indirect paths of the variables Material (X3), Labor (X2), External (X1), and Financial and Economic (X4). Materials are the biggest contributor to delays indirectly through a decrease in contractor effectiveness due to material availability and distribution issues. A local workforce that is not technically ready also triggers delays through the burden of additional training and design adjustments. External factors such as social conflicts and licensing constraints worsen project implementation through influence on contractors. Meanwhile, the financial aspect contributes through the Planning and Design pathway, where efficiency pressures and budget constraints result in suboptimal designs that must be revised as the project progresses. This dominant indirect pathway emphasizes the importance of field-condition-based design validation, cross-functional coordination from the beginning, and strengthening contractor and workforce capacity as the main strategy in overcoming project delays as a whole.

***Dominant Indicators Affecting Upstream Oil and Gas Project Delays in South Sumatra***

The results of the Outer Model analysis in this study identified a few dominant indicators that significantly affect the delay of upstream oil and gas projects in South Sumatra. The most prominent indicator is the low awareness of the community's legal (X1.6) in External constructs, which often triggers social pressure and project disruptions, especially in areas such as PALI and Musi Banyuasin. In addition, the lack of timely availability of materials was the main cause of delays, reinforced by the results of the FGD which highlighted the inconsistency of procurement schedules and technical specifications, as well as the limitations of logistics infrastructure in remote areas. In the Contractor variable (Z1), weak site investigation (Z1.3) was assessed as the cause of structural project deviation, as it resulted in sudden design revisions, rework, and social conflicts. On the labor side, low awareness of occupational safety (X2.4) causes problems in the field that trigger temporary work stoppages. This is closely related to the low level of education and the lack of local labor safety training. In the material aspect, the shortage of construction materials in the field (X3.2) shows that the availability of materials is a determining factor for the success of the upstream oil and gas project schedule. This indicator indicates that there are serious obstacles in the provision of materials at the right time and quantity at the project site.

Furthermore, the "inaccurate price negotiation" indicator (X4.5) of the Financial and Economic variables shows that the practice of under-pricing by local vendors, often leads to mismatches between budgets and actual costs, leading to cash flow shocks and schedule deviations. In the Planning and Design variable, the indicator "engineering design inappropriate" (Z2.4) dominates as the main cause of rework and delays, due to designs that are not based on a thorough field survey. This is exacerbated by the project owner's pressure for cost efficiency and production targets, which pushes the design to be done in a hurry without the support of accurate technical data. The geographical complexity of South Sumatra such as swamps, peatlands, and seasonal flooding magnifies the design challenges. Therefore, the long-term solution includes contractor involvement from the initial phase, the use of advanced mapping technologies (LiDAR, BIM), and the tightening of the design process based on field data. All of these findings imply that a comprehensive, collaborative, and contextual planning approach is key to addressing upstream oil and gas project delays in a systemic and sustainable manner.

## CONCLUSION

This study found that among six key factors, material variables had the strongest direct and indirect impact—mediated by contractors—on delays in upstream oil and gas construction projects in South Sumatra, followed by planning and design variables with direct effects. While labor, external, and financial factors showed no statistically significant direct influence, they remain practically relevant as confirmed by Focus Group Discussions. Six main issues were identified: low public legal awareness, poor work safety, material shortages, inaccurate price negotiations, minimal site investigations, and unsuitable engineering designs. These highlight the need for better material inventory management, data-driven planning, local contractor capacity building, and cross-functional coordination. Mitigation strategies proposed include implementing minimum-maximum inventory systems, enhancing subsurface-surface coordination, early contractor involvement, adopting digital monitoring technologies, thorough site investigations, and CSR programs to address social risks. For future research, the study recommends applying mixed-method approaches, separating external factors into sub-dimensions, incorporating quality and cost analyses, and replicating this research in other regions with differing geographical conditions to strengthen the model's national applicability.

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