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Analysis of Potential Influence of Design, Procurement and Implementation Management Models on Cost Ineeficiency due to Building Construction Waste Materials Based on SEM Analysist

James Thoengsal
Department Civil Engineering, Universitas Teknologi Sulawesi, Indonesia
Architect_james@yahoo.com

Abstract

The emergence of residual materials during the building construction process cannot be avoided by the construction operator, especially the impact that directly or indirectly results in wasting construction material costs. However, this can be minimized by applying an ideal waste material management concept from the planning, procurement to implementation stages. The purpose of this study is to analyze the level of potential impact of the application of the concept of waste management of building construction materials in an effort to reduce the impact of inefficiency in project material costs, where in this study is viewed from the point of view of the parties involved in the project carried out by the State Owned Contractor (SOE). The method used in this research is done by distributing questionnaires to the building construction organizers which are being handled by the SOE contractors, where the respondents consist of experienced and responsible parties in project activities. So the conclusion from the results of this study shows that the concept of the model provides an impact test value that is quite ideal and has the potential to be applied by construction operators, both contractors, planning consultants and material suppliers in an effort to reduce the impact of cost inefficiency due to the emergence of residual building construction materials in Indonesia in the future.

Keywords
management; waste; materials; buildings; cost; SEM

I. Introduction

Development is a change towards improvement (Shah et al, 2020). The phenomenon of increasing construction development in Indonesia, especially in big cities, is increasing from year to year, of course, it requires a lot of resources in the form of money, labor, equipment, methods and what is not important is material resources. Seeing the reality of the problems in building projects in the field, namely the management of waste material management that is not optimal by each stakeholder which in the end often results in residual material if traced throughout the life cycle of a building and its impact on environmental, cost and social aspects. Indonesia is a developing country in recent years, especially in Makassar City which is located in the eastern part of Indonesia, so that in carrying out economic, trade, business and government activities, it is necessary to provide supporting facilities and infrastructure such as building construction. The current construction of the building leads to the development of vertical and horizontal wide spans, this is due to the need for human activities that continue to increase so that it requires a lot of building facilities. The increase in the construction of buildings in Indonesia, especially in big cities such as Makassar, is increasing from year to year. The reality so far is that

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most of the implementation of construction material waste management at the planning stage to implementation is still low and not optimal, especially for private contractors compared to state Owned contractors (SOE). Previous studies have generally focused more on the identification phase of construction material waste, but there are still very few research references in Indonesia that examine the potential for implementing building material waste management in reducing the impact of cost inefficiency during construction. The existence of data sources from previous studies that show the impact of cost inefficiency due to the emergence of residual materials during the building construction process due to the lack of application of waste management. The proportion of material costs is around 40-60% of the total project cost. Where the proportion of overuncost contributions due to the emergence of residual materials during the construction of buildings ranges from 3 to 13.5. The purpose of this study is to test the concept of the model in providing predictive value of the relationship between the effects of management application in an effort to reduce the impact of cost deficiency due to the emergence of residual materials during the building construction process.

Management of waste material management is the responsibility of each construction operator, starting from planners, implementers, suppliers, supervisors and building owners. Poor management certainly has an effect on the generation of material waste. The occurrence of construction material waste can be caused by one or a combination of several sources and causes. Distinguish sources of construction material waste into six categories: (1) design-planning; (2) procurement of materials; (3) material handling; (4) implementation; (5) residuals; (6) others. The results of the research in the Netherlands, concluded the sources and causes of construction material waste based on the categories of causes of waste material that have been made, construction waste management encompasses the collection, transportation, storage, treatment, recovery and disposal of waste and is defined as a comprehensive, integrated, and rational systems approach to achieving and maintaining environmental quality and supporting sustainable development. The European Environment Information and Observation Network (EIONET) defines waste management as 'a strategic document designed to achieve the objectives of waste management and waste prevention and recovery' in addition to health and environmental impacts. Some significant effects on stakeholders and the project life cycle in generating construction material waste according to the European Commission Join Research Center Institute of Environment and Sustainability. Impact of Residual Construction Materials The impact of the resulting waste material has an effect on several aspects. From several literature studies, 3 (three) categories of waste material impacts have been identified, including environmental, social and cost aspects. Several references to factors that cause a negative impact on the cost aspect of the results of construction material waste. Positive Potential Implementation of Construction Material Waste Management The implementation of construction material waste management has become a standard that must be applied by every stakeholder in an effort to reduce the impact. The potential application of construction material waste management will have a significant positive impact if it is carried out simultaneously and sustainably, especially in the type of building project. The positive potential in implementation will certainly have an effect on environmental, social and cost aspects. Several references to factors that have the potential to be positive in reducing the impact on the cost spec. Construction Material Waste Management Lifecycle Management The design and planning phases of planning provide the best opportunity to prevent the generation of construction material waste (British Standard Institute, 1998), as shown in the opportunity curve to minimize the impact of construction waste generation. Opportunities still exist during the procurement, construction, operational and end-use stages but the greatest impacts are generally made during the early planning stages. The level of potential reduction of construction material waste has been investigated by Innes, who suggested that 33% of all material waste on construction sites is due to failure to implement measures.

II. Research Method

The type of research conducted in the form of survey research with an inferential-development method by conducting a study by making a model that can predict the effect of waste material management management on its potential in reducing the impact of deficiency in building construction project costs. Respondents in this study were State Owned Contractor (SOE) contractors as main contractors, planning consultants/supervisors, sub-contractors, several material suppliers involved in the building construction process and several academics/associations who are experts in the field of construction waste.

The research was carried out for 4 (Three) months after this research was approved to be carried out) and then the research location was planned to be carried out on several ongoing building projects and buildings that have been completed and those that are in progress which in this case is carried out by the contractor. State Owned Contractor (SOE) and research case studies were conducted in Makassar city.

The types and sources of data used in this study consisted of primary data and secondary data with the following explanation: a. Primary data In this study, it was obtained in the field through questionnaires, observations, documentation and interviews with parties who understand the topic under study, including planning consultants, implementing contractors, several material suppliers and academics/associations, as well as observation data obtained from periodic independent observations. at all project sites that have been determined during the research survey. b. Secondary data In this study, it was obtained through the results of library research in the form of journals, reference books, journals, internet sites and other supporting documents that were accurate and relevant to the study material.

The type of data used in this study consisted of primary data and secondary data, with data collection techniques, namely: a. Primary data collection Primary data collection techniques in this study include: 1. Observation, namely by direct observation in the field, to observe how the process of managing waste material is actually in the field at the construction stage. 2. Distributing questionnaires using a list of questions filled in by respondents, with answers provided in the form of a rating scale, both the State Owned Contractor (SOE) (Main Contractor), consultants, implementing sub-contractors, several material suppliers involved in the project process of building construction in Makassar City and several academics/associations who are experts in the field of construction waste. 3. In-depth and direct interviews with respondents at the research location. b. secondary data set Secondary data collection techniques in this study are in the form of library data, namely data collection in the form of literature studies in the form of journals, text books, as well as supporting data/documents and other documents related to the problem being studied.

The type of population in this study is purposive / saturated population or in other words the population is limited consisting of SOE contractors as main contractors, sub contractors, planning consultants and supervisors, several material suppliers involved in the project and several academics/associations who are experts in the field of construction waste. The research sample is architects and engineers from the planning consultant, implementing supervision, both project managers, quantity surveyors and quality surveyors at contracting companies who understand the problem being researched at the project study location that has been determined and several academics/associations who are experts in the field of construction waste. The sample selection was carried out by purposive sampling technique, namely the selection of samples that were tailored to the needs.

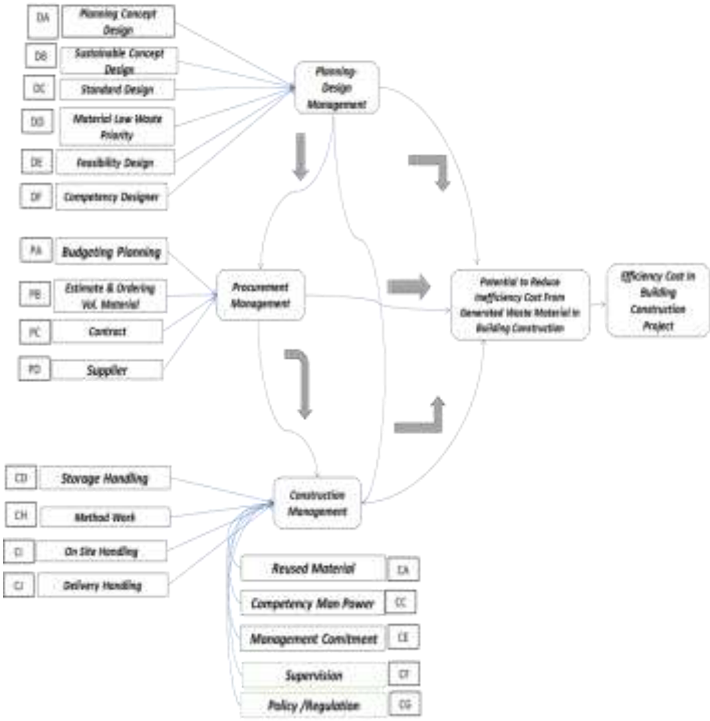

Figure 1. *Concept of planning, procurement and implementation management model in an effort to reduce cost inefficiency due to waste materials in building construction*

The concept of the research model in Figure 1 consists of measuring variables consisting of 20 categorical variables and 113 sub-categories of measuring variables. Where the main variables consist of the Planning Phase consisting of: Design Process, Modern Design Concepts, Design Standards, Material Selection, Design Feasibility, Consultant Competence, Procurement Phase consists of: Budget, Purchase of Materials and Contracts and Construction Phase consists of: Application of reused materials, Fabrication Materials, Worker Competence, Management, Supervision, Policy, Storage, Methods, Field Handling and Shipping Handling. Meanwhile, the cost impact variable consists of construction financial costs and construction material waste management implementation costs.

The data analysis technique used is the Structural Equation Modeling (SEM) Type Smart-PLS-22 software. In this stage, further modeling tests are carried out with the aim of finding out how much of a significant positive potential effect on the potential impact of reducing the cost deficiency impact of the remaining materials that arise during the building construction process based on the sub-category variables from each category of variables that have been determined as a measuring tool in the field to respondents.

III. Results and Discussion

Based on the results of the validation test and feasibility test of the effectiveness of the application of sub-variables from the previous number of 133 sub-variables reduced to 113 sub-variables which are considered ideal and effective in the concept of this research model. Which consists of 29 sub-variables in the planning stage (Planning-Design Phase) which consists of Categories of Design Concept Planning, Sustainable Design Concepts, Design Standards & Regulations, Selection of Low Waste Materials, Pre-Design and Planner Competencies. Then the research variables consist of 17 sub-variables at the procurement stage, including the categories of Budget Planning, Estimation and Ordering of Material Volume, Supplier Selection and Contract Planning. At the implementation stage (Construction Phase) consists of 71 sub variables and 10 categories of variables, among others: Material Reuse, Application of Prefabricated Materials, Human Resources Competence, Material Storage Handling, Management Commitment, Rules/Policies, Work Methods, Field Handling (On Site Handling), Monitoring/Supervision and Material Delivery Handling (Delivery Handling).

The analysis at this stage is to find out and test the measuring indicators of indicator/manifest variables on Latent variables/Constructs in the Outer Model, including Outer Loading Factor, Composite Reability, Convergent Validity and Discriminant Validity. Then proceed with the analysis of the Inner Model with measuring parameter indicators, including: R^2 value, F^2 influence value, Q^2 Predictive Relevance, Goodness of Fit (GOF) model reliability, Hypothesis Significant Test (T-Sign). From the results of the analysis of the model test with SEM PLS, the value of the outer loading factor on the sub-variables shows that there are several sub-variables that do not meet the criteria where the value is <0.5 so that there are several sub-variables that are dropped out of the model system because they are considered not to meet the standard requirements. in the model relationship. Where the sub variables that are dropped out are in the planning category: D1, D2, D5, D5, D7, D15, D23, D26, D19 Procurement categories: P8, P10 and P13 and Construction, namely: C1, C3, C4, C5, C6 , C12, C13, C14, C15, C16, C17, C22, C21, C28, C54, C58, C43, C45, C46, C47, C67, C69, C68, C63 and C62. So that there are 37 sub-variables removed from the model system so that the total sub-variable which initially amounted to 113 becomes 76 sub-variables and the Material Fabrication variable category at the Construction stage does not show a significant correlation value to the latent variable so that the variable category is omitted in the system model. So that the model concept is reanalyzed with the remaining sub-variables that meet the requirements for the outer loading factor value which can be seen in Figure 2 below:

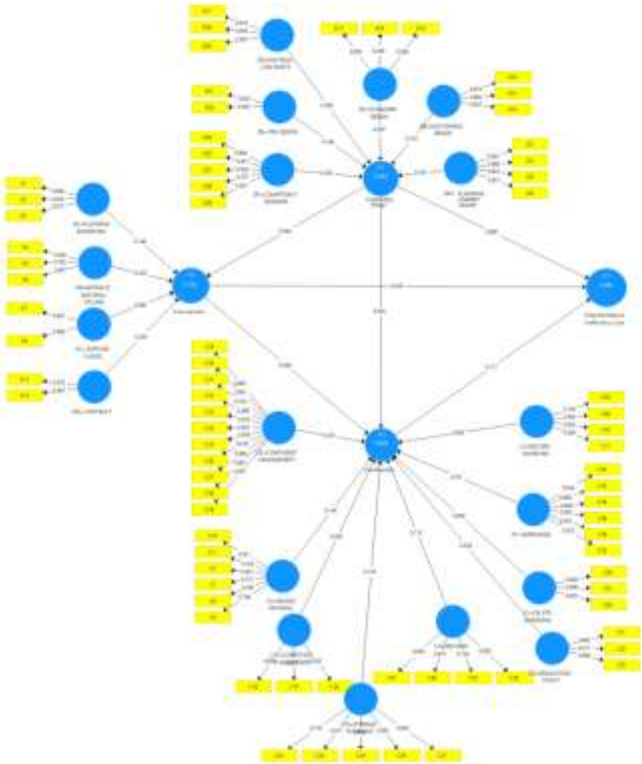

Figure 2. *The results of the analysis of the model concept test with Structural Equation Modeling SEM-PLS 22 final*

From the results of the phase II model concept analysis test after several sub-variables are removed from the model system, the ideal model concept system is obtained in predicting the relationship between the effect of the application of management concepts on the potential to reduce the impact of cost inefficiency due to the emergence of residual materials during the building construction process. From the results of the outer model analysis, the following parameter values are obtained: a. The Outer Loading Factor shows a value > 0.5 of most of the sub variables in the model system. So it can be said that the model meets the requirements of the influence of latent variables and indicators. b. Composite Reability (CR), the results of the PLS SEM analysis show that the average value of CR and Cronbach's Alpha shows a value > 0.6/0.7. So it can be said that the variables in the concept test of this model are consistent/stable. c. Convergent Validity (CV), from the analysis of Average Variance Extracted (AVE) shows the average value of the model > 0.5. So it can be concluded that the latent variable has been able to explain the relationships on the indicator variables in a block well, namely a minimum of 50% of all indicator variables. d. Discriminant Validity (DV), from the results of the Discriminant Validity test by means of Cross Loading, the indicator variables in each dominant block show a much higher DV value compared to other blocks in the model system, so the model fit is said to be good. From the results of the Inner model analysis, the following parameter values are obtained: a. Determinant coefficient of R^2, from the analysis of the model test, the R^2 value is obtained for each latent variable where the Planning-Design latent variable has a value of $R^2 = 0.844$ which can be said that the correlation effect of categorical variables at the planning stage plays an important role of 84.4%, while at the Procurement stage has a value of $R^2 = 0.722$ which can be said that the correlation effect of categorical variables at the Procurement stage gives an effect of 72.2%, while at the Construction stage has a value of R^2 = 0.806 which can be said that the correlation effect of categorical variables at the Construction stage has an effect of 80.6% and the potential effort variable to reduce the impact of cost deficiency due to the emergence of residual materials gives a value of R^2 = 0.496 which provides an explanation that the estimation results of the influence of the application of management concepts at the planning, Procurement and Construction stages provide opportunities or can explain 49.6% in efforts to reduce inefficiency i costs due to residual materials incurred in building construction if it is implemented in the first year running, while the remaining estimated values are variables that may not have been investigated in this study as well as error factors. b. Effect test f^2, from the analysis of the concept of the model, the average value of the effect test on the latent variable exogenous and endogenous f^2> 0.15 so that it can be concluded that the influence between latent variables has a sufficient influence in the concept of this model. From the research results obtained categorical variables that have a significant influence value f^2 at the Planning stage, namely the Planning Competence category variable with a value of f^2=2.433, then at the Procurement stage the categorical variable that has a significant influence value is the Material Volume Estimation category variable with a value of f^2= 2.9 and at the Construction stage the categorical variable that has a significant influence value is Management Commitment with a value of f^2 = 4.528 c. Goodess of Fit (GOF), from the analysis results obtained a GOF value of 0.77 > 0.38 so that it can be concluded that the concept of the model is quite good overall. d. Hypothesis Testing (Significant Level), from the output of the model test analysis, the average T-Sign value is > 1.96 (5% t-table). The results obtained from the model variable test with Structural Equation Modeling (SEM) are obtained categorical variables that have a significant influence value of f^2 on the planning stage management model, namely the Planning Competency category variable with a value of f^2=2.433, then at the Procurement stage the categorical variables have The significant influence value is the Material Volume Estimation category variable with a value of f^2 = 2.9 and at the Construction stage the category variable that has a significant influence value is Management Commitment with a value of f^2 = 4.528 and for the latent variable the value of the determinant coefficient R^2 of the management model at the planning stage is obtained. namely with a value of R^2 = 0.844, at the procurement stage with a value of R^2 = 0.722 and the construction stage with a value of R^2 = 0.806, and the value of the simultaneous determinant coefficient on the potential impact of material cost efficiency on construction projects simultaneously shows an R^2 value of 0.49 which means that provide an explanation that h the results of the estimation of the effect of the application of the management model concept at the planning stage.

IV. Conclusion

The results obtained from this study are categorical variables that have a significant influence value of f^2 at the Planning stage, namely the Planning Competence category variable with a value of f^2 = 2.433, then at the Procurement stage the categorical variable that has a significant influence value is the Material Volume Estimation category variable. with a value of f^2 = 2.9 and at the Construction stage the categorical variable that has a significant influence value is Management Commitment with a value of f^2 = 4.528 and for the latent variable the value of the determinant coefficient R^2 at the planning stage is R^2 = 0.844, at the procurement stage with a value of R^2 = 0.722 and the construction stage is with a value of R^2 = 0.806, and the value of the determinant coefficient on the potential impact of material cost efficiency on construction projects simultaneously shows an R^2

value of 0.49. So the conclusion from the results of this study shows that the concept of the model provides an impact test value that is quite ideal and has the potential to be applied by construction operators, both implementing contractors, planning consultants and material suppliers in an effort to reduce the impact of cost inefficiency due to the emergence of residual building construction materials in Indonesia in the future.

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