

Analysis of Multi-Project Resources in Dam Construction on Java Island Affecting Contractor Performance

Indriawan Subagyo, Muhammad Isradi

Universitas Mercu Buana, Indonesia

Email: indriawan.thesis@gmail.com, isradi@mercubuana.ac.id

ABSTRACT

The construction of dams is part of a national strategic project that requires optimal resource management in order to improve contractor performance. This study aims to analyze the influence of various project resource factors—such as human resources, materials, equipment, implementation methods, information technology, and the environment—on the performance of contractors in dam projects in Java. The research method used is quantitative with the Partial Least Square-Structural Equation Modeling (PLS-SEM) and Importance Performance Analysis (IPA) approaches. Data collection was carried out through the distribution of questionnaires to 125 respondents who were directly involved in four dam projects, namely the Cijurey, Jragung, Cabean, and Bago Dams. The results of the analysis show that not all resource variables have a significant effect on the performance of contractors. The variables that have a significant influence both in terms of importance and performance are equipment, implementation methods, and environment, while human and material resources do not have a significant influence. These findings confirm the importance of optimizing the management of equipment and working methods as well as adjusting to the project's environmental conditions. This research makes a practical contribution in the management of multi-dam projects, especially in determining the priority scale of resource management that has an impact on improving the overall performance of contractors.

KEYWORDS

Project resources, contractor performance, dams, PLS-SEM, Importance Performance Analysis, construction projects.



This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International

INTRODUCTION

The construction industry is a sector that plays a central role in the development process of a region or country. The construction of dams is one of the large-scale infrastructure projects within the construction industry, especially as the Indonesian state has carried out many dam constructions. Based on data from the Ministry of Public Works and Housing, as many as 64 dams are targeted to be built by 2024, with 21 dams on the island of *Java*—making it the area with the most dam construction.

According to the government's programs and targets related to the construction of many dams in Indonesian territory, especially on the island of *Java*, the increasing need for clean water, climate change, and the government's efforts to achieve food security are key drivers. Thus, the construction of dams on the island of *Java* is an important effort in meeting community needs sustainably and has an impact on the country's economy. A sustainable construction industry will make the

economic sector beneficial for the country's development, resulting in the country's economic growth (Rizal et al., 2024).

The implementation of dam construction as a large-scale or multi-project venture, of course, cannot be separated from high complexity. The success of the contractor, produced through its performance, is believed to be inseparable from the influence of resource factors in the project. Resources are the supporting elements crucial for the success of a construction project, while design risks can also affect project success (Haryono S, 2018). Effective resource management is a vital aspect for a contracting company to ensure that these projects can be carried out seamlessly and in line with their targets. As expressed by Rohmah, Sugandi, and Alfianto (2023), in the construction industry environment, the role of resources is very important to the quality of project results to achieve efficiency and client satisfaction.

In construction projects, resources that can affect contractor performance in achieving the success of multi-projects include human resources. In the construction industry, many factors affect project success, one of which is human resource management (HRDM) (Othman, 2014). Human resources are among the factors that can influence the success of development projects through the optimal performance produced by contractors. The presence of human resources has a great contribution during the implementation of construction projects because their abilities, such as skills and work capacity, greatly determine the course of the project. Infrastructure projects such as dam construction have their own challenges in resource management. In this context, aspects such as specific technical skills, compliance with occupational safety regulations, and the ability to work in diverse environments are important factors to consider (Hasan et al., 2019). Research by Putri et al. (2023) also explains that human resources have a positive influence on contractor performance, meaning that increasing the workforce can improve contractor performance. Thus, labor is the key to success, making it very important to achieving project performance. From another point of view, Kurniawan Winatha (2018) emphasized that a good resource selection method prioritizes not only technical expertise but also aspects such as company cultural suitability, adaptability, and leadership. The implementation of a holistic recruitment and selection policy can help companies select employees who are not only able to carry out technical tasks but can also contribute positively to the company's work culture and goals.

Other multi-project resources that can affect project performance are materials and equipment. Material resources are any type of materials used in the construction process of a project and are physical components in the infrastructure structure. Material resources are a key factor in the success of a construction project. With good management, material resources can be valuable assets to achieve project goals; however, material resources can also play a crucial role in causing losses to a project if not planned and managed properly by the construction project (Pamungkas et al., 2024). Equipment resources include all types of tools and machines used in work implementation. These two resources are aspects that support the running of a project and need to be closely monitored by contractors because they can affect contractor performance. Equipment resource management

factors influence the productivity of construction project implementation, with equipment resource management being the dominant factor (Ayu et al., 2024).

In addition to the factors mentioned above, resources in multi-projects that can also affect contractor performance are information technology and implementation methods. The implementation method itself is an action plan prepared to achieve the mission of a project by utilizing various resources. If the project implementation method is not appropriately applied, it can cause errors by the contractor. As explained by Halim et al. (2021), inappropriate implementation methods, wrong decision-making, and personnel competence mismatched with their duties influence project implementation in medium and high categories. Thus, the more appropriate the construction implementation method, the better the contractor's performance and the likelihood of completing the project within the specified time. Inappropriate work methods are the dominant factor causing project delays. Information technology also plays an important role in improving project contractor performance. Tools such as Geographic Information Systems (GIS) provide the ability to visualize and analyze spatial data, supporting more effective decision-making regarding infrastructure development. The use of information technology in project management has been proven to increase efficiency and effectiveness in various construction projects. Therefore, the application of information technology has a major impact on the effectiveness and efficiency of project management, which can subsequently improve overall project performance (Pamungkas et al., 2024).

Environmental resources refer to the physical and social environment. These two elements also play an important role during the implementation of construction projects. The physical environment includes the project location, soil conditions, climate, and other environmental factors that can affect project implementation. Meanwhile, the social environment refers to the community around the project and other social aspects. Both, if maximized, can have a positive influence. The physical and social environment shaped in a construction project can provide management with the impetus to achieve project goals (Farizi, 2024).

Based on this description, it can be understood that resources in multi-projects can affect contractor performance through several resource elements, such as human resources, materials, equipment, implementation methods, information technology, and the environment. However, in the implementation of dam infrastructure construction projects, there are several challenges in managing resources effectively to achieve success through contractor performance. One of the challenges faced is delays in construction on several large projects in Indonesia caused by resource factors. A survey in 2019 stated that more than 50% of major construction projects in Indonesia experienced delays due to resource problems (Central Statistics Agency, 2019). As also reported in the PUPR annual report, factors causing construction delays are related to unprofessional labor—choosing to go home before completing the construction period—poorly planned material resources, which leads to unexpected material needs during projects, and problems in the process of supplying equipment and materials, causing work in the field to be halted even though the project overhead continues (Book 3 of PUPR, 2021). Problems related to these resources hinder the implementation of infrastructure

construction projects and impact contractor performance, especially in dam construction projects on the island of *Java* where significant construction is occurring in the same area. The following is a map of dam construction projects throughout Indonesia (Rony et al., 2024; Schützenhofer, Kovacic, & Rechberger, 2022; Al-hajj & Zraunig, 2018).

Multi-project dam construction handles several construction areas; thus, creating good performance is essential to achieving maximum results. Achieving these missions is inseparable from the involvement of construction resources that need to be managed properly. Contracting companies need to pay attention to these resources so that they can be managed appropriately, since each resource can certainly provide benefits if managed or regulated properly. Especially in the last decade, dam construction has been carried out massively and evenly throughout Indonesia. This will impact the quality of dam construction and thus necessitates qualified contractor companies for these projects.

The purpose of this study is to analyze the project resource factors that influence contractor performance in multiple dam projects on the island of *Java* toward achieving the strategic plan for 2020–2024 through modeling analysis. The benefits of this research help relevant parties in the construction industry to understand the factors influencing performance and determine necessary corrective steps.

Based on a literature search, no research has been found that specifically discusses the influence of resource management on contractor performance in the context of multi-dam projects in Indonesia, especially on the island of *Java*. This indicates a significant and important research gap to address. This research contributes to the literature by expanding the scope of resource management studies within the construction industry, which has its own challenges. The special focus on dam projects as part of major infrastructure adds depth of analysis to distinctive technical, environmental, and managerial aspects. Additionally, through a comprehensive approach to six dimensions of resources—human resources, materials, equipment, implementation methods, information technology, and environment—this research produces best practice recommendations that can be used as strategic references for construction industry players engaged in similar projects.

RESEARCH METHOD

This study is a quantitative study with a descriptive approach that aims to analyze the influence of resource management in a multi-project context on contractor performance in dam construction projects on *Java Island*. This research strategy is systematically prepared, starting from problem identification to drawing conclusions that provide concrete solutions for construction industry players.

The research was carried out in four national strategic projects for dam construction, namely: Cijurey Dam Package 1 (West Java), Jragung Dam Package 3 (Central Java), Cabean Todanan Dam (Central Java), and Bagong Dam Package 1 (East Java). The four projects were chosen as research locations because they are part of the infrastructure development priorities financed through the State Budget,

with the duration of project implementation varying between 1,091 and 2,003 calendar days.

This research focuses on the identification and analysis of six main resources used in dam projects, namely human resources, materials, equipment, implementation methods, information technology, and project environment. These six variables are seen as critical factors in construction project management, especially in multi-site projects that present coordination and resource efficiency challenges. The study also explores how variations in resource management in each project affect the overall performance level of contractors.

The population in this study consists of all professional workers involved in the implementation of the project at the four dams. The population includes prime contractors, subcontractors, consultants, and commitment-making officials (*PPKs*). The total number of recorded population is 183 people. Based on the sample calculation formula (Yamane), with a significance level of 5%, a sample of 125 respondents was obtained. The selection of respondents was carried out purposively, with the criterion that respondents have at least three years of work experience and are directly involved in project management or operations.

Data were collected through two main approaches. First, a literature study was conducted by examining academic references and government policies related to infrastructure projects, construction management, and contractor performance indicators. Second, primary data collection was carried out through the distribution of structured questionnaires to respondents at each project location. The questionnaire is designed to measure two main aspects: the level of suitability and the level of satisfaction with the management of resources in the ongoing project.

The research instrument used was a questionnaire consisting of four main parts. The first part explains the background and purpose of the questionnaire. The second part contains the identity and profile of the respondent. The third part provides guidance for filling out the questionnaire, and the fourth part contains statements that must be assessed by the respondents. The measurement scale used is the Likert scale of 1–4, both for the level of conformity and satisfaction. This instrument has been designed based on indicators of each variable that have previously been identified through a literature study.

The independent variable in this study is project resource management, which consists of six dimensions: human resources, materials, tools, implementation methods, information technology, and environment. Each dimension has indicators developed based on the context of the dam project. The bound variable is contractor performance, measured through indicators such as timeliness, quality of work results, and response to changes or project constraints. These variables are expected to quantitatively explain the relationship between resource management and successful project implementation.

The analytical strategy in this study focuses on forming a model of the relationship between variables that can describe the functional influence of resource management on contractor performance. This approach enables researchers to compile a comprehensive mapping of conditions in the field and provides a solid basis for formulating improvement strategies going forward. This model is then

used to interpret how each dimension of the resource relates to each other and contributes to the overall performance of the project.

The implementation of this research is carried out in stages, starting with initial observation at the project sites to understand the context and characteristics of each project. After that, questionnaires were distributed and relevant secondary data were collected. The next stage is the analysis and mapping of the findings, as well as the interpretation of the data to draw conclusions in accordance with the research objectives.

Overall, the approach used in this study not only provides a descriptive picture of the condition of dam projects on *Java*, but is also applicable in providing managerial recommendations. With a research strategy built on the needs of multi-location projects, this study is able to formulate relevant data-driven solutions to support the improvement of contractor performance in large-scale infrastructure projects in Indonesia.

RESULT AND DISCUSSION

In this study, a descriptive analysis was carried out to determine the distribution of respondent characteristics. Furthermore, an Importance-Performance Analysis (IPA) is carried out to determine the priority scale based on the level of importance and performance. In addition, a SEM-PLS analysis was carried out to find out the factors that affect the performance of the contractor.

Descriptive Analysis

Descriptive analysis was carried out to determine the distribution of respondent characteristics. In this case, the characteristics of the respondents include age, gender, education, position/position, work experience, and project location.

Table 1. Distribution of Respondent Characteristics by Age

Age	Number of Respondents	Percentage (%)
17 – 24 Years	33	26,4
25 – 34 Years	50	40,0
35 – 44 Years	28	22,4
>45 Years	14	11,2
Total	125	100

(Source: Researcher's Processing)

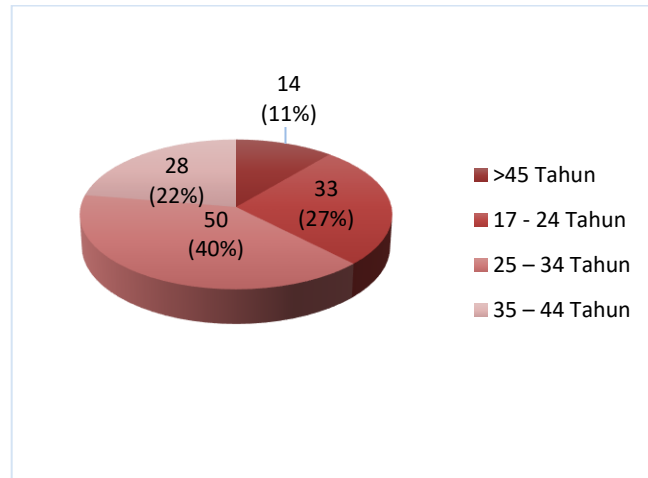


Figure 1. Distribution of Respondents by Age
(Source: Researcher's Processing)

Based on Table 1, it can be seen that the majority of respondents, namely 50 out of 125 respondents (40%) are aged 25-34 years. Meanwhile, 33 respondents (26.4%) were aged 17-24 years. A total of 28 respondents (22.4%) were aged 35-44 years and 14 respondents (11.2%) were aged >45 years. The distribution of respondent characteristics based on age can also be presented in Figure 1 which shows the largest portion, namely 40%, is in the age category of 25-34 years.

Table 2. Distribution of Respondents by Gender

Gender	Number of Respondents	Percentage (%)
Man	98	78,4
Woman	27	21,6
Total	125	100

(Source: Researcher's Processing)

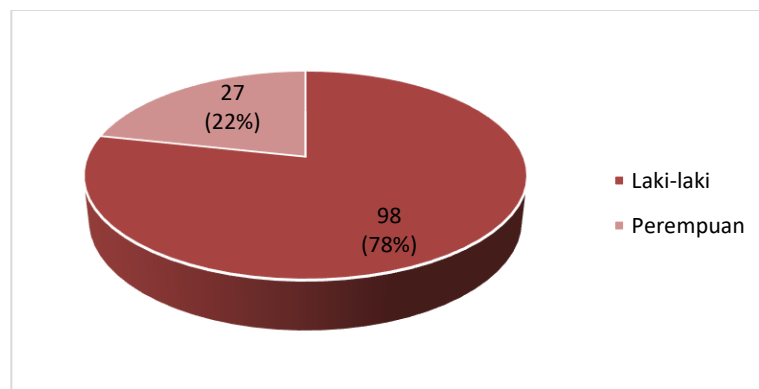


Figure 2. Distribution of Respondents by Gender
(Source: Researcher's Processing)

Based on Table 2, it can be seen that the majority of respondents were male, namely 98 out of 125 respondents (78.4%). Meanwhile, female respondents accounted for 27 out of 125 respondents (21.6%). As an illustration of the

distribution of respondents by gender, a diagram is presented as shown in Figure 2 which shows that men have the largest portion in the diagram.

Table 3. Distribution of Respondents by Education

Education	Number of Respondents	Percentage (%)
High School/Vocational School	13	10,4
Diploma	31	24,8
Strata 1	69	55,2
Loss 2	12	9,6
Total	125	100

(Source: Researcher's Processing)

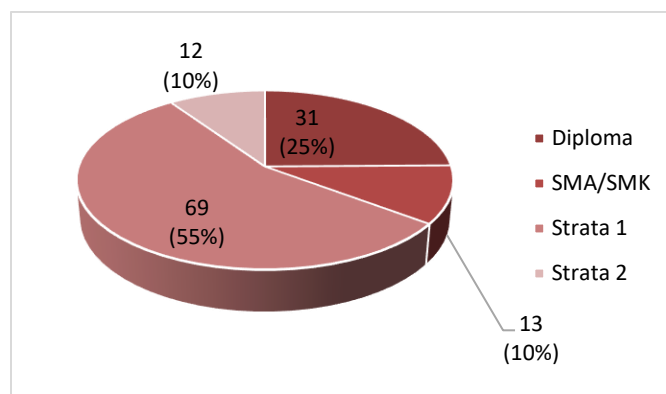


Figure 3. Distribution of Respondents by Last Education

(Source: Researcher's Processing)

Based on Table 3, it can be seen that the majority of respondents with the last education of Strata 1 were 69 out of 125 respondents (55.2%). Meanwhile, respondents with a diploma last education amounted to 31 out of 125 respondents (24.8%). Respondents with the last education of high school/vocational school were 13 out of 125 respondents (10.4%) and respondents with Strata 2 education were 12 out of 125 respondents (9.6%). As an illustration of the distribution of respondents based on the last education, a diagram is presented as shown in Figure 3 which shows that Strata 1 is the most dominant.

Table 4. Distribution of Respondents by Position/Position

Position/Title	Number of Respondents	Percentage (%)
Coordinator/Expert	14	11,2
Managerial/Team Leader	12	9,6
Implementer/Supervisor	36	28,8
Staff	63	50,4
Total	125	100

(Source: Researcher's Processing)

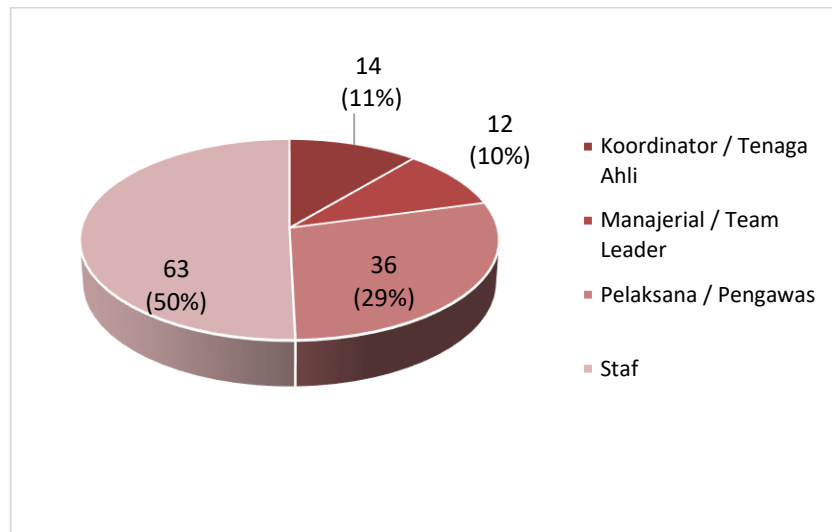


Figure 4. Frequency Distribution of Respondents by Position/Position
(Source: Researcher's Processing)

Based on Table 4, it can be seen that the majority of respondents serve as staff, namely 63 out of 125 respondents (50.4%). Meanwhile, respondents with executing/supervisory positions amounted to 36 out of 125 respondents (28.8%). Respondents served as team leaders/managers as many as 12 out of 125 respondents (9.6%) and respondents with positions as coordinators or experts as many as 14 out of 125 respondents (11.2%). As an illustration of the distribution of respondents based on position/position, a diagram is presented as shown in Figure 4 which shows that staff positions are the most dominant.

Table 5. Frequency Distribution of Respondents Based on Work Experience

Work Experience	Number of Respondents	Percentage (%)
1 – 5 Years	46	36,8
5 – 10 Years	54	43,2
10 – 15 Years	0	0
15 – 20 Years	11	8,8
>20 Years	14	11,2
Total	125	100

(Source: Researcher's Processing)

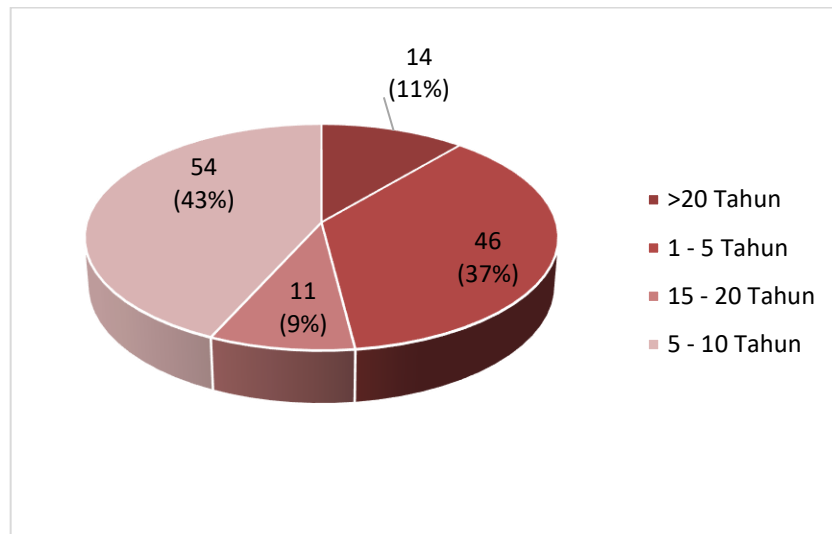


Figure 5. Frequency Distribution of Respondents Based on Work Experience
(Source: Researcher's Processing)

Based on Table 5, it can be seen that the majority, namely 54 out of 125 respondents (43.2%) have work experience for 5-10 years. As many as 46 out of 125 respondents (36.8%) had work experience for 1-5 years. Meanwhile, as many as 11 respondents (8.8%) had 15-20 years of work experience and 14 others (11.2%) had work experience >20 years. As an illustration related to the distribution of respondents, Figure 5 is presented which shows that respondents with 5-10 years of work experience are the dominant.

Table 6. Distribution of respondents by project location

Project Location	Number of Respondents	Percentage (%)
New Dam Project	32	25,6
Cabean Dam Project	32	25,6
Cijurey Dam Project	28	22,4
Jragung Dam Project	33	26,4
Total	125	100

(Source: Researcher's Processing)

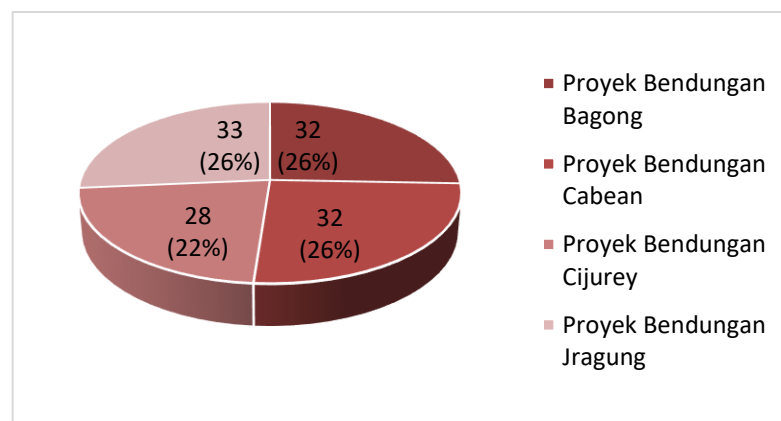


Figure 6. Distribution of Respondent Frequencies by Project Location

(Source: Researcher's Processing)

Based on Table 6, it can be seen that respondents tend to be evenly distributed throughout the project. Respondents who worked in the Bagong and Cabean dam projects were 32 out of 125 respondents (25.6%) respectively. Respondents who worked in the Cijurey dam project were 28 out of 125 respondents (22.4%). Meanwhile, respondents who worked in the Jragung Dam project were 33 out of 125 respondents (26.4%).

The Influence of Human Resources on Contractor Performance

Based on the results of the study, it was found that the level of interest of human resources (X1) did not have a significant effect on the performance of the contractor (Y), with a p value for X1 of $0.241 > \alpha (0.05)$ and T Statistics of $1.175 < 1.96$. In addition, it was also found that there was no effect on the performance assessment of human resources on contractor performance, with a p value for X1 of $0.302 > \alpha (0.05)$ and T Statistics of $1.074 < 1.96$. These two results explain that human resources on contractor performance in construction projects carried out at four research locations do not have a significant influence, both in terms of conformity and satisfaction results. In other words, human resources do not have a suitability for the contractor's performance, nor does there be an optimal level of satisfaction with the available human resources for the contractor's performance.

This result is certainly not in line with Margherita's (2022) research which explains that *human resources* or human resources have an important role, and are considered as literature that plays an important role in the success of a company, namely the projects carried out by the company. Research by Panjaitan et al. (2023) also revealed that human resources are the key to the success of human resources in carrying out their mission. However, in the results of this study, the optimal performance of the mission in the dam construction project is not determined by human resources. Because the results of the study found that there was no significant influence on human resources and construction performance.

Material Influence on Contractor Performance

Based on the results of the study, it was found that the level of importance of material resources to the contractor's performance did not have a significant influence. This is evidenced by the p-value for X2 of $0.371 > \alpha (0.05)$ and T Statistics of $0.895 < 1.96$, which explains that H2 is rejected, or there is no significant influence on material resources on the contractor's performance. In addition, performance related to the availability of material influence also had no effect on the contractor's performance, namely with a p-value for X2 of $0.306 > \alpha (0.05)$ and T Statistics of $1.024 < 1.96$ so that H8 was rejected and it can be concluded that material performance (X2) did not have a significant effect on the contractor's performance.

The Influence of Equipment on Contractor Performance

Based on the results of the study, it was found that the level of importance of equipment/tool resources to the performance of contractors has a significant influence. This result is proven by the p-value for X3 of $0.003 < 0.05$ and T Statistics of $2.975 > 1.96$ so that H3 is accepted. In addition, in the results of satisfaction with the performance, it was found that the p-value for X3 was $0.043 < 0.05$ and T Statistics 125 was $2.028 > 1.96$ so that H9 was accepted and it can be concluded that the tool performance assessment (X3) has a significant effect on the performance assessment related to contractor performance.

The results of this study are in line with research conducted by Phunde et al. (2024) which revealed that equipment resources are considered as the main material that plays a role as the capacity of construction equipment to provide value through performance, reliability, and new features to increase client satisfaction. And this explanation has been proven, because previously there has been a study on the role of equipment resources in construction performance projects in construction performance. The influence of equipment resources on construction performance is also in line with Embun's (2024) research that the implementation of construction projects requires the integration of various resources to achieve the expected final product. The selection of the right construction safety equipment has a significant impact on accident prevention and increased labor productivity.

The Influence of Implementation Methods on Contractor Performance

Based on the results of the study, it was found that the level of importance of implementation method resources on the performance of the implementation method has a significant influence. It is evidenced by the p-value for X4 of $0.006 < 0.05$ and T Statistics of $2.734 > 1.96$ so that H4 is accepted. There is also an influence on performance satisfaction related to this variable, namely with a p-value for X4 of $0.000 < 0.05$ and T Statistics of $5.510 > 1.96$ so that H10 is accepted and it can be concluded that the performance of the implementation method (X4) has a significant effect on the assessment of performance related to contractor performance.

These results show that the implementation method is one of the efforts that can optimize the running of construction projects. In line with Onibala's (2018) research which explains the implementation method as a procedure or way taken to achieve a certain goal, in accordance with the previously determined plan. With the implementation method, the work can be more directed and structured in its implementation in the field. The urgency of the implementation method is to minimize the existence of emergencies or work accidents, which can harm workers and companies. These results support the research of Moch, Kamin (2023) that the determination of the implementation method will have a significant impact on the cost, time, quality, and K3. Because basically the purpose of a construction project is to hold a building, therefore it needs an implementation method in the implementation of the project, as a concept of responsibility for the implementation of the project construction carried out, namely preparing all the needs needed in accordance with the applicable procedures or SOPs (Latief, 2020).

The Influence of Information Technology on Contractor Performance

Based on the results of the study, it was found that the level of importance in information technology resources on the performance of implementation methods has a significant influence. Namely with a p-value for X5 of $0.011 < \alpha (0.05)$ and T Statistics of $2.552 > 1.96$ so that H5 is accepted. As well as the results of satisfaction related to information technology resources on contractor performance, it was found that the p-value for X5 was $0.463 > \alpha (0.05)$ and T Statistics was $0.734 < 1.96$ so that H11 was rejected and it can be concluded that information technology performance (X5) does not have a significant effect on performance assessment related to contractor performance.

Based on the level of suitability, the available technology resources have been able to provide suitability to the contractor's performance. This shows that the available information technology can help the implementation of projects carried out by construction project workers. In line with the research of Jasim & Raewf (2020) which explains the existence of information technology is designed to help improve the work performance of managers, employees in daily activities and decision-making in the context of the industry. Available information technology is considered a set of digital tools used to manage the effectiveness of construction projects (Latiffi et al., 2013).

However, on the other hand, the results related to the level of satisfaction with information technology resources on contractor performance do not have a significant influence. This means that some construction workers, namely contractors, do not feel that the technological resources provided can affect their performance. This may be used as an input for companies to review the availability of information technology resources to increase satisfaction with contractor performance.

Environmental Influence on Contractor Performance

Based on the results of the study, it was found that the level of importance of environmental resources to the performance of the implementation method has a significant influence. Namely with a p-value for X6 of $0.007 < \alpha (0.05)$ and T Statistics of $2.722 > 1.96$ so that H6 is accepted and it can be concluded that the perception of the level of environmental importance (X6) has a significant effect on the perception of interests related to contractor performance. And the level of satisfaction with the results has an effect on environmental resources on the performance of the contractor, with the p-value for X6 being $0.001 < \alpha (0.05)$ and T Statistics being $3.445 > 1.96$ so that H12 is accepted.

These results explain that environmental resources have a significant influence on the performance of contractors. This means that the procedures of the available environmental resources have been in accordance with those required by the contractor's performance. Contractor workers need a good work climate, which has the potential to provide work motivation, which then affects the performance of the work carried out. These results are in line with the research of Tripathi & Kalia, (2024) which describes the work environment as a positive climate built to support optimal work outcomes. The reliability of the work environment is the

result of collaboration to optimize the construction work process (Xue et al., 2010). In addition, it was found that results related to the level of satisfaction concluded that the performance of the available environmental resources can also provide satisfaction to the performance of the contractor. Because the results found that the value of environmental resource satisfaction on contractor performance has a significant influence. This means that, Most contractor workers feel that the environmental resources currently available have been able to maximize their performance in the field. The results of this study are in line with the research of Radjawane & Darmawan (2022) which explains the relationship between the work environment and job satisfaction in construction workers.

CONCLUSION

Based on the results of the analysis, it was found that the project resource factor that most influenced contractor performance was equipment (tools), with a T Statistics value of $2.975 > 1.96$, followed by the implementation method at $2.913 > 1.96$, the environment at $2.860 > 1.96$, and information technology at $2.376 > 1.96$. Meanwhile, the other two factors, namely materials and human resources, did not show a significant influence, with T Statistics values of 0.870 and 1.111, respectively, which were below the threshold of 1.96. Furthermore, based on the analysis of the level of suitability (importance), the implementation method (X4) is the factor that contributes the most to contractor performance, as evidenced by the T Statistics value of $5.153 > 1.96$. This indicates that the H4 hypothesis is accepted, with the equation construction $X4 = 0.741X4.3 + 0.833X4.5 + 0.807X4.6 + 0.828X4.7 + 0.771X4.9$. In addition, the results of the Importance Performance Analysis (IPA) show that the highest level of satisfaction in multi-project resource management is in the dimension of the implementation method, especially in aspects such as giving direct direction to workers regarding the emergency response system and direct monitoring by the supervisory team of project implementation in the field. These findings confirm that the effectiveness of the implementation method is a key factor in ensuring the success of contractors in multi-location dam projects.

REFERENCES

- Al-hajj, A., & Zraunig, M. M. (2018). The Impact of Project Management Implementation on the Successful Completion of Projects in Construction. *International Journal of Innovation, Management and Technology*, 9(1). <https://doi.org/10.18178/ijimt.2018.9.1.781>
- Ayu, E. S., Khaidir, I., & Rita, E. (2024). s IKLU s. *CYCLICAL S: Journal of Civil Engineering*, 10(1), 80–90.
- Camngca, V. P., Amoah, C., & Ayesu-koranteng, E. (2022). Underutilisation of information communication and technology in the public sector construction project ' s implementation. *Information Communication and Technology*, 22(1), 1–20. <https://doi.org/10.1108/JFM-10-2021-0128>
- Farizi, F. Al. (2024). Literature Review Study: Infrastructure Management. *Student Scientific Creativity Journal (SSCJ)*, 4(4), 211–221.
- Halim, E. C., Andi, & Rahardjo, J. (2021). Application Of Interpretive Structural Modeling

- On Factors Causing Delays In Construction Projects In Surabaya. *Essential Dimensions of Civil Engineering*, 8(1), 60–77. <https://doi.org/10.9744/duts.8.1.60-77>
- Husin, S., & Fachrurrazi, F. (2019). *Aceh International Journal of Science and Technology The Significance Risk for Factors of Labour , Material , and Equipment on Construction Project Quality*. 8(2), 106–113. <https://doi.org/10.13170/aijst.8.2.13281>
- Jasim, Y. A., & Raewf, M. B. (2020). Impact of the Information Technology on the Accounting System. *Cihan University-Erbil Journal of Humanities and Social Sciences*, VI(1), 50–57. <https://doi.org/10.24086/cuejhss.v4n1y2020.pp>
- Latief, A. P. and Y. (2020). Implementation of Design and Build Contract in Government Building Construction Project Practice Implementation of Design and Build Contract in Government Building Construction Project Practice. *Materials Science and Engineering*, 897. <https://doi.org/10.1088/1757-899X/897/1/012016>
- Luo, H., Wang, M., Wong, P. K., & Cheng, J. C. P. (2020). Automation in Construction Full body pose estimation of construction equipment using computer vision and deep learning techniques. *Automation in Construction*, 110(November 2019), 103016. <https://doi.org/10.1016/j.autcon.2019.103016>
- Madina, K. (2023). Analysis Of The Enterprise ' S Provision Journal of Education , Ethics and Value. *Journal of Education, Ethics and Value*, 2(7), 30–32.
- Mahmoud, A. S., Ahmad, M. H., Yatim, Y. M., & Dodo, Y. A. (2020). Key performance indicators (KPIS) to promote building developers safety performance in the construction industry. *Journal of Industrial Engineering and Management*, 13(2), 371–401. <https://doi.org/10.3926/jiem.3099>
- Mardikaningsih, R., Retnowati, E., & Radjawane, L. E. (2022). The Impact of Stress, Work Environment and Working Time on Construction Worker Productivity. *Journal of Engineering Sciences Research (JUPRIT)*, 1(4), 38–52.
- Margherita, A. (2022). Human resources analytics: A systematization of research topics and directions for future research. *Human Resource Management Review*, 32(2), 100795. <https://doi.org/10.1016/j.hrmr.2020.100795>
- Meilani, T., & Muttaqin, R. (2024). The Effect of Career Development, Work Discipline, and Physical Work Environment on Employee Performance at PT Murni Konstruksi Indonesia Palu. *National Journal of Marketing Management & Human Resources*, 5(1).
- Moch. Khamim, M. Z. (2023). Analysis Of Strategies And Implementation Methods For Time And Cost Efficiency In Multi-Story Building Construction Projects. *Journal of Engineering, Social and Health*, 2(10), 1073–1085.
- Nasution, K. H., Islam, U., Sumatra, N., Permata, M., Islam, U., Sumatra, N., Hasibuan, A., Islam, U., & Sumatra, N. (2024). Health and Safety Analysis in the Work Environment of the North Sumatra Development Project (Case Study of PT Indomaret) Keyla Harista Nasution Maulidya Permata Abdurrozaq Hasibuan. *Journal of Public Health Sciences*, 2(2).
- Nugraha, A. S., & Putranto, L. S. (2019). The effect of heavy equipment management on the performance of the construction project and the construction company. *IOP Conference Series: Materials Science and Engineering*, 650(1). <https://doi.org/10.1088/1757-899X/650/1/012019>
- Onibala, E. C., Inkiriwang, R. L., & Sibi, M. (2018). Santa Familia Vocational School Construction Project In Tomohon City. *Journal of Static Civility*, 6(11), 927–940.
- Pamungkas, T. O., Rifai, M., & Soeryodarundino, K. (2024). The application of Lean Construction uses Root Cause Analysis and the Borde Method in identifying Waste Non-Value Added Activity (Case Study: Jragung Dam Construction Project Package I PT Waskita Karya). *Sustainable Civil Building Management and Engineering*

- Journal*, 1(2), 1–14.
- Panjaitan, A. R. P., Sjarifudin, D., Nuraeni, Soehaditama, J. P., & Zen, A. (2023). Analysis Function Human Resource Management: Recruitment, Training, Career Development, Industrial Relation. *East Asian Journal of Multidisciplinary Research*, 2(3), 1261–1272. <https://doi.org/10.55927/eajmr.v2i3.3601>
- Phunde, P. S., Sanap, P. S., Mahapatra, P. S., & Lagad, T. (2024). Investigation Of Value Creation In The Projects Of Construction Equipment Manufacturing Industry. *Library Progress International*, 44(3), 8105–8119.
- Putri, K., Rohmah, I., Sugandi, R. M., & Alfianto, I. (2023). Sumber Daya Proyek Konstruksi Patimban Port Development Project yang Mempengaruhi Kinerja Kontraktor The Patimban Port Development Project Construction Project Resources that Affect Contractor Performance. *Journal of Theoretical and Applied Civil Engineering*, 11(2), 165–178.
- Radjawane, L. E., & Darmawan, D. (2022). *Construction Project Worker Satisfaction Reviewing From The Role Of The Work Environment And Leadership*. 2(1997), 36–40.
- Rony, Z. T., Wijaya, I. M. S., Nababan, D., Julyanthry, J., Silalahi, M., Ganiem, L. M., Judijanto, L., Herman, H., & Saputra, N. (2024). Analyzing the Impact of Human Resources Competence and Work Motivation on Employee Performance: A Statistical Perspective. *Journal of Statistics Applications and Probability*, 13(2), 787–793. <https://doi.org/10.18576/jsap/130216>
- Schützenhofer, S., Kovacic, I., & Rechberger, H. (2022). Assessment of Sustainable Use of Material Resources in the Architecture, Engineering and Construction Industry - a Conceptual Framework Proposal for Austria. *Journal of Sustainable Development of Energy, Water and Environment Systems*, 10(4), 1–21. <https://doi.org/10.13044/j.sdewes.d10.0417>
- Tripathi, A., & Kalia, P. (2024). Examining the effects of supportive work environment and organisational learning culture on organisational performance in information technology companies : The mediating role of learning agility and organisational innovation. *Innovation*, 26(2), 257–277. <https://doi.org/10.1080/14479338.2022.2116640>
- Xue, X., Shen, Q., & Ren, Z. (2010). Critical Review of Collaborative Working in Construction Projects : Business Environment and Human Behaviors. *Journal Of Management In Engineering*, October, 196–208.