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ANALYZE THE EFFECT OF WASTE MATERIAL AND MATERIAL MANAGEMENT WITH LEAN CONSTRUCTION TO IMPROVE PROJECT COST PERFORMANCE

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Abstract

The purpose of this study is to measure how significant the influence of material management owned by the project team has an impact on the implementation of project financial performance. Research on stakeholder interaction analysis is designed based on its objectives, including explanatory research. The results showed that the application of the Lean Construction approach in material management can have a significant impact on improving project cost performance. Reducing material waste through the identification and elimination of waste provides the potential for significant cost savings. In addition, the use of effective material management strategies, such as reliable supplier selection, good inventory control, and proper coordination between project teams, also contributes to cost efficiency. In conclusion, material management has a significant influence on project financial performance directly with the lean construction process.

Keywords*: Cost; Lean Construction; Material Management; Waste Material.*

INTRODUCTION

Sleman Regency has 574.82 km2. The geographical location of Sleman Regency stretches from 110°13"00" to °33"00" with Longitude 110 East, 34"51" and up to 00747"03" South Latitude, the population of Sleman Regency in 2020 according to BPS data is 1,232,598, and the population growth rate of Sleman Regency is 1.02% in 2020.

This causes the growth rate in the area to be quite high, and of course, it must be followed by the provision of residential housing. So as not to make the formation of slum areas. The development of a city brings various kinds of impacts to the pattern of life of the community itself, one of which is the impact of the high flow of urbanization (Ramlah, Tahir, & Ma'ruf, 2021).

Due to the need for housing for the people of Sleman Regency and due to the lack of land available to be affordable for low-income people (Rachmawati, Budiarti, Febrita, & Sulistyani, 2017). So one solution for local governments is to build flats, either public flats or special flats. From data in the Special Region of Yogyakarta, there are 25 flats including special flats managed not by the local government spread across 3 regencies and Yogyakarta City, and the most flats are in Sleman Regency, totaling 7 units with growth from 2012.

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Until 2015 as many as 6 units and in other regions such as Yogyakarta City only 3 units and in Bantul Regency 4 units, therefore the most growth in the Special Region of Yogyakarta in terms of flats is in Sleman Regency. Through the construction of flats, it is expected to be able to encourage urban development which is also a solution to improve the quality of settlements.

The Ministry of Public Works and Public Housing (PUPR) continues to increase residential development for the community through the flats program (Rusun). For the Yogyakarta region, for example, in 2020 823 units of flats were built and this year it was continued again for 9,799 units.

With so many implementations of apartment construction projects, it will cause waste that can have an impact on ongoing projects. Waste is an activity that does not provide added value to both customers and owners. One of the efforts to minimize the impact of time waste is to minimize waste and increase value such as the principle of Lean Construction (Susanti & Suripto, 2021). Material management efforts in construction projects can avoid material waste and accumulation of waste or material residue in the project area that can affect the performance of a project (Liu, Yi, & Wang, 2020).

In the implementation stage, the use of materials is a very important resource element in realizing the planning objectives of a construction project (Sobotka & Czaja, 2015). However, it is different when viewed in reality in the field where the use of materials is often allocated not optimally and efficiently. This will have an impact on the amount of material waste that is wasted, causing deviations from the plan's material budget with its actual condition. Such conditions are often referred to as residual material (Devi, 2021).

In construction projects like today, projects are required to be able to complete work on time, cost-efficient, and good quality work. To face these challenges, methods are needed to increase effectiveness and competitiveness in the construction market industry, from the back of the service described above there are several problems as follows: (1) Lack of coordination in the material management process that is weak to supervision. (1) Low worker productivity causes work results to be less optimal and has an impact on increasing costs and longer time as well as inappropriate quality. (3) Lean construction work is needed so that the project's financial performance does not exceed what has been targeted. (4) There is an understanding of the character of the project that is not optimal.

Based on the description above behind this research or the problems identified, the formulation of this research problem is to find answers to the relationship between stakeholder interaction patterns on project implementation as follows: (a) Does the material management owned by the project team have an impact on the implementation of project financial performance? (b) Does the amount of project waste material have an impact on the implementation of the project's financial performance? (c) Do the project characteristics of the project team have an impact on the implementation of the project's financial performance?

The objectives of writing this research are: (1) Measuring how significant the influence of material management owned by the project team has an impact on the implementation of project financial performance. (2) Measure how significant the effect of the amount of project material waste has an impact on the implementation of project financial performance. The benefits of this research (a) Provide information to create an ideal material management pattern by maximizing each role based on their technical capabilities, within the limits of their respective duties and authorities, so that synergies can be well maintained which is expected to improve lean construction contribution to the overall success of the project. (b) Able to place the method as one of the influential methods, by providing appropriate treatment and roles and can synergize well for the success of the project.

RESEARCH METHODS

Research on stakeholder interaction analysis is designed based on its objectives, including explanatory research. Explanatory research according to Sudaryono (2017) is research that aims to describe generalizations or explain the relationship between one variable and another.

When viewed from the characteristics of the problem discussed, this study is included in the type of comparative causal research (causal-comparative research), which is research that shows the direction of the relationship between independent variables and related variables, in addition to measuring the strength of the relationship (Sudaryono, 2017).

Based on the method and measurement and analysis of the data, this research is classified as survey research (survey research), because it uses questionnaires as its main source, and also as quantitative research (quantitative research), which is research that aims to describe social phenomena or symptoms quantitatively or analyze how social phenomena or symptoms that occur in society are related to each other (Sudaryono, 2017).

The object is the whole object of research. The population of this research is the construction of flats in Sleman. Sleman Regency has an area of 574.82 km2. The geographical location of Sleman Regency stretches from 110 13 "00" to 33 "00" with longitude 110 East, 34 "51", and up to 007 47 "03" South Latitude. The population of Sleman Regency in 2020 according to BPS data is 1,232,598, and the population growth rate of Sleman Regency is 1.02% in 2020.

A variable is an attribute or trait or value of people, objects, or activities that have certain variations that are determined by researchers to be studied and then draw conclusions (Sugiyono, 2017). The characteristics of the research variables according to Sudaryono (2017) are to have a variety of values, distinguish one object from another object in a population, and can be measured.

The data taken and collected for this study are primary data and secondary data. Primary data by Sugiyono (2017) is a data source that directly provides data to the data collector, while secondary data is a data source that does not directly provide data to the

data collector, for example through another person or a document. Based on the data collection technique, namely through questionnaires (questionnaires).

Primary data was obtained by filling out questionnaires distributed to stakeholders as research subjects. Secondary data are obtained through similar research journals and research that supports the substance of this study, both research journals on stakeholder analysis and research journals on social competence and interpersonal skills.

Population by Sugiarti (2018) is a generalization area consisting of objects or subjects that have certain qualities and characteristics determined by researchers to be studied and then draw conclusions. While according to Sugiyono (2015), The sample is part of the number and characteristics possessed by that population. The population determined as subjects in this study include infrastructure project stakeholders who have a direct relationship and can have a direct impact on the project implementation process, which is focused on: (1) Main Contractors. (2) Planning Consultant/Supervisor. (3) Project Owner.

Sampling will be carried out with proportionally stratified techniques according to the population distribution of each stakeholder recorded using the Slovin formula to determine the number of research samples needed, with a confidence level of 95% or a margin of error of 5%.

$$\mathbf{n = \frac{N}{1 + (N \times e^2)}}$$

n = Number of Samples
e = *Margin of Error* = 5 %
N = Population = 99 Stakeholders Interest

From these data and formulas, the number of samples is obtained as follows:

$$n = \frac{99}{1 + (99 \times (0.05)^2)}$$

n = 79.36
n = 80 Sample

The number of samples based on the Slovin formula above, can be tabulated in the table, as the distribution of the stakeholder population, and the number of samples taken to be used as objects in this study.

Data collection techniques, according to Sugiyono (2019) can be divided into four kinds of ways, namely by interviews, questionnaires, observations, and a combination of the three. This study, following the data collection techniques in the theory above, will be carried out with a questionnaire technique (questionnaire) that will be distributed and filled in by respondents from samples taken from the population determined in the discussion of this study (Nolte et al., 2019). Such as the definition of questionnaires (questionnaires) submitted by Sudaryono (2017), that questionnaires or questionnaires are a technique or method of collecting data indirectly (researchers do not directly ask questions to respondents).

Descriptive statistics are statistics used to analyze data by describing or describing the data that has been collected as it is without the intention of making generalized conclusions or generalizations (Sudaryono, 2017).

According to Dary (2017), Descriptive statistics are statistics that provide an overview or description of data seen from the average, standard deviation, maximum and minimum. In this study, this analysis will describe the analysis of the results of the description of respondents as filled in the questionnaire, which can be categorized statistically based on the background of respondents, such as (a) Age of respondents. (b) Gender. (c) Work experience and length of service. (d) Recent education.

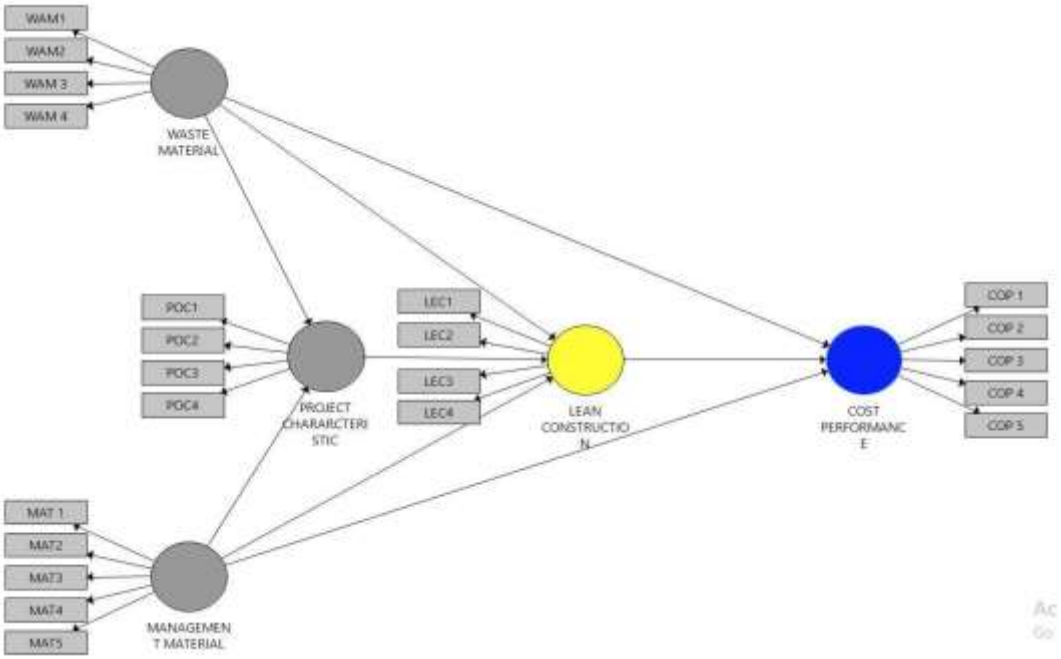
RESULTS AND DISCUSSION

This research was conducted by submitting questionnaires to respondents directly or through email addresses and electronic communication media. The total number of questionnaires distributed in this study amounted to 80 copies, of which 80 questionnaires have been filled in and re-received. Of the 80 questionnaires received, only 74 questionnaires could be processed, while the remaining 6 questionnaires could not be processed because the filling data was invalid and/or filled in by incompetent subjects in this study. The profile of respondents who participated in this study can be described in the table as follows:

Variable	Category	Frequency
Gender	Female	11
	Male	69
Work Position	Under staff	40
	Staff	25
	Supervisor	10
	Manager	5
Work experience	0–5	54
	6–10	12
	11–15	5
	16–20	5
	>20	3

Source: Data processing results (2023)

From the table above, an overview of the distribution and categorization of respondents in each work position studied can be obtained. The level of education and tenure of respondents who are almost entirely educated above high school and also the general period of service is above 5 years, greatly illustrates the capacity and qualifications of respondents sufficient to be able to represent the entity of the object of this study. The model of such interaction is determined as follows:



Picture 1 Model Lean Construction, WAM, POC, and MAT against COP
Source: Data processing results (2022)

A. Evaluation of the outer model

From the equation model above, 3 sample modeling models will be used, namely all test samples, and test samples. This evaluation will be used to measure loading factors, validity, and reliability.

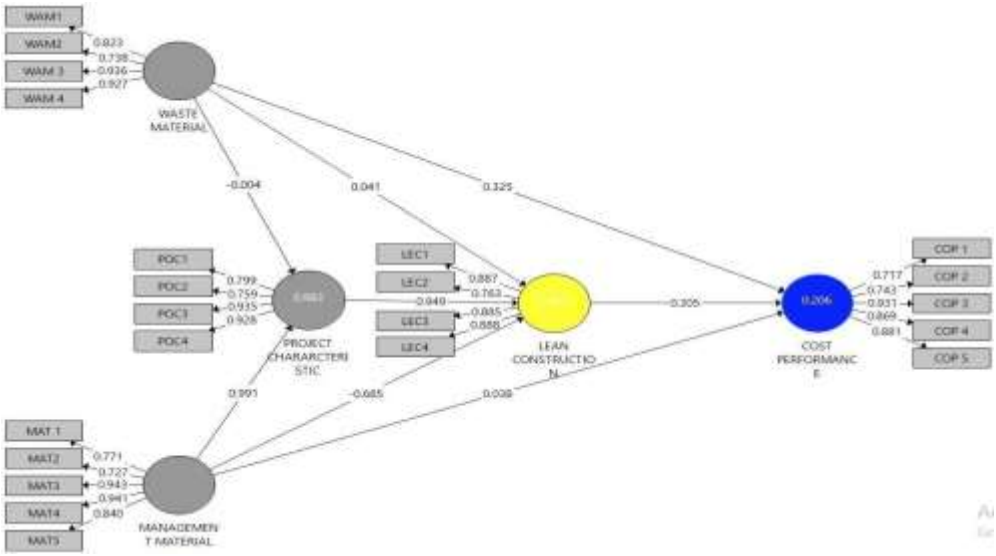


Figure 2 Outrr model of Lean Construction, WAM, POC, and MAT to COP
Source: Data processing results (2022)

B. Loading factor

The loading factor is used to see how much the indicator contributes to explaining its construct variables.

Table 1 Loading *Factor Values*

VAR	F. Loading	F. Loading	F. Loading	F. Loading	F. Loading
COP 1	0.717				
COP 2	0.743				
COP 3	0.931				
COP 4	0.869				
COP 5	0.881				
LEC1		0.887			
LEC2		0.763			
LEC3		0.885			
LEC4		0.888			
MAT 1			0.771		
MAT2			0.727		
MAT3			0.943		
MAT4			0.941		
MAT5			0.840		
POC1				0.799	
POC2				0.759	
POC3				0.935	
POC4				0.928	
WAM 3					0.936
WAM 4					0.927
WAM1					0.823
WAM2					0.738

Source: Data processing results (2022)

C. Convergent validity

In addition to using loading factor criteria, model validity testing also looks at the results of convergent validity values using AVE values obtained from SmartPls outputs as in Table 2 below.

Table 2 Average Variance Extracted (AVE) Value

	Average Variance Extracted (AVE)
Cost Performance	0.693
Lean Construction	0.735
Management Material	0.721
Project Characteristic	0.738
Waste Material	0.739

Source: Data processing results (2022)

The results above show that all research variables in the sample area model are above 0.5, so it can be concluded that the convergent validity of all variables is good.

D. Discriminant validity

Meanwhile, to see whether the measurement indicator does not have unidimensional properties, a discriminant validity measuring instrument is used by looking at the cross-loading value and the Fornell-Locker criterion. The estimation results in the model, show that all indicators in the three test sample areas have cross-loading values in their respective constructs that are higher than cross-loading values in

other constructs, so all indicators can be concluded to have good discriminant validity values.

Table 3 Fornell-Locker Criteria Values

	COP	LESS	MAT	POC	WAM
Cost Performance	0.832				
Lean Construction	0.319	0.857			
Management Material	0.083	0.252	0.849		
Project Characteristic	0.089	0.266	0.991	0.859	
Waste Material	0.325	0.012	-0.098	-0.101	0.860

*) the value in the diagonal direction in bold is the AVE root value

Source: Data processing results (2022)

The table above shows that all constructs have met good discriminant validity because each construct has an AVE root value higher than its highest correlation value.

E. Inner Model Evaluation

The results of the analysis of this measurement model with PLS are shown in the figure below, which can explain the results of the R square value and its t-statistic.

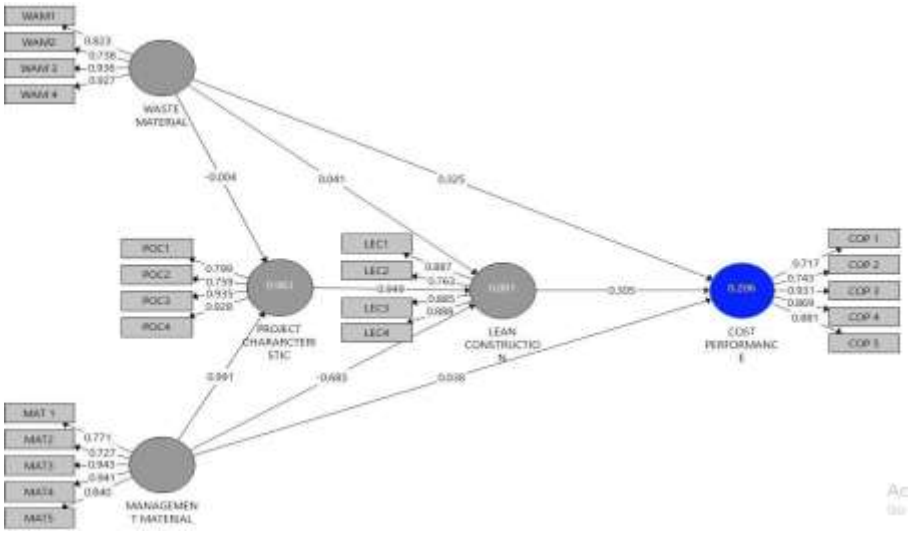


Figure 3 Standardized Model of Measurement for the entire test sample

Source: Data processing results (2022)

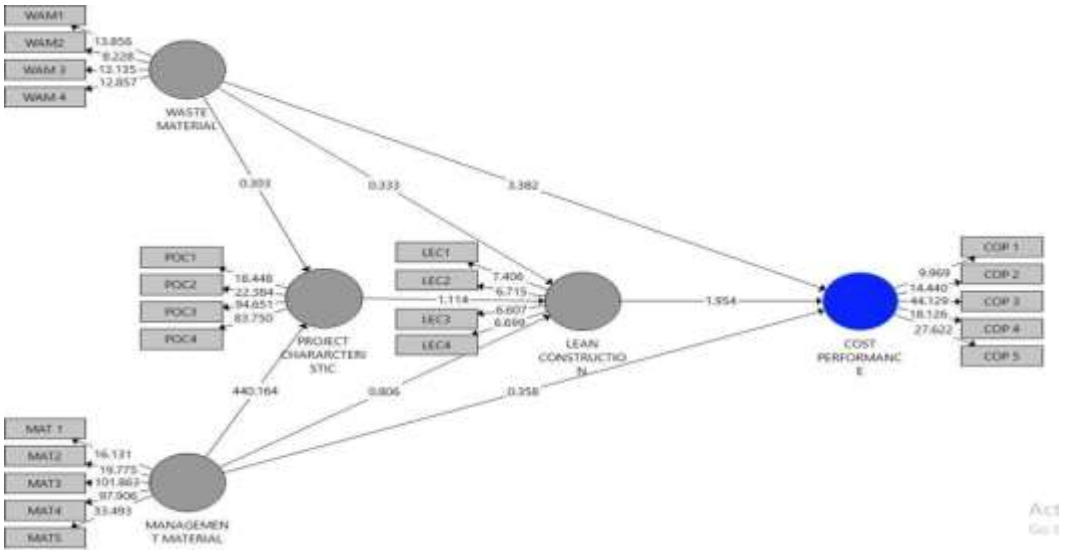


Figure 4 Model t-value Measurement for the entire test sample
Source: Data processing results (2022)

From the picture of the measurement model results above, the equation obtained from measurement model 1 is as follows: COP = 0.444 LEC + 0.534 WAM + 0.029 MAT, R2 = 0.706 LEC = 0.127 WAM + 0.667 MAT+0.788 POC, R2 = 0.801 POC = 0.427 WAM + 0.687 MATR2 = 0.963

Based on this equation, it can be concluded that lean construction, material residue, and material management have an influence of 70.6% on Cost Performance. While the remaining 29.4% was influenced by other factors that were not included in this study. The remaining material has the greatest influence according to this equation with a coefficient of 0.534 in a positive and unidirectional direction, meaning that the spatial and management of material waste and the use of materials will directly affect the increase in the success of the project's financial performance of 0.534 every increase of 1 unit. Meanwhile, material management has a positive contribution of 0.029 and lean construction can influence the success of financial performance by 0.444.

From the other equations it can be concluded, it can be concluded that lean construction has an influence of 80.1%, from the management of remaining materials, the character of the project, and materials management have an influence. While the remaining 19.9% is influenced by other factors not included in this study. Materials management has the greatest influence according to this equation with a coefficient of 0.667 in a positive and unidirectional direction, meaning that the implementation of material management methods and the use of materials will directly affect the increase in the success of the lean construction project by 0.667 for every increase of 1 unit. Meanwhile, project characteristics have a positive contribution of 0.788 and lean construction can have an impact on the success of financial performance of 0.127.

In the material management equation and the remaining material gives an effect of 96.3%. The greatest influence is provided by material management which contributes an influence of 0.667 in a positive direction. So that the project characteristics are more

influenced by material management than the rest of the material which only has a positive influence of 0.127.

F. The effect of lean construction on material management, material residue, and project characteristics on the implementation of project financial performance in all sample data

Based on the results of hypothesis testing on the interaction model for all sample data, it can be seen that the H1 hypothesis which states a significant relationship between lean construction and the success of project financial performance can be proven.

Similarly, the H2 hypothesis states that there is a significant influence between material management on the success of project financial performance. Indeed, no one has specifically placed material management as a research variable in a lean contribution pattern to the success of project financial performance. However, this research approach can be used as a useful reference in placing material management skills as one of the measuring variables of the lean construction model.

Similarly, the H2 hypothesis states that there is a significant influence between material management on the success of project financial performance. Indeed, no one has specifically placed material management as a research variable in a lean contribution pattern to the success of project financial performance. However, the research approach can be used as a useful reference in placing material management skills as one of the measuring variables of the lean construction model In partial hypothesis each variable is known for hypothesis 3 material management influences lean construction, material management influences project characteristics, project characteristics influence lean construction, material residual management provides Effect on project cost performance and material residual management Effect on lean contractual.

In general, this measurement model, assessing the influence of lean construction still has quite a strong role in management patterns in infrastructure projects while project character does not have a direct effect on the implementation of project financial performance. This shows that the pattern of management and management of strong material residues that are rooted in community life in both regions still dominates the lean construction system to improve the value of project financial performance (Caldera, Desha, & Dawes, 2017). This indicates that lean construction still has an impact on the implementation of project financial performance.

G. Research Implications

From the analysis and discussion above, information was obtained about the results of partial, mediated, and simultaneous hypothesis tests, which briefly, can be explained in the summary of the analysis of the results as follows:

In the lean construction process, material management and material residual management still contribute to significant results of lean construction itself, which

shows that lean construction partially provides a significant influence on the financial performance of the project. Similarly, the project is characteristic of the success of the performance of the project.

While the character of the project shows different symptoms in material management variables, where the character of the project according to the sample is considered not to have a significant influence on lean construction. However, if the characteristics of the project are known with lean construction, it is not partially able to explain the significant relationship to the success of the project's financial performance (Messah, Wirahadikusumah, & Abduh, 2017).

If you look at the mediation test, in line with the partial hypothesis, where lean construction both as a predictor and mediator can explain its significant relationship to the success of project performance and success as its criterion. This is different from the results in project characteristics where predictors and mediators can be explained well in the relationship of significance to the success of project financial performance as its criterion.

The explanation above proves that in terms of project management, good material management status and waste material management are much stronger in carrying out lean construction activities on projects, in general, to make project financial performance good. Although the influence of project character is still strong enough to affect lean construction, material management, and waste material management are still very significant.

However, when viewed simultaneously, all research variables together, influence the success of the Project's financial performance well. This proves that all variables of lean construction have a significant role in the success of the project's financial performance. So that the composition of management can be applied to determine lean construction patterns to obtain better results.

By looking at the results above, this study obtained an illustration, that in carrying out lean construction, in addition to material management factors, it turns out that the management of residual materials also influences the success of project financial performance. So it is generally understood that, although the influence of a strong project character affects the success of the project, the material management side has grown considerably, and lean construction is acceptable and coexists with project conditions.

From this explanation, the implications of this research are expected to be the basis for determining methods to find the right way to do lean construction to handle the project. Construction actors can also use the results of this research in determining HR development programs to have suitable and appropriate skills and competencies following what is needed by project conditions.

In addition to being used for the determination of appropriate human resources, this research can also be used to determine the pattern of project completion that occurs both by carrying out lean construction and between material management and waste material management appropriately according to the conditions of the project pattern.

So that in dealing with project problems, the best solution can be produced that does not have an impact on project implementation fatally.

CONCLUSION

The results of this study provide an overview of the process of construction financial performance in multi-story building projects measured based on material management variables, waste material management, and lean construction of project financial performance. From all samples processed in this study, the following conclusions can be compiled: (1) Material management has a significant influence on project financial performance directly with the lean construction process. (2) Management of residual materials has a significant influence on financial performance. (3) Lean construction residue consistently has a significant influence on the financial performance of the project both on direct influence. (4) Material management and waste material management together consistently have a significant influence on project financial performance and lean construction both on direct influence.

BIBLIOGRAPHY

Caldera, H. T. S., Desha, Cheryl, & Dawes, L. (2017). Exploring The Role Of Lean Thinking In Sustainable Business Practice: A Systematic Literature Review. *Journal Of Cleaner Production*, *167*, 1546–1565.

Dary, Astri Wulan, & Ilyas, Fitrawati. (2017). Pengaruh Gender, Penghargaan Finansial Dan Pertimbangan Pasar Kerja Terhadap Minat Mahasiswa Akuntansi Untuk Berkarir Menjadi Akuntan Publik Dan Non Akuntan Publik. *Jurnal Akuntansi*, *7*(1), 51–60.

Devi, Kharisma. (2021). *Analisis Dan Evaluasi Sisa Material Konstruksi Pada Proyek Pembangunan Gedung Kuliah 4 Lantai Universitas Muhammadiyah Riau*. Universitas Islam Riau.

Liu, Jingkuang, Yi, Yanqing, & Wang, Xuetong. (2020). Exploring Factors Influencing Construction Waste Reduction: A Structural Equation Modeling Approach. *Journal Of Cleaner Production*, *276*, 123185.

Messah, Yunita, Wirahadikusumah, Reini, & Abduh, Muhamad. (2017). Konsep Dan Penerapan Pengadaan Berkelanjutan Untuk Proyek Konstruksi–Studi Literatur. *Prosiding Konferensi Nasional Inovasi Lingkungan Terbangun*.

Nolte, S., Liegl, G., Petersen, M. A., Aaronson, N. K., Costantini, A., Fayers, P. M., Grønvold, Mogens, Holzner, B., Johnson, C. D., & Kemmler, G. (2019). General Population Normative Data For The Eortc Qlq-C30 Health-Related Quality Of Life Questionnaire Based On 15,386 Persons Across 13 European Countries, Canada And The Unites States. *European Journal Of Cancer*, *107*, 153–163.

Rachmawati, Rini, Budiarti, Charina Vertinia, Febrita, Diana, & Sulistyani, Estin. (2017). Inclusive Development Through Providing Vertical Housing For Low

Income Family In Yogyakarta Urban Areas. *Forum Geografi*, *31*(2), 246–257.

Ramlah, Ramlah, Tahir, Muh, & Ma'ruf, Adnan. (2021). Evaluasi Dampak Program Rumah Susun Lette Kecamatan Mariso Kota Makassar. *Kajian Ilmiah Mahasiswa Administrasi Publik (Kimap)*, *2*(4), 1131–1246.

Sobotka, Anna, & Czaja, Joanna. (2015). Analysis Of The Factors Stimulating And Conditioning Application Of Reverse Logistics In Construction. *Procedia Engineering*, *122*, 11–18.

Sudaryono, D. (2017). Metodologi Penelitian: Penelitian Kualitatif. *Depok: Pt. Rajagrafindo Persada, Depok*.

Sugiarti, Endang. (2018). Pengaruh Kedisiplinan Terhadap Kinerja Pegawai Pada Badan Meteorologi Klimatologi Dan Geofisika Wilayah Ii Ciputat. *Kreatif: Jurnal Ilmiah Prodi Manajemen Universitas Pamulang*, *6*(3), 49–58.

Sugiyono. (2017). *Metode Penelitian Kualitatif : Untuk Penelitian Yang Bersifat : Eksploratif, Enterpretif, Interaktif, Dan Konstruktif*. Bandung: Alfabeta.

Sugiyono, Metode. (2015). Penelitian & Pengembangan (Research And Development/R&D). *Bandung: Penerbit Alfabeta*.

Sugiyono, P. D. (2019). Metode Penelitian Kuantitatif, Kualitatif, Dan R&D (Sutopo. *Bandung: Cv. Alfabeta*.

Susanti, Ajeng Renita, & Suripto, S. (2021). Evaluasi Waste Dan Implementasi Lean Construction Proyek Gedung Kampus X. *Jurnal Rivet*, *1*(02), 65–72.