Formosa Journal of Science and Technology (FJST)
Vol. 4, No. 5, 2025: 1355-1370

Implementation of Sustainable Construction in the Construction Stage of Building Construction Projects in Aceh Province

Nauwir Rahmi[1], Fachrurrazi[2*], Cut Zukhrina Oktaviani[3]
Universitas Syiah Kuala
Corresponding Author: Fachrurrazi, fachrurrazi@usk.ac.id

A R T I C L E I N F O

Keywords: Sustainable Construction, Implementation, Development, Building

Received : 10, April
Revised : 24, April
Accepted: 26, May

A B S T R A C T

Since the issuance of the Minister of Public Works and Housing Regulation No. 9 of 2021, the implementation of sustainable construction has become an obligation. However, the lack of understanding and awareness among contractors and construction workers is still a hindrance, especially as it is considered to require more cost and time. This study aims to identify sustainable construction factors that have been implemented and assess their performance at the construction stage of building projects in Aceh Province. The method used was a quantitative approach with 165 respondents through the proportionate stratified random sampling technique. The analysis was carried out using descriptive statistics, and Importance Performance Analysis (IPA). The results showed that six indicators that have very low performance and need to be improved in the top priorities are in quadrant A, including energy efficiency, resource efficiency, material use efficiency, local material use, local labor utilization and supply chain management.

ISSN-E: 2964-6804
DOI: https://doi.org/10.55927/fjst.v4i5.81
https://traformosapublisher.org/index.php/fjst

INTRODUCTION

Construction projects have contributed to environmental change. There is not a single result of construction work that does not change the environment. Damming river flows, irrigating rice fields, building bridges, and arranging a city are some examples of human activities that can change the environment and natural resources. In its implementation, construction work requires a large amount of natural resources such as cement, sand, splits, mountain rocks/river stones, asphalt, and so on. It is all used for the benefit of humans. However, the construction and building process itself also contributes to energy waste and global climate change. Therefore, the parties involved in the construction process, especially architects and civil engineers, have a responsibility to reduce the impact of development on the environment. The trick is to apply sustainable construction (Hansen, 2017).

Sustainable construction is development to meet the needs of the present without reducing the ability of future generations to meet their needs (Ervianto, 2023). Based on this understanding, the construction industry must continue to develop. But in the use of natural resources, the construction industry must use them wisely and minimize any potential future losses that may arise from meeting current construction needs. Thus, there needs to be a limit that is a sign for actors in the construction industry (Hansen, 2017). These limits can create harmonization between humans and their environment, including all natural resources they have.

The application of sustainable construction in developed countries is more focused on technological innovation. Meanwhile, in developing countries such as Indonesia, it still focuses on social, economic, and environmental aspects (Ervianto, 2023). The implementation of sustainable construction in Indonesia is regulated in the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 9 of 2021 concerning Guidelines for the Implementation of Sustainable Construction. In the regulation, it is stated that the implementation of construction services to erect buildings or civil buildings must implement sustainable construction. This shows that with the issuance of the regulation, all construction projects since 2021 are required to implement sustainable construction. In related regulations, the sustainable construction implementation scheme has 4 stages starting from general planning, programming, implementation of construction consultation, and implementation of construction work. The stage of sustainable construction implementation includes 3 aspects, namely construction, operation and maintenance, and demolition.

The implementation of sustainable construction in the implementation of the construction phase of building construction projects in Aceh Province faces various significant challenges. One of the main problems is the lack of understanding and awareness among contractors and construction workers about the principles of sustainable construction, which are often considered to require higher costs and longer time. In addition, regulations and policies that support sustainable construction are still not strong enough or have not been implemented consistently at the local level. All of this has resulted in a slow shift towards more sustainable construction methods in Aceh Province, despite the urgent need to reduce the environmental impact of construction activities. In connection with the above problems, this study wants to look at "The Application of Sustainable Construction at the Development Stage of Building Construction Projects in Aceh Province".

LITERATURE REVIEW

Construction Projects

A construction project is a series of activities that only occur once or are carried out and have a certain period of time. The length or shortness is determined by the size or complexity of the project, the difficulty of implementation, and other factors. In a series of project activities, there is always a process of transforming project resources into a result of activities in the form of buildings. In general, the characteristics of construction projects can be viewed in three perspectives, namely unique, involving a number of resources, and needing an organization (Ervianto, 2023).

Sustainable Construction

Sustainable construction is known as the application of modern construction or an improvement of the application of traditional construction. In general, traditional construction focuses on three goals such as cost, quality, and time. However, for sustainable construction, focus on several additional things, such as minimizing the use of natural resources, reducing harmful emissions, and reducing environmental degradation. When viewed from the activities of the current industrial sector, the construction industry is one of the largest contributors to environmental problems. This is because construction activities are carried out inappropriately (unsustainably). As a result, these activities lead to increased carbon emissions, climate change, resource scarcity, and increased waste (Fassa, 2022).

Sustainable Construction Implementation

The implementation of construction services to erect buildings or civil buildings must implement sustainable construction. The stages of implementing sustainable construction are carried out at the stages of general planning, programming, implementation of construction consultation, and implementation of construction work.

METHODOLOGY

This study uses a quantitative method approach. The quantitative method is used to research respondents through the collection of questionnaire data, then analyze the data with statistical methods, the output of which is in the form of numbers. The research methodology includes the stages of research, the determination of research objects and locations, the determination of data types, the determination of populations and samples, the design of questionnaire instruments, the collection of pilot testing questionnaire data, the testing of instruments, the collection of research questionnaire data, and the analysis of research questionnaire data.

RESEARCH RESULTS

The questionnaire was collected in two stages. In the first stage, as many as 30 questionnaires were collected for instrument testing (pilot testing). In the second stage, a total of 165 questionnaires were collected for research purposes. Based on all the data that has been collected, the results and discussions can be described.

Validity Test

By connecting the Degree of Freedown (DF) value to the two-way option at the 5% level error, the Rtable value for 30 samples was obtained at 0.361. Based on the appendix, a summary of the validity test results can be viewed in the Table. 1.

Table 1. Summary of Validity Test Results

No.	Indicator	R_{-count}	R_{-table}	Remarks
1	Implementation of solid and liquid waste management	0.757	0.361	Valid
2	Implementation of the use of recycled construction materials	0.070		Not valid
3	Selection of subcontractor suppliers with environmental management certification	0.102		Not valid
4	Energy efficiency	0.671		Valid
5	Implementation of air quality maintenance	0.636		Valid
6	Use of local materials to reduce transportation	0.539		Valid
7	Improving business competitiveness	0.867		Valid
8	Implementation of value management	0.569		Valid
9	Project life cycle assessment	0.175		Not valid
10	Implementation of supply chain management	0.595		Valid
11	Implementation of prefabricated construction materials	0.867		Valid
12	Application of lean construction principles	0.618		Valid
13	Use of Building Information Modelling (BIM) technology	-0.005		Not valid
14	Analysis of carbon emissions contained	0.168		Not valid
15	Analysis of required energy	0.036		Not valid
16	Establishing building life cycle costs during service life	0.074		Not valid
17	Linking research results with implementation	0.045		Not valid
18	Knowledge sharing	0.850		Valid
19	Resource efficiency	0.682		Valid
20	Education programs	0.820		Valid
21	Collaboration and partnership	0.113		Not valid
22	Creation of future technologies	0.170		Not valid

No.	Indicator	R_{-count}	R_{-table}	Remarks
23	Creation of technology to mitigate impact	-0.006		Not valid
24	Recruiting and retaining good employees	0.657		Valid
25	Implementation of environmental management systems in construction work	0.815		Valid
26	Implementation of occupational health and safety management systems in construction work	0.867		Valid
27	Implementation of efficient use of construction materials (reduce)	0.734		Valid
28	Involving subcontractors and suppliers that support sustainability principles	0.096		Not valid
29	Contractors documenting the entire construction stage project process	0.028		Valid
30	Rainwater harvesting technology and its utilization	0.047		Not valid
31	Reuse of water	0.074		Not valid
32	Use of renewable resources	0.107		Not valid
33	Use of alternative energy sources such as solar panels	0.162		Not valid
34	Use of local labor resources	0.815		Valid
35	Not using endangered materials	0.617		Valid
36	Availability of Construction Safety Plan (RKK) documents	0.798		Valid
37	Availability of Environmental Management and Monitoring Plan (RKPPL) documents	0.833		Valid
38	Availability of Traffic Management Plan (RMLLP) documents	0.865		Valid
39	Availability of Construction Quality Plan (RMPK) documents and quality programs	0.657		Valid
40	Implementation of building lightning protection systems according to standards (NSPK)	0.651		Valid
41	Implementation of water infiltration area provision	0.068		Not valid
42	Use of environmentally friendly construction materials	0.747		Valid
43	Use of reused construction materials	0.449		Valid
44	Noise reduction implementation	0.231		Not valid
45	Implementation of drainage systems in building areas	-0.062		Not valid
46	Disaster adaptation implementation	0.607		Valid
47	Building implementation that avoids reduction of natural/artificial lake capacity	-0.016		Not valid
48	Construction implementation that avoids loss of habitat or protected areas	0.657		Valid
49	Community participation involvement	0.620		Valid
50	Handling public complaints	0.594		Valid

No.	Indicator	R_{-count}	R_{-table}	Remarks
51	Implementation of gender-responsive, disability-inclusive, and marginalized-friendly facilities	-0.006		Not valid
52	Provision of community access and interaction spaces	0.060		Not valid
53	Strengthening local micro, small, and medium enterprises	0.674		Valid
54	Implementation of ornaments and landscape planning	0.591		Valid
55	Implementation of buildings that consider the preservation of cultural heritage or traditional areas	0.650		Valid
56	Implementation of buildings that support local cultural preservation	0.430		Valid

Table 1 shows that the sustainable construction variable has 23 invalid indicators out of 56 review indicators. In the event that there is an invalid indicator on the variable, the indicator must be eliminated. The results of this validity test show that the sustainable construction variable leaves 33 indicators that are feasible or appropriate to be reviewed at the construction stage of building construction projects in Aceh Province. Furthermore, this valid indicator is continued to the reliability test stage.

Reliability Test

Based on the appendix, a summary of the reliability test results can be seen in Table 2.

Table 2. Summary of Reliability Test Results

Variabel	*Cronbach Alpha*	Information
Sustainable construction	0,960	*Reliable* against 33 valid indicators

Table 2 shows that the continuous construction variable has a Cronbach Alpha value of 0.960 > 0.6, so that the variable can be declared reliable. The results of this reliability test show that all valid indicators are representative or have a level of conformity with sustainable construction variables at the construction stage of building construction projects in Aceh Province. Based on the results of the instrument tests that have been carried out, the design of the questionnaire instrument needs to be modified by eliminating a number of invalid indicators.

Respondent Perception

Based on the results of the PCA factor analysis, 6 factors have been identified, including 17 sustainable construction indicators, which have been applied at the construction stage of building construction projects in Aceh Province. The indicator will be identified for its level of importance and satisfaction. In detail, the respondents' perception of the level of importance and satisfaction with the implementation of sustainable construction can be described below.

Respondents' Perception of the Level of Importance of Sustainable Construction Implementation at the Development Stage

Respondents' perceptions of the level of importance of the implementation of sustainable construction at the development stage have 5 levels, namely Very Not Important (STP), Not Important (TP), Less Important (KP), Important (P), and Very Important (SP). For more information, the respondents' perception of the importance of implementing sustainable construction at the development stage can be seen in Table 3.

Table 3. Respondents' Perception of the Level of Importance of Sustainable Construction Implementation at the Development Stage

No.	**Variables and Indicators**	**Respondent Perception**					**Shoes**	***Mean***	**Inter Precision *Red***
		STP (1)	TP (2)	KP (3)	P (4)	SP (5)			
1	Environmental and quality compliance standard factors								
a	Availability of Environmental Management and Monitoring Work Plan (RKPPL) documents	-	-	-	74	91	751	4,552	SP
b	Availability of Work Traffic Management Plan (RMLLP) documents	-	-	-	77	88	748	4,533	SP
c	Availability of Construction Work Quality Plan (RMPK) documents and quality programs	-	-	-	64	101	761	4,612	SP
	Mean level of importance, environmental and quality compliance standard factors							4,566	SP
2	Standard factors of K3 compliance and security								
a	Implementing an occupational health and safety management system on construction work	-	-	-	56	109	769	4,661	SP
b	Availability of Construction Safety Plan (RKK) documents for the implementation	-	-	-	54	111	771	4,673	SP
c	Implementation of the use of lightning rods for buildings in accordance with Norms, Standards, Procedures, and Criteria (NSPK)	-	-	13	135	17	664	4,024	P
	Mean level of importance, standard factors, compliance, K3,							4,453	P

	and safety								
3	Efficiency factor								
a	Energy efficient	-	-	-	72	93	753	4,564	SP
b	Resource efficiency	-	-	-	78	87	747	4,527	SP
c	Implementation of the efficiency of the use of construction materials (*reduce*)	-	-	-	68	97	757	4,588	SP
	Mean interest rateefficiency factor							4,560	SP
4	Factor material								
a	Using local materials to reduce shipping transportation	-	-	-	53	112	772	4,679	SP
b	Implement supply chain management	-	-	14	39	112	758	4,594	SP
c	Implementation of the use of prefabricated construction materials	-	-	124	41		536	3,248	KP
	Mean level of importance of material factors							4,174	P
5	Competitive Factors								
a	Increase business competitiveness	-	-	-	117	48	708	4,291	P
b	Recruit and retain good employees	-	-	-	55	110	770	4,667	SP
c	Using local workforce resources	-	-	-	66	99	759	4,600	SP
	Mean level of importance of competitive factors							4,519	SP
6	Knowledge development factors								
a	Knowledge sharing	-	-	-	102	63	723	4,382	P
b	Educational programs	-	-	-	110	55	715	4,333	P
	Mean level of importance of knowledge development factors							4,358	P
	Mean level of importance of sustainable construction implementation							4,438	P

Table 3 shows that of the 6 factors for the implementation of sustainable construction, there are 3 factors perceived as important and 3 more factors perceived as very important by respondents. The factors that are perceived to be important are the standard factor of K3 compliance and security, with a mean value of 4.453, the material factor with a mean value of 4.174, and the knowledge development factor with a mean value of 4.358. Meanwhile, the factors that are perceived to be very important are the standard factor of environmental compliance and quality, with a mean value of 4.566, the efficiency factor with a mean value of 4.560, and the competitiveness factor with a mean value of 4.519. In general, respondents perceive that the implementation of sustainable construction at the construction stage of building construction projects in Aceh Province is at an important level of importance, with a mean value of 4,438.

Respondents' Perception of the Level of Satisfaction with the Implementation of Sustainable Construction at the Development Stage

Respondents' perception of the level of satisfaction with the implementation of sustainable construction at the development stage has 5 levels, namely Very Dissatisfied (STP), Dissatisfied (TP), Satisfied (KP), Satisfied (P), and Very Satisfied (SP). The output of the frequency of perception of research respondents through SPSS software. More details of respondents' perception of the level of satisfaction with the implementation of sustainable construction at the development stage can be seen in Table 4.

Table 4. Respondents' Perception of the Level of Satisfaction with the Implementation of Sustainable Construction at the Development Stage

No.	Variables and Indicators	Respondent Perception					Shoes	*Mean*	Inter Precision *Red*
		STP (1)	TP (2)	KP (3)	P (4)	SP (5)			
1	Environmental and quality compliance standard factors								
a	Availability of Environmental Management and Monitoring Work Plan (RKPPL) documents	-	-	10	103	52	702	4,255	P
b	Availability of Work Traffic Management Plan (RMLLP) documents	-	-	21	107	37	676	4,097	P
c	Availability of Construction Work Quality Plan (RMPK) documents and quality programs	-	-	10	92	63	713	4,321	P
	Mean level of satisfaction, environmental compliance and quality standards, factors							4,224	P
2	Standard factors of K3 compliance and security								
a	Implementing an occupational health and safety management system on construction work	-	-	21	71	73	712	4,315	P
b	Availability of Construction Safety Plan (RKK) documents for the implementation	-	-	24	79	62	698	4,230	P
c	Implementation of the use of lightning rods for buildings in accordance with Norms, Standards, Procedures, and Criteria (NSPK)	-	-	18	90	57	699	4,236	P

	Mean level of satisfaction factor standard compliance and safety							4,261	P
3	Efficiency factor								
a	Energy efficient	-	-	86	58	21	595	3,606	P
b	Resource efficiency	-	-	57	87	21	624	3,782	P
c	Implementation of the efficiency of the use of construction materials (*reduce*)	-	-	70	74	21	611	3,703	P
	Mean level of satisfaction efficiency factor							3,697	P
4	Factor material								
a	Using local materials to reduce shipping transportation	-	-	59	71	35	636	3,855	P
b	Implement supply chain management	-	-	45	85	35	650	3,939	P
c	Implementation of the use of prefabricated construction materials	-	-	13	121	31	678	4,109	P
	Mean level of satisfaction of material factors							3,968	P
5	Competitive Factors								
a	Increase business competitiveness	-	-	34	130	1	627	3,800	P
b	Recruit and retain good employees	-	-	-	85	80	740	4,485	P
c	Using local workforce resources	-	-	71	46	48	637	3,861	P
	A level of satisfaction with the competitive factor							4,048	P
6	Knowledge development factors								
a	Knowledge sharing	-	-	69	48	48	639	3,873	P
b	Educational programs	-	-	93	72	-	567	3,436	KP
	Mean level of satisfaction factor knowledge development							3,655	P
	Mean level of satisfaction with the implementation of sustainable construction							3,975	P

Table 4 shows that of the 6 factors for implementing sustainable construction, all of them were perceived as satisfied by the respondents. The factors perceived by the participants were the standard factor of environmental compliance and quality with a mean value of 4.224, the standard factor of K3 compliance and safety with a mean value of 4.261, the efficiency factor with a mean value of 3.697, the material factor with a mean value of 3.968, the competitiveness factor with a mean value of 4.048, and the knowledge development factor with a mean value of 4.048, and the knowledge development factor with a mean value of 3.968, and the knowledge development factor with a mean value of 3.968. The mean is 3.655. In general, respondents perceive that the implementation of sustainable construction at the construction stage of building construction projects in Aceh Province is at a satisfaction level that is satisfactory, with a mean value of 3.975.

***Importance Performance Analysis* (IPA)**

In the context of science, the mean value of each indicator and the combined mean value of the indicators at the level of importance and satisfaction are needed. The combined mean value of the indicators plays an important role in the formation of the science quadrant. The mean value of each indicator plays an important role in the distribution of the position of each indicator in the science quadrant.

Table 5. Recapitulation of Mean Value of Interest and Satisfaction

No.	Sustainable Construction Implementation Indicators at the Development Stage	*Mean*	
		Importance Level (*and*)	Satisfaction Rate (x)
1	Availability of Environmental Management and Monitoring Work Plan (RKPPL) documents	4,552	4,255
2	Availability of Work Traffic Management Plan (RMLLP) documents	4,533	4,097
3	Availability of Construction Work Quality Plan (RMPK) documents and quality programs	4,612	4,321
4	Implementing an occupational health and safety management system on construction work	4,661	4,315
5	Availability of Construction Safety Plan (RKK) documents for the implementation	4,673	4,230
6	Implementation of the use of lightning rods for buildings in accordance with Norms, Standards, Procedures, and Criteria (NSPK)	4,024	4,236
7	Energy efficient	4,564	3,606
8	Resource efficiency	4,527	3,782
9	Implementation of the efficiency of the use of construction materials (reduce)	4,588	3,703
10	Using local materials to reduce shipping transportation	4,679	3,855
11	Implement supply chain management	4,594	3,939
12	Implementation of the use of prefabricated construction materials	4,248	4,109
13	Increase business competitiveness	4,291	3,800
14	Recruit and retain good employees	4,667	4,485
15	Using local workforce resources	4,600	3,861
16	Knowledge sharing	4,382	3,873
17	Educational programs	4,333	3,436
	Mean combined indicators	4,502	3,994

The combined mean value of the indicators for the level of interest was obtained at 4.502, and for the satisfaction level obtained at 3.944. This shows that in general, respondents perceive the implementation of sustainable construction at the construction stage of building construction projects in Aceh Province to be at an important level of great importance and a level of satisfaction. The complete quadrant of Cartesian science that has been analyzed with Minitab software can be shown in Figure 1.

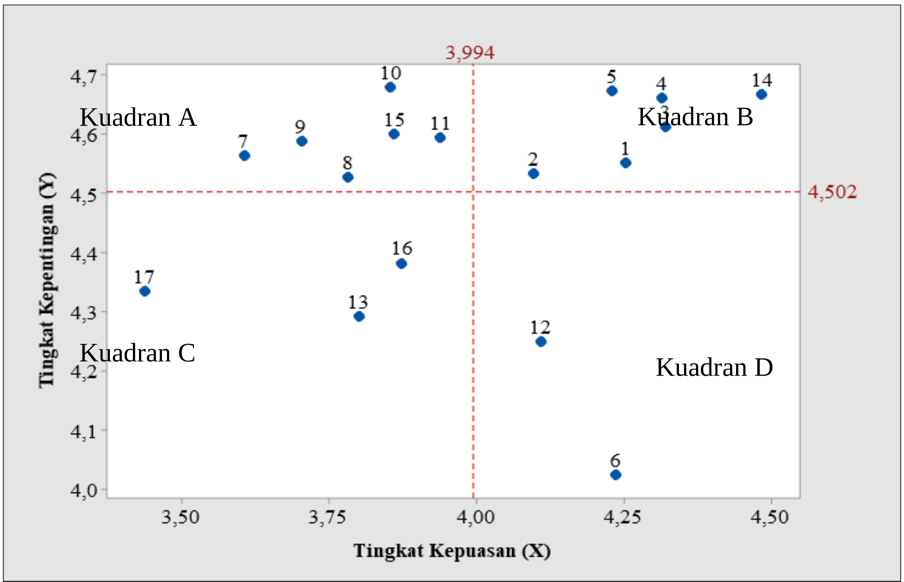

Figure 1.Performance Level of Sustainable Construction Implementation at the Development Stage in the Science

Based on Figure 1, the distribution of indicators for the implementation of sustainable construction at the construction stage of building construction projects in Aceh Province.

Table 6. Distribution of Sustainable Construction Implementation Indicators at the Development Stage in the Science Quadrant (1/2)

	Quadrant A (Top Priority)		Quadrant B (Maintain Performance)
7	Energy efficient	1	Availability of Environmental Management and Monitoring Work Plan (RKPPL) documents
8	Resource efficiency	2	Availability of Work Traffic Management Plan (RMLLP) documents
9	Implementation of the efficiency of the use of construction materials (reduce)	3	Availability of Construction Work Quality Plan (RMPK) documents and quality programs
10	Using local materials to reduce shipping transportation	4	Implementing an occupational health and safety management system on construction work
11	Implement supply chain management	5	Availability of Construction Safety Plan (RKK) documents for the implementation
15	Using local workforce resources	14	Recruit and retain good employees
	Quadrant C (Low Priority)		**Quadrant D (Excessive)**
13	Increase business competitiveness	6	Implementation of the use of lightning rods for buildings in accordance with Norms, Standards, Procedures, and Criteria (NSPK)
16	Knowledge sharing	12	Implementation of the use of prefabricated construction materials
17	Educational programs		

Figure 1 and Table 6 show that quadrants A and B are each distributed with 6 indicators, quadrant C is distributed with 3 indicators, and quadrant D is distributed with 2 indicators. This shows that the indicators of sustainable construction implementation at the construction stage of building construction projects in Aceh Province that need to improve performance with a main priority of 6 indicators, that need to maintain performance as many as 6 indicators, that need to improve performance with a low priority as many as 3 indicators, and that do not require performance improvement as many as 2 indicators. In order to improve performance, performance improvement will focus on quadrant A.

DISCUSSION

Based on the results of the research that has been obtained, it concerns the performance of the implementation of sustainable construction at the construction stage of building construction projects in Aceh Province. The discussion can be described below.

Performance of Sustainable Construction Implementation at the Construction Stage of Building Construction Projects in Aceh Province

The performance of sustainable construction implementation at the construction stage of a building construction project refers to the extent to which sustainability principles, can be effectively applied and integrated during the construction process by the contractor. This performance reflects the project's ability to achieve sustainability goals, including reducing negative environmental impacts, improving operational efficiency, and creating a safe work environment, while still meeting applicable quality and regulatory standards. The implementation of sustainable construction is important to be evaluated with IPA, in order to identify and prioritize areas that need performance improvement. The results of the performance evaluation of 17 indicators of sustainable construction implementation at the construction stage of building construction projects in Aceh Province are as follows:

1. Quadrant A (Main Priority – Low Performance): There are 6 indicators that need to be improved immediately because their performance is still low, namely: energy efficiency, resource efficiency, material use efficiency (reduce), local material use, supply chain management, and local labor utilization. Low performance is caused by a lack of technology, planning, and training, as well as weak supervision and coordination.
2. Quadrant B (Good Performance – Needs to Be Retained): A total of 6 indicators show good performance and must be maintained, namely: the availability of RKPPL, RMLLP, RMPK, RKK, K3 management system, as well as good labor recruitment and retention practices. This shows compliance with regulations and commitment to quality and safety.
3. Quadrant C (Low Priority – Low Performance): Three indicators that are low performance but not top priority are: increasing business competitiveness, knowledge sharing, and educational programs. It needs to be improved through innovation, knowledge sharing systems, and more relevant training.
4. Quadrant D (Overperformance – No Need to Improve): Two indicators have excellent performance to the point of being considered excessive, namely: the use of lightning rods as per the NSPK and the use of prefabricated materials. The focus of improvement can be shifted to other indicators that are still low.

CONCLUSION

The implementation of sustainable construction at the construction stage of building construction projects in Aceh Province that requires performance improvement in the main priority (quadrant A) there are 6 indicators, namely energy efficiency, resource efficiency, implementation of construction material use efficiency (reduce), using local materials to reduce shipping transportation, implementing supply chain management and using local labor resources.

RECOMMENDATION

It is recommended that contractors improve the performance of sustainable construction indicators located in quadrant A, so that the achievement of sustainable construction goals at the development stage in Aceh Province can be more optimal.

FURTHER STUDY

Further research can explore qualitatively the perception, knowledge, and capacity of project actors (contractors, workers, and project owners) towards energy efficiency, resource efficiency, as well as the use of local materials and supply chain management. In addition, comparative studies between other regions or provinces in Indonesia can be conducted to identify best practices and more effective implementation strategies.

REFERENCES

Agusven, T., Satriadi, Hafizni, R., Santoso, N.K., Hasnarika, 2023. Dasar Metodologi Penelitian Kualitatif. Rey Media Grafika, Batam.

Chamikara, Perera, Rodrigo, 2018. Competencies of the Quantity Surveyor in Performing for Sustainable Construction. International Journal of Construction Management 20, 237–251.

Ervianto, W.I., 2023. Manajemen Proyek Konstruksi Edisi Terbaru. Andi Offset, Yogyakarta.

Fassa, F., 2022. Perencanaan Konstruksi Berkelanjutan. Podomoro University Press, Jakarta.

Handayani, L.T., Asmuji, 2023. Statistik Deskriptif. UM Jember Press, Jember.

Hanifah, N., Julia, 2018. Prosiding Seminar Nasional Pendidikan Dasar - Membedah Anatomi Kurikulum untuk Membangun Masa Depan Pendidikan yang Lebih Baik. UPI Sumedang Press, Sumedang.

Hansen, S., 2017. Quantity Surveying Pengantar Manajemen Biaya dan Kontrak Konstruksi. Gramedia Pustaka Utama, Jakarta.

Herlina, V., 2019. Panduan Praktis Mengolah Data Kuesioner Menggunakan SPSS. Elex Media Komputindo, Jakarta.

Oke, A., Aghimien, D., Aigbavboa, C., Musenga, C., 2019. Driver of Sustainable Construction Practices in the Zambian Construction Industry, in: International Conference on Applied Energy. pp. 3246–3252.

Okoye, P.U., Odesola, I.A., Okolie, K.C., 2020. Evaluating the Importance of Construction Activities for Sustainable Construction Practices in Building Projects in Nigeria. Journal of Sustainable Construction Materials and Technologies 5, 430–439.

Permen PUPR RI No. 9 Tahun 2021, 2021. , Tentang Pedoman Penyelenggaraan Konstruksi Berkelanjutan.

Rangan, P.R., 2023. Kapasitas Elemen Struktur Terhadap Beban Gempa. Tohar Media, Makassar.

Reddy, A.S.A., Kumar, R., Raj, A., 2017. Sustainable Construction - An Indian Perspective, in: Proceedings of Advances in Sustainable Materials, Construction and Technology (ASMCT). pp. 1–9.

Riyanto, S., Hatmawan, A.A., 2020. Metode Riset Penelitian Kuantitatif Penelitian di Bidang Manajemen, Teknik, Pendidikan, dan Eksperimen. Deepublish, Yogyakarta.

Riyanto, S., Putera, A.R., 2022. Metode Riset Penelitian Kesehatan & Sains. Deepublish, Yogyakarta.

Siregar, S., 2023. Statistik Parametrik untuk Penelitian Kuantitatif: Dilengkapi dengan Perhitungan Manual dan Aplikasi SPSS Versi 17. Bumi Aksara, Jakarta.

Siswanto, A.B., Salim, M.A., 2020. Manajemen Proyek. Pilar Nusantara, Semarang.

Suhardi, M., 2023. Buku Ajar Dasar Metodologi Penelitian. Pusat Pengembangan Pendidikan dan Penelitian Indonesia, Lombok Tengah.

Willar, D., Waney, E.V.Y., Pangemanan, D.D.G., Mait, R.E.G., 2020. Sustainable Construction Practices in the Execution of Infrastructure Projects. Journal Sustainable Development in Construction 1, 1–19.

Yusuf, M., Daris, L., 2019. Analisis Data Penelitian. IPB Press, Bogor.

Zamzam, F., Marnisah, L., 2021. Model Penulisan Tesis Manajemen Kuantitatif Berbasis Analisis dan Implikasi Manajerial. Deepublish, Yogyakarta.