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Key success factors analysis for improving cost performance of green retrofit infrastructure on the jetty project

Ato Muhan Iswidyantara, Albert Eddy Husin*
Department of Civil Engineering, Faculty of Engineering, Universitas Mercu Buana, Indonesia

Abstract
Several rating definitions must be met following the envision's system. The envisioned system aims to develop the green building concept in the existing jetty building. These definitions are quality of life, leadership, resource allocation, nature, climate, and resilience. This sustainability is needed to initiate changes in the planning, design, and provision of sustainable infrastructure together with the company. This also applies to implementing long-term infrastructure investments that are more cost-effective, resource-efficient, and adaptable. The study uses a qualitative and quantitative method, where data is obtained by distributing questionnaires and simulating using Statistical Products and Solution Services (SPSS). The application of Value Engineering (VE) and Life Cycle Cost Analysis (LCCA) has been chosen by researchers on existing jetty buildings with the green jetty concept, with investment costs in economic green jetty buildings and a return on investment costs of less than four years. In achieving the ten most influential factors in improving cost performance in sustainable dock construction, the results of the SPSS simulation processing obtained the ten most influential factors, namely: Planning, Energy, Siting, Materials, Ecology, Community, Economy, Operation, and Maintenance Cost, Follow-up Inspection, and Labor Experience.

Keywords:
Cost Performance;
Envision;
Green Retrofit;
Jetty;
Life Cycle Cost Analysis;
Value Engineering;

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Corresponding Author:
Albert Eddy Husin,
Department of Civil Engineering,
Faculty of Engineering,
Universitas Mercu Buana,
Indonesia
Email:
albert_eddy@mercubuana.ac.id

INTRODUCTION

Research on Green Infrastructure and Buildings in Indonesia is still scarce. Consideration of environmental sustainability is simply not in the mainstream policy yet. Research on the green jetty building will contribute to the body of science in Environmental Engineering and open a new perspective of development that can help sustain the green environment.

Green Infrastructure is a spatial planning concept that applies environmentally friendly infrastructure. In this study, the environmentally friendly buildings that will be discussed are jetties which in Indonesia has not implemented a green jetty. The purpose of a green jetty is to create an infrastructure that does not interfere with the natural cycle of the environment, starting from the planning, development, and operation to the maintenance stages, paying attention to aspects of protecting, saving, reducing the use of natural resources. Green Infrastructure includes natural systems and engineered solutions.

The Sustainable Development Goals (SDGs), also known as the global goal, were adopted by all United Nations members in 2015 as the universal voice to end poverty, protect the planet and ensure everybody enjoys peace and prosperity in 2030. The world leader and governments agree on the agenda of SDGs, which consist of 17 goals and 169 targets, as shown in Figure 1 [1].

Figure 1. Sustainable Development Goals [1]

In the Sustainable Development Goals, No. 11 on Sustainable Cities and Communities. The rapid urbanization experienced by many cities in the world has led to rapid economic growth. The government is responsible for encouraging public transportation in urban areas to improve traffic safety and reduce emissions. In addition, provide input to the government to provide safe green open spaces such as parks, squares, and gardens for residents. In the rapid pace of global urbanization, participatory planning becomes very important in overcoming segregation and reducing carbon emissions in urban areas. Providing innovation in sustainable solid waste management is also important in reducing the environmental impact caused by cities.

The SDGs provided a global framework for all nations to start embarking on a more environmentally friendly development by considering nature. The movement will shift infrastructure development from grey infrastructure into green infrastructure. By definition, Green Infrastructure is spatial management that applies the principles of environmentally friendly infrastructure from the design, construction, operation, and maintenance of such facilities.

This process of green infrastructure/building mainly aims to protect, save, and decrease the use of natural resources. It is a radical departure from our dominant approach to infrastructure. The Environmental Protection Agency, USA defines Green Infrastructure as a concept, effort, or approach to maintaining a sustainable environment through structuring green open space and maintaining natural processes that occur in nature, such as rainwater cycles, soil conditions, etc.

The concept of green infrastructure is to shape the environment with a natural process that is maintained; covering rainwater management, water quality management, to flood mitigation.

The focus of implementing green infrastructure is to support community development by improving environmental conditions and maintaining green open space1. On the other hand, the European Environment Agency (EAA) states that Green Infrastructure is based on protecting and enhancing nature and natural processes that are consciously integrated into spatial planning and territorial development.

The Indonesian government has published president regulation No. 59/2017 about the implementation goal achievement of sustainable development [2]. The Regulation of the Minister of Public Works and Public Housing of Republic Indonesia No. 21 of 2021 concerns in the evaluation of the performance of the green building. It defines Green Building as a building with all the technical standards. It acquires performances that can be measured on energy savings, water, and other resources through implementing green building principles according to its function and classification in every step of its construction. The regulation is mandatory for new buildings to be designed with green building standards.

Green Building Principles include the following: (1) Equation of Objectives, understanding, and action plans, (2) Reduction of Resources, (3) Reduction of Heaps of Waste, (4) Reuse of Resources, (5) Use of Cycle Resulting Resources recycling, (6) protection and management of the environment through preservation, (7) mitigation of risks to safety, health, climate change, and disaster (8) oriented to the life cycle (9) oriented to empowering the desired quality (10) technological innovation for continuous improvement (11) increasing institutional support, leadership, and management in implementation.

Green Building Technical Standards: (1) Green buildings must meet the technical standards, which consist of (a) building planning and design standards, (b) building construction implementation and supervision standards, (c) building utilization standards, and (d) building demolition standards. (2) In addition to the technical standards as referred to in paragraph (1), green buildings must meet the technical standards at each implementation stage, including (a) programming, (b) technical planning, (c) construction implementation, (d) utilization, and (e) disassembly. (3) Green buildings are organized by: (a) the central government for state-owned green buildings or regional governments for regionally owned green buildings, (b) green building owners who are legal entities or individuals, (c) users and/or green building managers who are legal entities or

individuals, and (d) service providers who are competent in the field of buildings.

The stages of implementation for new buildings include the following stages: (1) Programming, (2) Technical Planning, (3) Construction Implementation, (4) Utilization, and (5) Demolition.

Provisions for the Green Building Technical Planning Stage consist of: (1) site management, (2) energy use efficiency, (3) efficient use of air, (4) indoor air quality, (5) use of environmentally friendly materials, (6) waste management; and (7) wastewater management.

Envision

Envision is to force dramatic increase and need in sustainable performance and physical infrastructure endurance by helping owner, planner, engineer, society, contractor, and other infrastructure stakeholders. Envision applies to long-term infrastructure investment that is cost-saving, resource-saving, and adaptable. For the level of verification appreciation to achieve acknowledgement, a project must reach the minimum percentage of the valid envision total point. The project can be admitted into four levels of appreciation: bronze (more than 20%), silver (more than 30%), gold (more than 40%), and Platinum (more than 50%) [3]. The rating on envisioning is presented in Figure 2.

Many infrastructure projects in Indonesia were built without considering clean energy and green conditions. As a result, even modern and renewed port infrastructure did not have any characteristics of green buildings and green infrastructure. Green buildings and green infrastructure are new phenomena in Indonesia. Sustainable, green, and smart buildings are development issues that have emerged recently. But future development of sustainable green ports must be seriously considered to support the global green movement.

NYCDEP and NYCDDC have embraced Envision to assess and improve the sustainability of their projects as they seek to implement Mayor Bill de Blasio's vision outlined in One NYC for a stronger, more equitable, more equitable, more sustainable and resilient City [4].

Many infrastructure projects in Indonesia were built without considering clean energy and green conditions. Even modern and renewal port infrastructure did not have any characteristics of green building and green infrastructure.

Green building and green infrastructure are therefore new phenomena in Indonesia.

Figure 2. Rating On Envision [3]

Sustainable, green, and smart buildings are development issues that have emerged recently. But future development of sustainable green ports must be seriously considered to support the global green movement.

Many concepts of implementing green buildings have provided various benefits in developed countries, but implementation is still largely not beneficial in developing countries, including Indonesia [5]. The development of facilities and infrastructure in Indonesia is growing rapidly. This can be seen from the number of infrastructure developments in all fields [6].

Green infrastructure is an infrastructure that pays attention to the concept of conservation that has functions and benefits for human life. The fundamental aspect of the green infrastructure development concept is to prioritize the principles of multifunction, sustainability, and resource-saving, which consist of various natural environment features. In addition, community involvement in planning, management, and monitoring is a must. In general, two things differentiate between green infrastructure and gray infrastructure. First, Green infrastructure is related to or imitates natural ecosystems, whereas gray infrastructure is the result of engineering or human thinking that does not take inspiration or follow natural ecology. Second, Green infrastructure is multifunctional, meaning it can provide more than one type of service to the community. For example, a city park is the city's lungs and a reservoir for rainwater. Also, green buildings with all their utilities and facilities are "green" and multifunctional. In contrast to gray infrastructure, which generally only has one specific function, such as a bridge that functions as a link from one place to another. Although the two types of infrastructure differ, gray infrastructure can be part of green infrastructure.

Green Jetty is a new thing for most national or international port in Indonesia where the port is a restricted area, but almost all ocean-going port in developed countries has applied

green jetty. A port is not only busy with loading and unloading containers but also close to sports and maritime tourism. To create many functions, a port must have and preserve its environment with the sustainable green port concept.

Especially Carbon Footprint as a result of loading and unloading activity, must be reduced to minimum capacity. Also, the green environment must be maintained with the maximum effort so that the conservation function in the port area can be maintained.

Jetty is one of the infrastructures implementation of the jetty construction Civil Engineering and Architecture [7]. the wharf is surrounded by a complex marine environment [8], an essential component of a port transportation system to promote economic prosperity [9].

Green building is a holistic concept that starts with the understanding that the built environment can have profound positive and negative effects on the natural environment and the people who inhabit buildings daily. Green building is an effort to amplify the positive and mitigate the negative of these effects throughout the entire life cycle of a building [10].

Environmental Performance Index (EPI) 2022 gives a database resume about sustainable conditions worldwide. Using 32 working indicators in 11 problem categories, EPI ranks 180 countries in environmental health and ecosystem vitality. This indicator gives a national scale of how close a country in creating an environmental policy target [11]. At this moment, Indonesia is on rank 164 of 180 countries. While in the Asia Pacific region, Indonesia ranks 10 of 25 countries.

Indonesia is a maritime country consisting of islands stretching from Sabang to Merauke, with 17,508 islands [12]. Indonesia is the biggest archipelago country in the world and can potentially be a world maritime center. Its purpose is to be a big, powerful prosperous maritime country by returning its identity as a maritime country, securing policy and maritime, and exploring the maritime potential to create economic equality in Indonesia. Infrastructure can increase the economic competitiveness of Indonesia [13].

To proceed the world maritime country, there are many aspects such as infrastructure, politics, social culture, law, security, and economy. Indonesian sea territory supremacy, revitalization in sea economy sectors, empowerment and development of maritime connectivity, rehabilitation of environmental damage and biodiversity damage, the quality and quantity increase of human resources main program in creating Indonesia as a world maritime center.

Cost budgeting is a document consisting of performance estimation of revenue and expenses, structured in monetary size that will be reached in a certain amount of time and attach past data as a form of control and performance evaluation.

Cost budgeting has several benefits:

1. Activity in a project is better for achieving the goal.
2. To motivate worker
3. No dissipation in unnecessary things.
4. Can grow responsibility to worker.
5. As a reference to know advantages and disadvantages of the worker.
6. Using a more efficient resource.

One of the main problems obstructing the success of most projects is overbudgeting [14]. World business council for sustainable development found that most respondents believe green feature adds 17% to a building cost [15].

MATERIAL AND METHOD

Material

Current research on the jetty, a product or technology, is evaluated proactively against the working environment using a Life Cycle Assessment Analysis (LCAA). In this research, the jetty has technical specifications measuring 500 x 22 m, with an electricity requirement of 718 kVa. This evaluation includes all life cycles so that product performance can be analyzed or compared to others to develop a product or make a decision [16].

LCCA deterministic is a traditional methodology where the user sets each variable input such as service time, analysis period, discount level, time, and cost of maintenance activity. Stable value is usually based on historical data and user evaluation [17], where the costs that have been invested in green jetty can be returned in less than four years. Sustainability and value enhancement are major considerations in the modern construction world. Thus, the integration of sustainability and Value Engineering (VE) will potentially boost the value of a construction project [18]. VE is a management tool used to reach important functions from a product at a low cost [19]. Value Engineering (VE) is an evaluation method used to analyze the resources of a project [20].

Method

Mixed methods are used in this research, namely qualitative and quantitative. Qualitative research is research with data that describes

actual phenomena or events, while quantitative is a type of data in numeric or number systems. In qualitative research, you get a deep understanding, develop a theory and describe reality. In comparison, quantitative is more about explaining the relationship between variables, testing theory, and generalizing social phenomena that will be research material. Research quantitative and qualitative research can often only be distinguished from the data that is used [19]. Qualitative and quantitative research is the most suitable research method because the data are obtained directly from the owner, consultant, and project implementer.

RESULTS AND DISCUSSION

There are many software solutions to this issue, but one of the most famous is SPSS. The data analysis process will use a simulation tool, namely SPSS ver. 26 (Statistical Products and Solution Services) accompanied by interviews and questionnaires, which will be found the dominant things from several variables and their sub-factors that affect the cost performance that the author wants to examine. The flow of data analysis SPSS is depicted in Figure 3. Figure 4 shows a flow chart regarding the steps that will be carried out in the research.

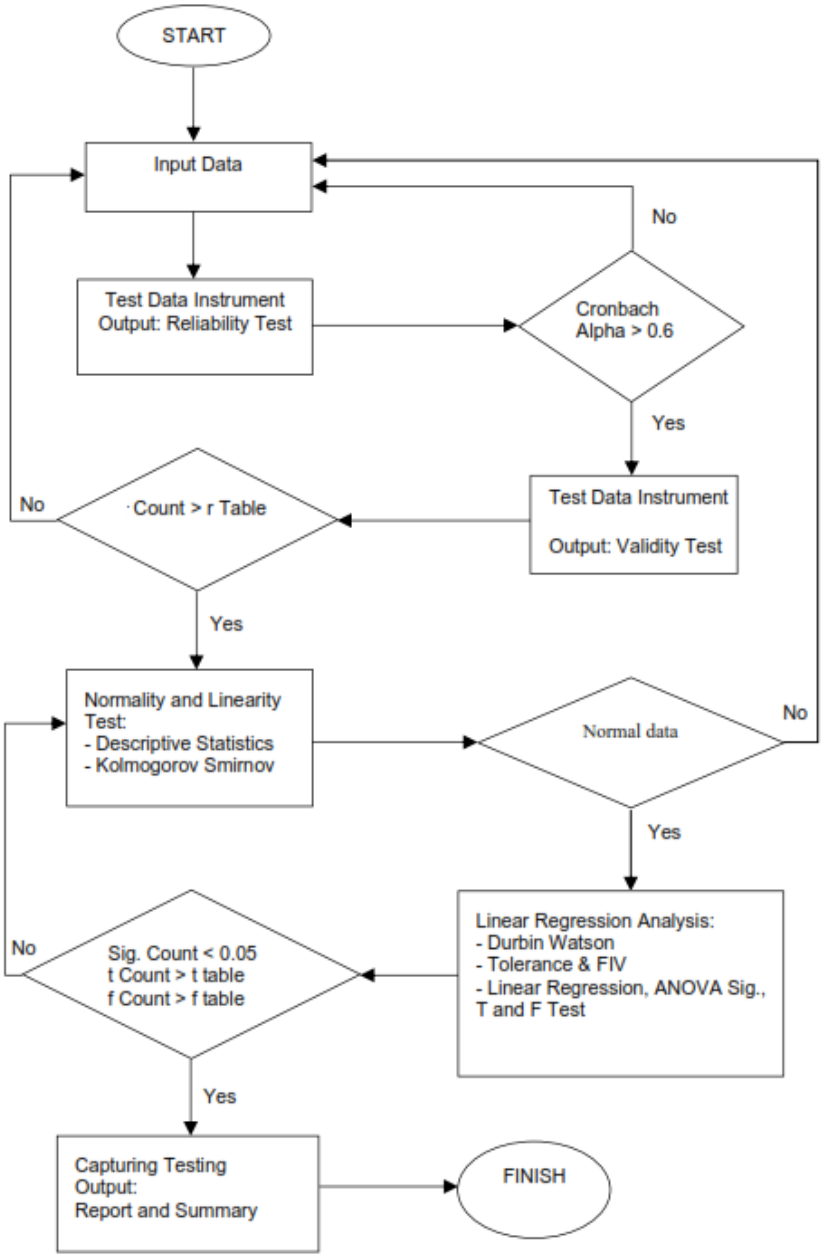

Figure 3. Research Flow [21]

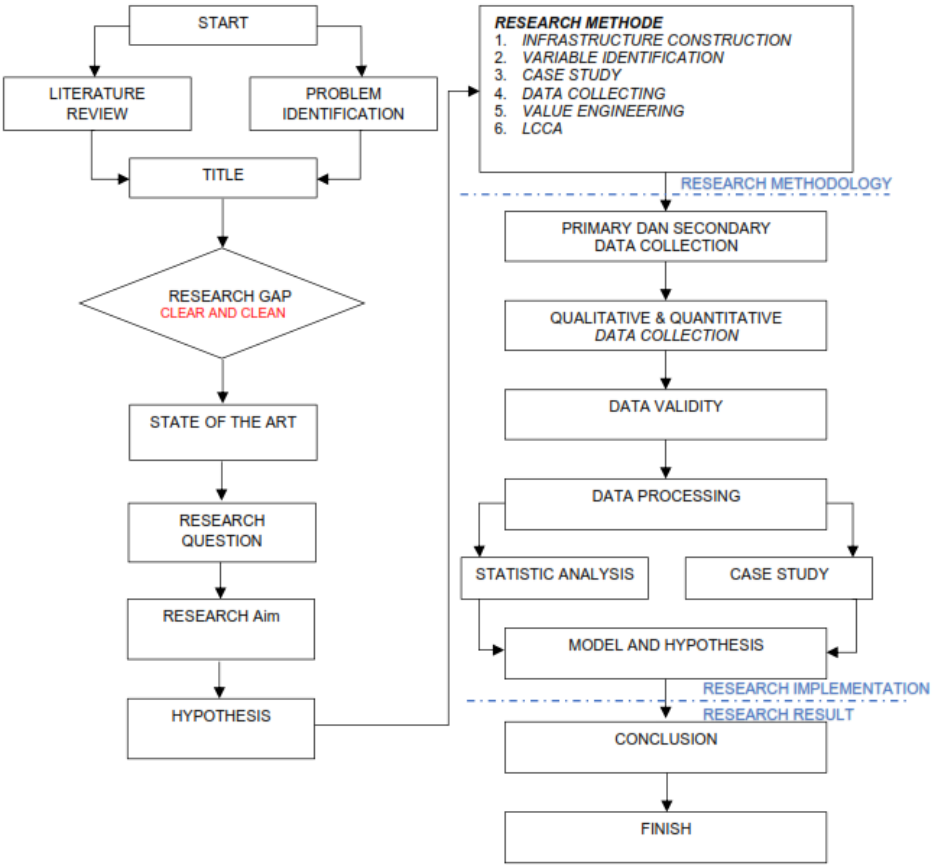

Figure 4. Research Flow

Variable

The data analysis program SPSS (Statistical Products and Solution Services) is used to measure the degree of closeness of the relationship between all independent variables / X (independent) on the dependent variable / Y (dependent) Cost Performance Improvement.

Main Factor

The Main Factor is the main sub-dimensions of the variable. The main variable is broken down into smaller sub-dimensions, and each main factor has a sub-factor component.

Sub Factor

Sub-factor is a sub-dimension of the main factor. Sub-factors are questions that will be answered and filled in by the respondent by giving a certain rating for each item. The distribution of sub-factors for each main factor is listed in Table 1.

Determining the Number of Respondents: Looking for the minimum number of respondents using (1), (2) and (3).

$$Z\left(\frac{\varepsilon}{2}\right) = \frac{1-\varepsilon}{2} = \frac{1-0.05}{2} = 0.475 \quad (1)$$

$$m = \frac{Z^2 x\ P\ x\ (1-P)}{\varepsilon} = \frac{0.9600}{0.0025} = 384.16 \quad (2)$$

$$n = \frac{m}{1 + \left(\frac{m-1}{N}\right)} = \frac{384.16}{7.49} = 51.26 \quad (3)$$

Minimum Respondents 52 person.
is known:
Z = The values are taken from the Z distribution table (1.96)
P = Degree of variation between population elements (0.5)
Ɛ = Limited population sample value (0.05)
N = Number of sub-factor variables (59)
n = Minimum number of respondents required

Table 1. Key Success Factor

No	Variable	Main Factor	Sub Factor		Reference
1	Jetty (X1)	Planning	X1.1	Picture documents	[22]
			X1.2	Work Time	[23]
			X1.3	Job Location	[24]
			X1.4	Job Specifications	[22]
		Supervision	X1.5	Job Value	[24]
			X1.6	Late Presentation	[22]
			X1.7	Materials Used	[22]
			X1.8	Labor Experience	[24]
2	Green Retrofit Infrastructure (X2)	Quality Of Life	X2.1	Wellbeing	[3]
			X2.2	Mobility	[3]
			X2.3	Community	[3]
		Leadership	X2.4	Collaboration	[3]
			X2.5	Planning	[3]
			X2.6	Economy	[3]
		Resource Allocation	X2.7	Materials	[3]
			X2.8	Energy	[3]
			X2.9	Water	[3]
		Natural World	X2.10	Siting	[3]
			X2.11	Conservation	[3]
			X2.12	Ecology	[3]
		Climate And Resilience	X2.13	Emissions	[3]
			X2.14	Resilience	[3]
3	Value Engineering (X3)	Information Stage	X3.1	General Data	[25]
			X3.2	Specification	[25]
			X3.3	Engineering And Design	[25]
			X3.4	Method And Process	[25]
			X3.5	Material	[25]
			X3.6	Maintenance	[25]
		Functional Stage	X3.7	Identification	[26]
			X3.8	Functional Requirements	[26]
		Creative Stage	X3.9	Technique	[27]
			X3.10	Destination	[27]
			X3.11	Idea	[27]
		Evaluation Stage	X3.12	Review	[25]
			X3.13	Improvement	[25]
			X3.14	Alternative	[25]
			X3.15	Technique Evaluation	[27]
		Development Stage	X3.16	Identification Of Problems	[26]
			X3.17	Alternative Selection	[26]
		Presentation Stage	X3.18	Implementation Completion	[27]
			X3.19	Resource	[27]
		Implementation Stage	X3.20	Implementation Check	[26]
			X3.21	Follow-Up Inspection	[26]
4	Life Cycle Cost Analysis (X4)	Retrofit Cost	X4.1	Initial Cost	[28]
			X4.2	Energy Cost	[28]
			X4.3	Replacement Cost	[28]
			X4.4	Operating Costs and Maintenance	[28]
		Analysis LCC	X4.5	Interest Rate	[28]
			X4.6	Analysis Period	[28]
			X4.7	Present Time / Year	[28]
			X4.8	Ignore Inflation	[28]
		LCC Modeling	X4.9	Modeling Without Rest Value	[28]
			X4.10	Modeling With Residual Value	[28]
5	Cost Performance (Y)	Internal	Y.1	Material Cost	[29][28]
			Y.2	Labor Costs	[29][28]
			Y.3	Equipment Cost	[29][28]
			Y.4	Shipping Costs	[29][28]
		External	Y.5	Price Fluctuation Material	[30]
			Y.6	Environmental Cost	[30]

Data Input: Number of questionnaires distributed among themselves and sent via email, package, or social media. According to the initial plan, the number of respondents was 65 sets, as listed in Table 1. That is more than double the minimum number of respondents. To anticipate the data received by respondents cannot reach 100% or the data cannot be used as a reference for one reason or another after the normality test by SPSS. Questionnaires were distributed to the

building owner, project manager, vice project manager, head of the engineering project, vice head of engineering project, budget supervisor dan budget planner.

Population Data: The incoming data after being collected, is checked and then grouped based on education (Table 2), position (Table 3), experience (Table 4), and projects determined (Table 5). This is important so that the objectives of the questionnaire are right on target and that the data is valid and reliable.

Data Processing and Analysis Methods: Data analysis is data processing activity after the data is collected and ready to be presented in the form or as a research report. The data is tabulated using Microsoft Excel. Arranged based on variables and sub-factors of each variable. Each data analysis has its portal, limits, or parameters as a basis for decisions or conclusions by the provisions of SPSS. What is important in data processing with SPSS is the basis for decision making.

Table 2. Number of Respondents

Type of Questionnaire	Delivered To Respondents	Received Back	Percentage Back
Hardcopy	65 sets	52 sets	80 %

Table 3. Level of Respondent Education

No	Label of Education	Sum of Respondents	Percentage (%)
1	Diploma	10	19.23
3	Undergraduate (Bachelor)	30	57.69
4	Graduate (Magister)	10	19.23
5	Doctoral Degree (Ph.D.)	2	3.85
	amount	52	100.00

Table 4. Experience of Respondents at Work

No.	Experience of Respondents	Sum of Respondents	Percentage (%)
1	<5 years	10	19.23
2	5 to 10 years	18	34.62
3	> 10 Years	24	46.15
	amount	52	100.00

Table 5. Position of Respondents in Work

No	Label of Education	Sum of Respondents	Percentage (%)
1	Owner	6	11.54
2	Project Manager	12	23.08
3	Site Manager	10	19.23
4	Project Engineer	6	11.54
5	Site Engineer	8	15.38
6	Planning consultants	5	9.62
7	Supervising consultants	5	9.62
	amount	52	100

There are certain provisions so that the data from the respondent is declared worthy of being measured for analysis, both from existing comparisons and from tables that must be licensed. The final result of this data processing is the equation that affects the independent variables on the independent variables and the ranking of the most influencing sub-factors.

The flow of SPSS data analysis is structured to facilitate the sequence of data testing until results are obtained, namely the influence of the variable X (dependent) on the Y factor (independent), either separately or in combination. Data that is entered to be said to be good and feasible in looking for the factors that influence a job successful (Key Success Factors) or getting the desire must go through several statistical tests by attaching the basis for decision making and data that meets the SPSS version 26.0. The output from the regression will include, among others, a table providing the mean, standard deviation, and the number of repeated measures for all variables in the model (Descriptive Statistics), the correlations among all variables (Correlations), and the regression coefficients with the respective 95% confidence intervals (Coefficients and Residual Statistics).

Data Reliability Test: Test data reliability to determine whether the data collection tool shows the level of accuracy, stability, or consistency. A reliability test can be done with Alpha Cronbach. A construct or variable instrument is said to be reliable if it gives a Cronbach's Alpha coefficient value greater than 0.6 (as a general standard value for the acceptance of the reliability of a research instrument) [31]. In general, the reliability of a research instrument in the range > 0.60 to 0.80 can be said to be good, if in the range > 0.80 to 1.00 it is considered very good, as listed in Table 5, Table 6, Table 7 and Table 8. It can be seen that the sub-factor X1 data entered into SPSS, the value of Cronbach's Alphas is all from the minimum requirement, namely 0.6, so the X1 data in Table 6 is Reliable.

Table 6. Value of Cronbach's Alpha X1 Jetty

Sub Factor	Scale Mean if Item Deleted	Cronbach's Alpha if Item Deleted	Reliability Standard Value	Reliability Reliable / Unreliable
X1_01	33.15	.833	.600	Reliable
X1_02	33.15	.826	.600	Reliable
X1_03	32.85	.821	.600	Reliable
X1_04	32.85	.812	.600	Reliable
X1_05	32.77	.819	.600	Reliable
X1_06	32.87	.833	.600	Reliable
X1_07	32.96	.837	.600	Reliable
X1_08	32.71	.834	.600	Reliable

Table 7. Value of Cronbach's Alpha X2 Green Retrofit

Sub Factor	Scale Mean if Item Deleted	Cronbach's Alpha if Item Deleted	Reliability Standard Value	Reliability Reliable / Unreliable
X2_01	64.69	.938	.600	Reliable
X2_02	64.71	.937	.600	Reliable
X2_03	64.52	.939	.600	Reliable
X2_04	64.60	.941	.600	Reliable
X2_05	64.23	.940	.600	Reliable
X2_06	64.56	.940	.600	Reliable
X2_07	64.46	.941	.600	Reliable
X2_08	64.23	.939	.600	Reliable
X2_09	64.60	.937	.600	Reliable
X2_10	64.42	.939	.600	Reliable
X2_11	64.69	.940	.600	Reliable
X2_12	64.50	.941	.600	Reliable
X2_13	64.63	.939	.600	Reliable
X2_14	64.65	.938	.600	Reliable

Table 8. Value of Cronbach's Alpha X3 VE

Sub Factor	Scale Mean if Item Deleted	Cronbach's Alpha if Item Deleted	Reliability Standard Value	Reliability Reliable / Unreliable
X3_01	86.27	.920	.600	Reliable
X3_02	86.40	.916	.600	Reliable
X3_03	86.56	.916	.600	Reliable
X3_04	86.58	.922	.600	Reliable
X3_05	86.63	.918	.600	Reliable
X3_06	86.08	.917	.600	Reliable
X3_07	86.25	.919	.600	Reliable
X3_08	86.19	.919	.600	Reliable
X3_09	86.37	.917	.600	Reliable
X3_10	86.44	.921	.600	Reliable
X3_11	86.33	.917	.600	Reliable
X3_12	86.60	.920	.600	Reliable
X3_13	86.23	.922	.600	Reliable
X3_14	86.44	.923	.600	Reliable
X3_15	86.35	.919	.600	Reliable
X3_16	86.15	.916	.600	Reliable
X3_17	86.65	.918	.600	Reliable
X3_18	86.63	.919	.600	Reliable
X3_19	86.38	.920	.600	Reliable
X3_20	86.54	.921	.600	Reliable
X3_21	85.77	.917	.600	Reliable

It can be seen that the sub-factor X2 data entered into SPSS, the value of Cronbach's Alphas is all from the minimum requirement, namely 0.6, so the X2 data in Table 7 is Reliable. It can be seen that the sub-factor data X3 entered into SPSS, the value of Cronbach's Alphas is all from the minimum requirement, namely 0.6, so the X3 data in Table 8 is Reliable. It can be seen that the sub-factor data X4 entered into SPSS, the value of Cronbach's Alphas is all from the minimum requirement, namely 0.6, so the X4 data in Table 9 is Reliable.

Table 9. Value of Cronbach's Alpha X4 LCCA

Sub Factor	Scale Mean if Item Deleted	Cronbach's Alpha if Item Deleted	Reliability Standard Value	Reliability Reliable / Unreliable
X4_01	40.54	.729	.600	Reliable
X4_02	40.06	.744	.600	Reliable
X4_03	40.75	.702	.600	Reliable
X4_04	39.98	.744	.600	Reliable
X4_05	40.52	.747	.600	Reliable
X4_06	40.37	.715	.600	Reliable
X4_07	40.06	.733	.600	Reliable
X4_08	40.81	.695	.600	Reliable
X4_09	40.67	.728	.600	Reliable
X4_10	40.56	.745	.600	Reliable

T-test: The T-test is a parametric statistic used to conduct comparative studies [32]. The function of the t-test is to test the mean difference between two samples (samples). There are two kinds of t-tests according to the nature of the sample being tested.

The t-test in one group uses a One-Sample T-Test, while the t-test in two groups is divided into two types: Independent Sample T-Test and Paired Sample T-Test. Independent Sample T-Test was used to test two unrelated sample groups and Paired Sample T-Test was used to test two groups.

The method of testing the hypothesis with t arithmetic in regression analysis is if T count > T table, then the hypothesis is accepted. Otherwise, if T count < T table, then the hypothesis is rejected. Or you can use Significance or probability or Alpha.

Decision making on t-test by comparing t count with t table; Variable X1 (jetty) has a positive and significant effect on Y, illustrated by sig. (X1) 0.000 less than 0.05. So the value of the coordinates of t table = t (a / 2; nk-1) = t (0.05 / 2; 52-4-1) = t (0.025; 47), it can be seen in the table that t table = 2.011741; t count = 9.243, so t value = 9.243 > 2.011741. So that the value of H0 is rejected and H1 is accepted.

The X2 (Green Retrofit) variable has a positive and significant effect on Y. This is represented by sig. (X1) 0.000 less than 0.05.

Table 10. T-Test Result

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	1.045	.263		3.977	.000
Jetty	.068	.007	.104	9.243	.000
Green Retrofit	.137	.006	.370	21.338	.000
VE	.132	.007	.428	17.838	.000
LCCA	.121	.012	.174	10.152	.000

The value of the coordinates of t table = t (a / 2; nk-1) = t (0.05 / 2; 52-4-1) = t (0.025; 47), it can be seen in the table that t table = 2.011741; t count = 21.338, so t value = 21.338 > 2.011741. So the value of H0 is rejected and H1 is accepted.

Variable X3 (VE) has a positive and significant effect on Y. This is described by sig. (X1) 0.000 less than 0.05. The value of the coordinates of t table = t (a / 2; nk-1) = t (0.05 / 2; 52-4-1) = t (0.025; 47), it can be seen in the table that t table = 2.011741; t count = 17,838, so t value = 17,838 > 2,011741. So that the value of H0 is rejected and H1 is accepted.

Variable X4 (LCCA) has a positive and significant effect on Y. This is illustrated by sig. (X1) 0.000 less than 0.05. The value of the coordinates of t table = t (a / 2; nk-1) = t (0.05 / 2; 52-4-1) = t (0.025; 47), it can be seen in the table that t table = 2.011741; t count = 10,152, so t value = 10,152 > 2,011741. So the value of H0 is rejected and H1 is accepted.

F test: to see how the effect of all the independent variables together on the dependent variable. Or to test whether the regression model that we make is good/significant or not good/non-significant. Basis of decision making by comparing f table and f count; Variables X1, X2, X3, X4 has a positive and significant effect on Y, this is illustrated by sig. (F) 0.000 < 0.05.

Table 11. T-Test Result

ANOVA					
Model	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Regression	712.497	4	l78.124	3814.289	.000b
Residual	2.195	47	.047		
Total	714.692	51			

a. Dependent Variable: Cost Perform
b. Predictors: (Constant), Jetty, Green Retrofit, Value Engineering, Lifecycle Cost

Table 12. Average Score And Ranking

Rank	No. Sort	Sub Factor	Mean	Sub Factors
1	13	X2_05	5.27	Planning
2	16	X2_08	5.27	Energy
3	18	X2_10	5.08	Siting
4	15	X2_07	5.04	Materials
5	20	X2_12	5.00	Ecology
6	11	X2_03	4.98	Community
7	14	X2_06	4.94	Economy
8	47	X4_04	4.94	Operation and Maintenance Costs
9	43	X3_21	4.92	Follow-up Inspection
10	8	X1_08	4.90	Labor Experience

Coordinate value of f table = f (k; n-k) = t(4; 52-4) = t(4; 48), See the table that f table = 2.57 ; f count = 3814,289. The calculated f value = 3814,289 > 2.57, so H0 is rejected and H1 is accepted.

Mean and Ranking: the average value (ẋ) is a technique used to describe a data variable based on the average data, as the value of dividing the number of cases by the number of data, where the highest value has the most influential factor in the development of a green jetty.

CONCLUSION

This research concludes that after processing the questionnaire using SPSS, the results of the factors that affect cost performance in implementing the green jetty applying the value engineering method and life cycle cost analysis are as follows: Planning, Energy, Sitting, Materials, Ecology, Community, Economy, Operation and Maintenance Costs, Follow-up Inspection, and Labor Experience. Therefore, the next idea that needs to be researched is implementing a green building on a jetty as cost-effectively and efficiently as possible without reducing quality.

REFERENCES

[1] G. Halkos and E. C. Gkampoura, “Where do we stand on the 17 Sustainable Development Goals? An overview on progress,” *Economic Analysis and Policy*, vol. 70, pp. 94-122, 2021, doi: 10.1016/j.eap.2021.02.001.

[2] J. D. Sachs, G. Schmidt-Traub, M. Mazzucato, D. Messner, N. Nakicenovic & J. Rockström, “ Six Transformations to achieve the Sustainable Development Goals,” *Nature Sustainability*, vol. 2, pp. 805-814, 2019, doi: 10.1038/s41893-019-0352-9

[3] I. J. Navarro and V. Yepes, and J. V. Martí, “A Review of Multicriteria Assessment Techniques Applied to Sustainable Infrastructure Design,” *Advances in Civil Engineering*, “ vol. 2019, ID: 6134803, 2019, doi: 10.1155/2019/6134803

[4] O. N. Ezirim and C. U. Okpoechi, “Community-driven Development Strategy for Sustainable Infrastructure,” *Journal of Human, Earth and Future*, vol. 1. No. 2, 2020, doi: 10.28991/HEF-2020-01-02-01

[5] A. E. Husin, T. Karolina, D. I. Rahmawati, and C. F. Abdillah, “Increasing Value of Façade at Green Hotel Building Based on Value Engineering,” *Open Civil Engineering Journal*, vol. 15, no. 1, pp. 398–405, 2022, doi: 10.2174/1874149502115010398.

[6] A. T. Nugraha, G. Prayitno, M. E. Situmorang, & A. Nasution, "The Role of Infrastructure in Economic Growth and Income Inequality in Indonesia," *Economics & Sociology*, vol. 13, no. 1, pp. 102-115, 2020, doi: 14254/2071-789X.2020/13-1/7

[7] A. Prihantoro and A. E. Husin, "Value increase of jetty project based on system dynamics," *Civil Engineering and Architecture*, vol. 9, no. 3, pp. 892–898, 2021, doi: 10.13189/CEA.2021.090331.

[8] C. Zhang, L. Yang, G. Hu, and S. Tang, "A new LNG wharf health assessment model considering structural weak areas," *Proceedings of the Institution of Mechanical Engineers, Part O: Journal of Risk and Reliability*, vol. 26, no. 3, 2021, doi: 10.1177/1748006X211027877.

[9] L. Su, H. P. Wan, Y. Dong, D. M. Frangopol, and X. Z. Ling, "Seismic fragility assessment of large-scale pile-supported wharf structures considering soil-pile interaction," *Engineering Structures*, vol. 186, no. February, pp. 270–281, 2019, doi: 10.1016/j.engstruct.2019.02.022.

[10] A. I. Imron and A. E. Husin, "Peningkatan Kinerja Biaya Berbasis Value Engineering Pada Proyek Green Hospital," *Jurnal Aplikasi Teknik Sipil*, vol. 19, no. 3, pp. 323-334, 2021, doi: 10.12962/j2579-891x.v19i3.9144.

[11] R. M. Adeel-Farooq, J. Olajide Raji & G. M. Qamri, "Does financial development influence the overall natural environment? An environmental performance index (EPI) based insight from the ASEAN countries," *Environment, Development and Sustainability*, 2022, doi: 10.1007/s10668-022-02258-x

[12] M. Fajrunnajah, "The Dock Construction Inter-Island in Indonesia," *Applied Research on Civil Engineering and Environment (ARCEE)*, vol. 2, no. 01, pp. 23–27, 2020, doi: 10.32722/arcee.v2i01.2863.

[13] A. E. Husin, D. I. Rahmawati, M. Meisaroh, and B. D. Kussumardianadewi, "Performance Improvement of Box Girder Construction on Toll Road Projects based on M-PERT and VE," *The Open Civil Engineering Journal*, vol. 15, no. 1, pp. 299–309, 2021, doi: 10.2174/1874149502115010299.

[14] A. M. Kamaruddeen, C. F. Sung, and W. Wahi, "A study on factors causing cost overrun of construction projects in Sarawak, Malaysia," *Civil Engineering and Architecture*, vol. 8, no. 3, pp. 191–199, 2020, doi: 10.13189/cea.2020.080301.

[15] C. R. Balaji, A. R.G. de Azevedo and M. Madurwar, "Sustainable perspective of ancillary construction materials in infrastructure industry: An overview, ", *Journal of Cleaner Production*, vol. 365, ID: 132864, 2022, doi: 10.1016/j.jclepro.2022.132864

[16] S. H. Budisulistiorini, "Life Cycle Assessment of Paper Towel and Electric Dryer As Hand Drying Method in the University of Melbourne," *Teknik*, vol. 28, no. 2, pp. 132–141, 2007.

[17] A. Imron and A. E. Husin, "Value engineering and lifecycle cost analysis to improve cost performance in green hospital project," *Archives of Civil Engineering*, vol. 67, no. 4, pp. 497–510, 2021, doi: 10.24425/ace.2021.138514.

[18] A. S. Gunarathne, N. Zainudeen, C. S. R. Perera, and B. A. K. S. Perera, "A framework of an integrated sustainability and value engineering concepts for construction projects," *International Journal of Construction Management*, vol. 22, no. 11, pp. 1–13, 2020, doi: 10.1080/15623599.2020.1768624.

[19] H. Elhegazy, "State-of-the-art review on benefits of applying value engineering for multi-story buildings," *Intelligent Buildings International*, vol. 14, no. 5, pp. 1–20, 2020, doi: 10.1080/17508975.2020.1806019.

[20] A. E. Husin, "Performance improvement of diaphragm wall at high rise building by value engineering utilization," *ARPN Journal of Engineering and Applied Sciences*, vol. 14, no. 18, pp. 3301–3309, 2019.

[21] A. E. Husin and E. A. Budianto, "Influential factors in the application of the Lean Six Sigma and time-cost trade-off method in the construction of the ammunition warehouse," *SINERGI*, vol. 26, no. 1, p. 81, 2022, doi: 10.22441/sinergi.2022.1.011.

[22] A. Kamal, M. Abas, D. Khan, and R. W. Azfar, "Risk factors influencing the building projects in Pakistan: from perspective of contractors, clients and consultants," *International Journal of Construction Management*, vol. 22, no. 6, pp. 1141–1157, 2022, doi: 10.1080/15623599.2019.1683693.

[23] C. Barth and S. Koch, "Critical success factors in ERP upgrade projects," *Industrial Management & Data Systems*, vol. 119, no. 3, pp. 656–675, 2019, doi: 10.1108/IMDS-01-2018-0016.

[24] J. F. Ding, J. F. Kuo, W. H. Shyu, and C. C. Chou, "Evaluating determinants of attractiveness and their cause-effect

relationships for container ports in Taiwan: users' perspectives," Maritime Policy & Management, vol. 46, no. 4, pp. 466–490, 2019, doi: 10.1080/03088839.2018.1562245.

[25] F. Usman, N. A. Jalaluddin, and S. A. Hamim, "Value Engineering in building information modelling for cost optimization of renovation works: A case study," *International Journal of Engineering & Technology*, vol. 7, no. 4, pp. 431–435, 2018, doi: 10.14419/ijet.v7i4.35.22856.

[26] X. Lin et al. "Status of value management studies in construction projects: A systematic review," *Ain Shams Engineering Journal*, vol. 14, no. 1, ID: 101820, 2023, doi: 10.1016/j.asej.2022.101820

[27] Benjamin and J. Johan, "Analysis of value engineering application at the design stage of a deep excavation system," *IOP Conference Series: Materials Science and Engineering*, vol. 852, no. 1, 2020, doi: 10.1088/1757-899X/852/1/012060.

[28] P. Samani, J. Gregory, V. Leal, A. Mendes, and N. Correia, "Lifecycle Cost Analysis of Prefabricated Composite and Masonry Buildings: Comparative Study," *Journal of Architectural Engineering*, vol. 24, no. 1, p. 05017012, 2018, doi: 10.1061/(asce)ae.1943-5568.0000288.

[29] T. C. Marrana, J. D. Silvestre, J. de Brito, and R. Gomes, "Lifecycle Cost Analysis of Flat Roofs of Buildings," *Journal of Construction Engineering and Management*, vol. 143, no. 6, p. 04017014, 2017, doi: 10.1061/(asce)co.1943-7862.0001290.

[30] E. Plebankiewicz, "Model of predicting cost overrun in construction projects," *Sustainability*, vol. 10, no. 12, p. 4387, 2018, doi: 10.3390/su10124387.

[31] X. Li, M P. Martens, and W. Wiedermann, "Conditional Direction of Dependence Modeling: Application and Implementation in SPSS," *Social Science Computer Review*, 2022, doi: 10.1177/08944393211073

[32] R. Choudhary, "Application of 'independent t-test' by using SPSS for conducting physical education researches," *International Journal of Physical Education, Sports and Health*, vol. 5, no. 1, pp. 237–241, 2018.