# ANALYSIS OF INDICATORS INFLUENCING DELAYS IN THE DEVELOPMENT OF ELECTRICAL POWER TRANSMISSION PROJECTS AT PLN UNIT INDUK PEMBANGUNAN JAWA BAGIAN TIMUR DAN BALI

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## Abstract

Delays in electricity transmission projects within PLN UIP JBTB have become a dominant issue. The majority of projects during the 2020–2024 period experienced delays, as reflected by milestone deviations, cost overruns, and time overruns, which disrupted electricity supply reliability and adversely affected the company's corporate image. This study aims to analyze the indicators that form latent variables influencing project delays using an explanatory qualitative approach with the PLS-SEM method. Primary data were collected through questionnaires from 140 respondents selected via purposive sampling, comprising project owners, technical experts, and consultants. The results indicate that the elimination of the indicator related to community resistance to the project suggests that project delays are not driven by overt social opposition, but rather by weak communication quality and insufficient community engagement. In the licensing factor, all indicators demonstrate that project delays result from the cumulative effects of slow processing, administrative unpreparedness, and weak inter-agency coordination. Regarding the financial factor, project delays are more strongly influenced by the project financial system's ability to maintain cash flow continuity and cost control than by perceptions of the financial impact of delayed payments. The human resources factor confirms that project delays are associated with an imbalance between workload and workforce capacity, competence, productivity, and motivation. Meanwhile, the logistics and supply chain factor indicates that unprepared procurement and material distribution systems are a significant source of project delays, even when construction activities are technically well planned.

*Keywords: Electricity Transmission, PLN UIP JBTB, PLS-SEM, Project Delay*

## INTRODUCTION

PT Perusahaan Listrik Negara (Persero), commonly known as PLN, is one of Indonesia's state-owned enterprises (BUMN) operating in the electricity sector. PLN has been entrusted with a highly strategic mandate by the government to safeguard and ensure the continuity of the development and operation of a reliable and efficient electricity sector as a driver of economic growth. PLN's role as a provider of electricity infrastructure is crucial in meeting electricity demand across various economic sectors, such as industrial, commercial, social, and household sectors, as well as in enhancing productivity and efficiency in diverse activities. This role aims to improve public welfare and prosperity in a fair and equitable manner and to stimulate economic activity (Rusdy, 2024). The positive growth in electricity sales each year has enabled PLN to consistently achieve its best profits annually. These record-breaking annual profit achievements subsequently encouraged PLN to revise its vision in 2024 to become a Global Top 500 company and the #1 customer choice for energy solutions. In terms of milestones, this vision is expected to be achieved by 2028 through the Transformation 2.0 program under the theme of *moonshots*. PLN's acceleration to achieve its vision by 2028 is supported by the opportunity of steadily growing electricity demand each year. Therefore, in an effort to optimally capture existing demand opportunities, achieve the company's strategic objectives, and carry out the government mandate in the electricity sector, PLN continuously prepares annual plans for the development of electricity infrastructure to meet national electricity needs, as set out in the Electricity Supply Business Plan (*Rencana Usaha Penyediaan Tenaga Listrik* – RUPTL). The RUPTL is PLN's long-term strategic document that serves as a guideline for the development of the electricity system within PLN's service areas over

the next ten (10) years. Timely completion of electricity infrastructure development is a highly sensitive variable, as it is closely related to meeting public electricity needs as well as accelerating the company's operational and financial performance. PT PLN (Persero) Unit Induk Pembangunan Jawa Bagian Timur dan Bali commonly referred to as PLN UIP JBTB, is one of PLN's units responsible for ensuring the availability of adequate electricity infrastructure, including the construction of substations and transmission lines. Its working area covers the Provinces of Central Java, East Java, and Bali. The annual increase in electricity demand has led PLN to formulate a plan for the development of electricity projects for the period 2021–2030, which was approved by the government through the Ministry of Energy and Mineral Resources (ESDM) as the RUPTL 2021–2030. Specifically, the planned transmission network and substation projects of PLN for the period 2021 to 2030 in Java, Madura, and Bali. Total planned PLN projects for the development of transmission networks in Java, Madura, and Bali for the period 2021–2030 amount to 12,716 kms. Furthermore, the planning of PLN projects for the construction of substations from 2021 to 2030 is amount to 45,010 MVA.

In the implementation of latent variables, almost all projects are prone to delays, which are mainly caused by factors such as design approvals, materials, human resources, and external factors (Assaf & Al-Hejji, 2006). Delays in construction projects are a common phenomenon in many countries and are caused by various aspects, including technical, financial, and administrative factors (Sweis et al., 2008). Construction projects are highly complex and involve significant uncertainty; if the causal factors are not properly identified and managed, they may result in obstacles to achieving project objectives in terms of time, cost, and quality (Zali et al., 2025). The implementation of construction projects is always associated with dynamic risks or constraints that may change over time, making the inhibiting variables difficult to predict (Liwoso et al., 2020). To achieve system sustainability, the involvement of multiple stakeholders is required (Zainuddin & Sujiat, 2021). A project has unique characteristics because it consists of a series of activities carried out within a limited timeframe and with specific resource allocations, under various uncertain field conditions that arise as a consequence of uncertainty itself (Tjakra & Sangari, 2011). This indicates that each project has different uncertainty factors that affect the timeliness of project completion. PLN transmission construction projects extend across diverse geographical conditions such as residential areas, straits, rice fields, farmlands, highways, and others, each of which presents potential events that may influence project implementation (Hartono & Wiguna, 2023).

During the period 2020–2024, out of 15 transmission projects undertaken by PLN UIP JBTB, 14 projects experienced completion delays, representing 93.33%. Meanwhile, only one project was completed on time, accounting for 6.67%. The fact that only a small number of transmission projects are completed on time. Understanding of this phenomenon remains limited because the mapping of factors causing project delays is primarily based on evaluation reports, progress meetings, and internal audits, which are descriptive, fragmented, and do not adequately represent the relationships among factors. In contrast, numerous studies indicate that a wide range of factors contribute to project delays. However, these findings are generally analyzed separately and have not been integrated into a comprehensive model that explains the interrelationships and influences among factors on the timeliness of project completion. From 2020 to 2024, electricity transmission projects at PLN UIP JBTB exhibited a consistent pattern in which almost all projects experienced delays. These delays are no longer incidental cases but have become a recurring systemic phenomenon. Such delays not only result in deviations from planned schedules but also directly lead to increased costs (cost overruns), reduced productivity, disruptions in operational planning and electricity supply provision, and a decline in the company's image in the eyes of the government, investors, and electricity consumers. More critically, there is uncertainty regarding the project factors influencing these delays. Project management is generally aware of what has occurred but lacks scientific arguments explaining why delays continue to recur and which factors actually contribute most dominantly to project delays. Without such understanding, project management tends to act reactively rather than strategically. This condition creates an urgent need for research, as the problem requires immediate resolution.

Although previous studies on project delays within PLN have been conducted, there are clear distinctions between those studies and the present research. First, prior studies are generally partial in nature, focusing only on a limited number of specific factors. Given that projects are *typical* in nature meaning that not every occurrence represents the same factor affecting different projects (Orellano & Gourc, 2025) this study adopts factors that frequently emerge across various studies. Second, previous research tends to emphasize descriptive risk analysis, whereas this study focuses on confirmatory influence analysis by integrating all factors into a comprehensive model. Third, earlier studies typically analyze project scale in specific cases, while this study examines projects distributed across Central Java, East Java, and Bali with diverse project characteristics using data from 2020–2024. Fourth, this study incorporates a factor that has rarely been addressed in prior research, namely supply chain.

A problem refers to an actual condition that has occurred, whereas risk represents an uncertain condition that must be anticipated early to prevent it from becoming a future problem (Mulcahy, 2010). Defining potential events that may affect project objectives such as financial, operational, legal, and environmental aspects is therefore a crucial step. Based on internal data and annual reports of PLN UIP JBTB, a number of strategic projects experienced significant schedule deviations compared to their initial plans due to various internal and external factors. These factors include issues related to project management, limitations in human resources (HR), financial constraints, technical challenges, logistics, supply chain issues, social factors, land acquisition, and licensing.

## LITERATURE REVIEW

### Definition of a Project

According (Cleland & King, 1975) a project is a combination of various resources brought together within a temporary organizational structure to achieve a specific objective. Furthermore, Schwalbe, as translated by (Manlian et al., 2023) explains that a project is a temporary endeavor undertaken to produce a unique product or service. (Andersen et al., 2025) also defines a project as an organized effort or activity aimed at achieving specific goals, objectives, and expectations by utilizing available budgets and resources, which must be completed within a predetermined timeframe. Based on these definitions, a project can be understood as a series of activities that are carried out only once and are generally short-term in nature, in which there is a process of transforming project resources into an output, typically in the form of a constructed facility or physical structure.

### Project Delay

Delay is defined as a portion of the execution time that cannot be utilized as planned, resulting in subsequent activities being postponed or not completed on time according to the scheduled plan (Ervianto, 2023). Project delays may be caused by the contractor, the project owner, or by natural and environmental conditions beyond human control, commonly referred to as force majeure. A delay in a construction project implies an extension of the project completion time as originally planned and stipulated in the contract documents. Work completion that does not adhere to the schedule or is not completed on time reflects a deficiency in productivity levels. The impact of such delays includes inefficiencies and waste in project financing, whether in the form of direct or indirect costs incurred in government-funded projects, or in the form of investment cost overruns and financial losses in private-sector projects (Arianie & Puspitasari, 2017). Based on the above explanations, a delay can be described as a condition in which a construction project activity experiences an extension of time or is not carried out in accordance with the expected plan. Project delays can be clearly identified through project schedules. By examining the schedule, the impact of delays in one activity on subsequent activities can be observed, enabling timely preventive or corrective actions to be taken.

A construction project is considered delayed when the execution of the work cannot be completed in accordance with the contract. If the project work cannot be carried out as stipulated in the contract, an extension of time will be granted. If, after this extension, the project is still not completed as agreed, the project owner may grant additional time to the contractor to complete the work. In other words, the owner provides extra time for project completion. However, if the project remains unfinished despite the additional time granted, contract termination may occur (Madjid & Saputri, 2021). Granting additional time for project completion thus serves as a resolution mechanism. Delays also have the potential to trigger conflicts between project owners and contractors, particularly when responsibility for the delay is not clearly defined in the contract. Such conflicts often lead to disputes that may escalate into legal proceedings. Dispute resolution processes are not only time-consuming but also increase financial burdens on the company. Project delays in construction are a common phenomenon, with nearly 80% of projects experiencing delays (Kaming et al., 2019). These delays often recur in affected work segments and are influenced by various specific factors. Discrepancies between planned schedules and actual project completion may result from unforeseen internal or external factors. In other words, project delays may arise from both predictable factors and unexpected situations.

The success of a construction project is measured by its ability to be completed on time according to schedule, within the predetermined budget, in compliance with specified requirements, and in a manner that satisfies stakeholders (Majid & McCaffer, 1998). According to (Bakhtiyar et al., 2012) construction delay refers to the postponement of work completion as stipulated in the contract, which often leads to legal claims. Such delays occur when contractors fail to complete work within the timeframe agreed upon in the contract. Meanwhile, (Kamaruzzaman et al., 2016) identifies that project delays may be caused by factors originating from contractors or project owners, as well as by external factors not directly related to either party. In general, project delay refers to an

extension of the implementation duration specified in the contract documents. Construction project delays frequently become a source of conflict and disputes between project owners and contractors, leading to significant financial consequences for both parties. Contractors may be subject to penalty fines as stipulated in the contract and must bear additional overhead costs for the extended project duration. On the other hand, project owners may suffer losses in the form of reduced revenue due to delays in the operationalization of the facilities under construction.

## METHOD

The type of research employed in this study is explanatory qualitative research, which aims to explain the indicators influencing delays in the development of electricity system projects. This study is grounded in qualitative data in the form of respondents' perceptions, viewpoints, and subjective experiences regarding latent variables, which are subsequently converted into numerical form using a Likert scale for analytical purposes within an integrated relational framework. The use of the Partial Least Squares–Structural Equation Modeling (PLS-SEM) method emphasizes that this study seeks to analyze the indicators that form latent variables in order to identify which indicators have the greatest influence on the factors causing delays in electricity transmission projects at PLN UIP JBTB. Since, Likert scales is in range point 1 to 5 that can be treated as continuous or interval variables which then can be calculated statistically (Huh & Gim, 2025).

This research model is designed to analyze the indicators influencing project delays in electricity transmission projects at PLN through variables. There are five main independent variables, namely Social Factors (X1), Licensing Factors (X2), Financial Factors (X3), Human Resource Factors (X4), Logistics & Supply Chain Factors (X5), which influence Project Delay (Y). In addition, Land Acquisition & Right of Way (ROW) (Z1) and Project Management (Z2) serve as mediating variables in the relationship between these factors and project delays. The relationships among variables with its indicators in this model are tested using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) method. The mode is illustrated in Figure 1.
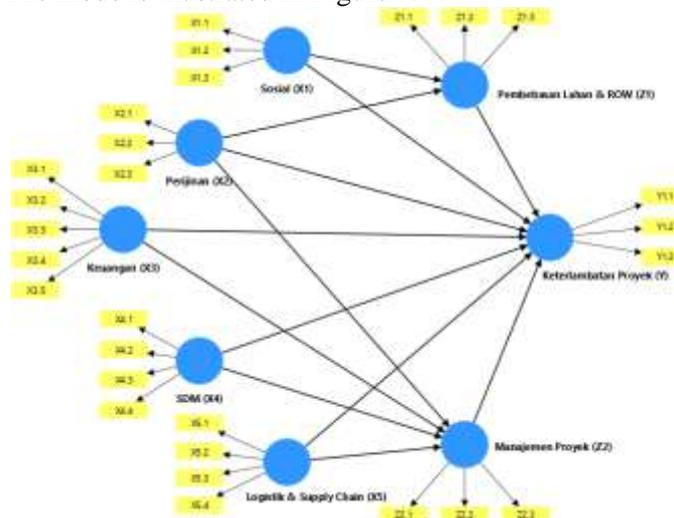


**Figure 3. Total Relationship Path Coefficients / Total Effects**

The hypotheses proposed in accordance with the research model are formulated based on a review of the literature and previous studies. Hypothesis testing is conducted by comparing the value of inner model with the standard criteria based on following criteria: (1) The loading score greater than 0.6 (significant); (2) The loading value of an indicator associated with a latent variable must be higher than its loading on other latent variables (cross loading); (3) Meeting the requirements of the reliability test, in which both Cronbach's Alpha and Composite Reliability values must be greater than 0.6 (Hair & Alamer, 2022). The population of this study consists of all employees or internal stakeholders involved in projects at PLN UIP JBTB. This population includes project leaders, technical experts, and project consultants who are actively involved and possess sufficient experience in the planning, implementation, and supervision stages of projects. Their roles and experience make them relevant sources for identifying factors contributing to project delays. The sample was selected using a purposive sampling technique, whereby respondents were deliberately chosen based on specific criteria established by the researcher. These criteria include having a minimum of five years of experience in PLN UIP JBTB projects, direct involvement in project management, implementation, or supervision, relevant professional backgrounds in the electricity or construction

sector, and holding at least a Supervisor, Engineer, or Officer position. Based on PLS-SEM methodological considerations and the number of research indicators, a sample size of 140 respondents was determined. This number is considered sufficient and representative of the population, enabling valid and reliable analysis results. The data collection process in this study was conducted using several complementary methods to ensure the completeness and validity of the research findings. First, a literature review was carried out to gather theoretical foundations related to delays in electricity transmission projects, including the identification of key influencing indicators. This review also served to identify research gaps by analyzing previous studies and relevant scientific publications, which became the basis for developing the research model and hypotheses. Second, observational methods were employed through systematic recording and documentation of actual conditions during the implementation and completion of ongoing electricity transmission projects. In addition, the researcher examined data from transmission projects within the PLN UIP JBTB area covering the period from 2020 to 2024.

These observations and document reviews were used to obtain a comprehensive understanding of project progress as well as the practical and contextual indicators influencing project delays. The findings from field observations and secondary data analysis were utilized to strengthen the identified research gap. Third, primary data were collected using a questionnaire as the main research instrument. The questionnaire was designed based on the latent variables and indicators formulated in Subchapter 3.3 concerning the research model and hypotheses. A closed-ended questionnaire format was applied, in which respondents were required to select one answer that best reflected their perception. Each statement was measured using a five-point Likert scale to represent the level of agreement, ranging from strongly disagree to strongly agree. This scale enabled the quantification of respondents' attitudes and perceptions regarding the indicators affecting project delays in a structured and measurable manner. This study employed Partial Least Squares–Structural Equation Modeling (PLS-SEM) using SmartPLS version 3 as the main data analysis technique. The analysis was conducted to evaluate the measurement of outer model. Indicator analysis was performed to assess the quality of the measurement model. This stage included tests of convergent validity through indicator loading factors, discriminant validity through cross-loading comparisons, and reliability testing using Cronbach's Alpha and Composite Reliability to ensure the consistency and accuracy of the measurement instruments. Through this comprehensive analytical approach, the study was able to evaluate the indicators of the proposed latent variables on delays in electricity transmission projects.

## RESULTS AND DISCUSSION
### Indicator Analysis
Indicator analysis was conducted by performing a series of tests on the outer model, which must meet the following required criteria:
1. Convergent Validity Test, with loading factors greater than 0.6.
2. Discriminant Validity Test, in which the cross-loading value of an indicator explaining its latent variable must be higher than the loading value explaining other latent variables.
3. Reliability Test, with Cronbach's Alpha values greater than 0.6 and Composite Reliability values greater than 0.7.

Among all indicators, two indicators were found to be invalid, namely X1.1 (community resistance to the project) and X3.5 (impact of delayed contract payments). Both indicators had outer loading values below 0.6. Therefore, these two indicators were eliminated from the model in a stepwise manner by removing one indicator that did not meet the validity criteria, while the other invalid indicator was retained in the model for re-testing. The result indicates that the outer loading values of indicators X1.1 and X3.5 still do not meet the convergent validity criteria. Therefore, both indicators were eliminated from the measurement model., resulting in a revised research model. Subsequently, a re-test of convergent validity was conducted based on the revised research model. This re-test aimed to ensure that the remaining indicators were able to optimally represent their respective latent variables. All indicators for each latent variable showed outer loading values greater than 0.70. This indicates that each indicator made a strong contribution to explaining its latent variable; therefore, the convergent validity test results were declared valid. The next stage was the discriminant validity test. The loading value of an indicator on its associated latent variable must be higher than its loading value on other latent variables, because each indicator should truly measure its own latent variable rather than explain other variables. If an indicator explains another latent variable more strongly, it is considered non-discriminative, causing the boundaries of the latent variables to become unclear. All latent variables showed cross-loading values that were higher than their correlations with other latent variables. The discriminant validity test results indicate that all latent variables in this research model met the discriminant validity criteria, meaning that each latent variable had clear conceptual distinctions and was able to explain the measured phenomena

specifically. The research model was therefore considered adequate and could be continued to the reliability test stage to assess the level of internal consistency of the indicators in measuring the latent variables. All latent variables in this study showed Cronbach's Alpha and Composite Reliability values above the minimum required thresholds. This indicates that the indicators for each variable had good internal consistency in representing their latent variables.

## Hypothesis Testing

Hypothesis testing in this study is focused on the measurement model (outer model) with the objective of empirically demonstrating that the indicators used are able to adequately represent the latent variable constructed in the model that influence project delays. The results of the convergent validity test indicate that all indicators have outer loading values $\geq 0.60$, except for indicator X1.1 (Community resistance to the project) and X3.5 (Impact of delayed contract payments). Apart from these two indicators, all remaining indicators also satisfy the criteria for discriminant validity and reliability testing. These results indicate that the retained indicators are able to properly represent the latent variable, exhibit clear conceptual distinctions in describing the respective latent variable, and demonstrate good internal consistency.Based on these findings, it can be concluded that all indicators retained in the model are proven to be valid and reliable in representing the factors influencing project delays; therefore, the measurement hypotheses (outer model) in this study are accepted.

## Discussion

The evaluation of the measurement model (outer model) in this study provides a deeper empirical understanding of how operational indicators observed in the field are able to reflect the project realities experienced by project implementers. The convergent validity results indicate that almost all theoretically formulated indicators are proven to represent the latent variable they are intended to measure. The elimination of the indicator community resistance to the project (X1.1) suggests that project delays in the context of this study are not triggered by overt social opposition, but rather by the quality of community engagement and communication. This finding reflects a shift in the nature of social issues in modern infrastructure projects, where open conflicts are becoming less frequent, while insufficient involvement and miscommunication emerge as more significant sources of delay.

Regarding the licensing factor, all indicators were found to be valid and reliable, indicating that project delays are not caused by a single aspect, but rather by the cumulative effects of processing speed, administrative completeness, and the effectiveness of inter-agency coordination. This finding confirms that permitting-related issues are systemic and administrative in nature, making partial or fragmented management approaches less effective. Accordingly, project delays from a permitting perspective are more appropriately understood as failures in process governance rather than merely bureaucratic constraints. For the financial factor, indicators related to project financial management mechanisms—such as payment timeliness, budget adequacy, contractor cash flow capability, and cost control—demonstrate strong measurement validity. In contrast, the indicator impact of delayed contract payments (X3.5) does not meet the convergent validity criteria. This result indicates that project delays are not directly influenced by perceptions of financial impact, but rather by the capacity of the project's financial system to maintain cash flow continuity and cost stability.

In terms of human resources, all tested indicators were validated and found to be reliable, indicating that project delays are closely associated with the actual capacity of the workforce on site. The validity of indicators related to workforce quantity, quality, productivity, and motivation suggests that human resource issues in projects are not merely a matter of labor quantity, but also involve competence, work efficiency, and the sustainability of workforce motivation. This finding reinforces the view that project delays often reflect an imbalance between work demands and available human resource capacity. For the logistics and supply chain factor, indicators related to procurement timeliness, supplier capacity, clarity of technical specifications, and material distribution were shown to strongly represent this factor. This indicates that project delays largely originate from insufficient readiness of supporting systems rather than from construction activities alone. Consequently, logistics-related issues should be understood as challenges in planning and system integration, rather than solely as operational problems in the field.

## Managerial Implications

For the social factor, project-related social issues are more effectively managed through the strengthening of proactive communication and community engagement strategies. Therefore, it is necessary to ensure the existence of structured and continuous communication mechanisms implemented by personnel with adequate social competencies in the field. For the Licensing factor, all indicators reflect that project delays are strongly influenced by the effectiveness of administrative processes and inter-agency coordination. This highlights the need to strengthen

permit document control systems, enhance cross-agency coordination, and ensure administrative readiness from the early stages of the project. For the financial factor, the findings indicate that project delays are more closely related to financial management mechanisms than to perceptions of their impacts. Accordingly, management should emphasize payment schedule certainty, evaluate contractors' financial health, and strengthen project cost control functions. For the human resource factor, all indicators confirm that project delays are closely associated with the actual capacity of the workforce in terms of quantity, quality, productivity, and motivation. Therefore, balanced workforce planning, competency enhancement through training, and continuous management of workforce motivation and productivity are required. For the logistics and supply chain factor, the results indicate that project delays often stem from supply chain unpreparedness. Consequently, alignment between project implementation schedules, procurement planning, technical specifications, and material distribution is essential.

## CONCLUSION

The indicators forming the latent variables are able to adequately represent their respective latent constructs, reflecting the empirical phenomena within the project delay model. Indicators with the highest outer loading values for each latent variable indicate the operational aspects that most strongly represent actual field conditions. The Social Factor is more strongly represented by the indicators of community involvement and communication with the public. In terms of Permitting, the construct is predominantly determined by the speed of the permitting process and the quality of coordination among permitting authorities. The Financial Aspect is more dominantly represented by the timeliness of project payments by the owner and cost control by the contractor. The Human Resources Factor is simultaneously represented by all indicators, namely worker competence, capacity, motivation, and productivity. Regarding the Logistics and Supply Chain aspect, the construct is more dominantly determined by the qualifications and capacity of suppliers. The mediating variable Land Acquisition and Right of Way (ROW) is jointly formed by all indicators, namely community expectations regarding land and ROW prices, land disputes with the community, and clarity of ROW boundary demarcation. Meanwhile, the mediating variable Project Management is more dominantly represented by the indicator of site supervision. As the outcome variable, Project Delay is more dominantly represented by the milestone delay indicator. The elimination of the indicators of social resistance and the impact of delayed contract payments does not indicate the absence of these phenomena; rather, it reflects that these indicators do not possess sufficient explanatory power within the empirical context of transmission projects at PLN UIP JBTB.

## RESEARCH IMPLICATIONS

This study focuses on the evaluation of the outer model to identify valid and reliable indicators forming the latent constructs related to project delay. However, the analysis has not yet explored the structural relationships among variables. Therefore, further studies are recommended to extend this research by examining the inner model, including causal relationships, mediation effects, and effect size analysis, in order to obtain a more comprehensive understanding of the mechanisms driving delays in power transmission projects.

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