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Factor Analysis of Sustainable Procurement Implementation in the Public Sector Construction Industry

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Abstract

Public procurement holds significant potential to advance a country's sustainability agenda due to its substantial procurement volume. However, the gap between the principles of sustainable construction and their implementation in Indonesia remains suboptimal, with limited studies addressing sustainable procurement in the construction sector. Therefore, this research aims to identify the factors of the implementation of sustainable procurement in the public sector of the construction industry. Data were collected through a questionnaire survey involving 50 respondents from the procurement department of the Ministry of Public Works and Housing (PUPR). The research used a 5-point Likert scale for measurement, and data were analyzed using exploratory factor analysis. This research found five main factors in sustainable procurement practices, namely: environmental purchasing, implementation of management systems, implementation of economic benefits, implementation of government regulations, and social procurement.

Keywords

Sustainable procurement, public sector, construction industry, exploratory factor analysis (EFA)

INTRODUCTION

Procurement or the process of acquiring goods, services and works through public contracts is one of the main economic activities of public organizations[1]. In construction projects, procurement encompasses all activities related to acquiring goods, services and consultations necessary to achieve project objectives[2]. Traditional procurement methods may degrade environmental quality, leading to indirect costs such as repairing damage[1]. According to the Global Status Report, CO2 emissions from building operations increased by approximately 5% from 2020, surpassing the 2019 peak by 2%. Rising global temperatures necessitate proactive environmental management to mitigate further damage.

According to the Central Statistics Agency (BPS), the construction industry in Indonesia grew by 4.72% in the third quarter of 2022. Indonesia's construction sector is expected to continue to grow, supported not only by the government but also by foreign investment and the private sector. BPS stated that Indonesia's construction sector in 2022 will contribute 9.77% of Gross Domestic Product (GDP). In 2023, the Indonesian construction market is expected to continue its growth path with a projected value of IDR 332.95 trillion, up 5.77% from the forecast of IDR 314.77 trillion in 2022. Procurement challenges in the public sector construction industry are critical due to government financing. The challenge for the public sector throughout the world is to address increasing demand by paying attention to environmental aspects while still being able to increase economic and social value[3]. Therefore, sustainable procurement practices encompassing environmental, social, and economic aspects are essential for construction projects.

Public procurement has the potential to drive a country's sustainability agenda due to the large volume of procurement [4]. Sustainable procurement policy in Indonesia is regulated in Presidential Regulation of the Republic of Indonesia Number 12 of 2021 concerning amendments to Presidential Regulation Number 16 of 2018 concerning Sustainable Procurement of Goods and Services which explains that sustainable procurement is the Procurement of Goods/Services which aims to achieve beneficial value in a sustainable manner. economical not only for Ministries/Institutions/Regional Apparatus as users but also for the community, and significantly reduces negative impacts on the environment in the entire usage cycle. This policy can encourage sustainable procurement practices to be implemented in real terms.

Global concern over sustainable procurement is growing, yet studies indicate that developing countries lag behind their developed counterparts in this regard[5]. Some existing research focuses on environmental impacts[2], social impacts[6] and economic impacts[3]. In Indonesia, research related to sustainable procurement is still relatively new, especially regarding the implementation of sustainable procurement. There is research discussing factors influencing sustainable construction procurement [7], the influence of policy and institutional factors on sustainable procurement in the LRT TOD apartment project[8], the introduction of sustainability principles in construction procurement in Indonesia[9], and the

development of a framework methodology for sustainable construction procurement[10].

The problem between sustainable construction principles and their implementation in Indonesia is still not optimal[11]. These problems can occur due to lack of knowledge, different user priorities, difficulties in assessing the level of sustainability of supply chain actors and the lack of role of government regulations. The implementation of sustainable construction is very important from the procurement stage because it has an impact on sustainable development goals. Therefore, there is a need to integrate sustainability into project procurement. The success of sustainable procurement will provide long-term benefits from environmental, social and economic perspective, and can also enhance the company's reputation. This research aims to analyze the factors of the implementation of sustainable procurement in the public sector of the construction industry.

RESEARCH SIGNIFICANCE

This study is highly valuable as it contributes to the existing body of knowledge and can serve as a useful resource for future academic research on sustainable procurement. It provides a comprehensive understanding of the issues underlying the implementation of sustainable procurement in construction projects by examining the complexities and challenges associated with this field of research.

The practical implications of this research extend beyond academia, impacting both industry experts and practitioners. The conclusions and recommendations offer a practical guide for evaluating and monitoring the implementation of sustainable procurement. Additionally, the findings of this study can help raise awareness and build capacity among construction industry professionals in integrating sustainability into procurement processes, thereby increasing the adoption of sustainable procurement practices.

METHODOLOGY

The research process began by identifying variables related to sustainable procurement through a literature review. A preliminary questionnaire was then administered to experts to assess the relevance of these variables. Following this, the main questionnaire was distributed to the public procurement team to evaluate the factors influencing the implementation of sustainable procurement in Indonesia. The research population are practitioners involved in construction project procurement in Indonesia. The sample in this study was selected using a purposive sampling method with the selected sample being the Ministry of Public Works and Public Housing, due to its role in procurement of construction goods and services. A total of 50 respondents participated in this research. Exploratory factor analysis (EFA) was carried out to analyze new groups of existing variables and rank the loading factors formed to determine the factors in implementing sustainable procurement.

A. RESEARCH VARIABLE

These research variables include the factors that will be examined in the implementation of sustainable procurement in the public sector of the construction industry. These 30 variables were derived from previous research and are listed in Table 1.

Table 1 Research Variables

No	Variable	Source
1	Environmental purchasing	[2], [5], [12]–[15]
2	Implementation of *Construction and demolition waste* (CDW) *recycling*	[2], [5], [9], [11], [13], [16], [17]
3	Implementation of sustainable design	[2], [18]
4	Use of BIM	[18]
5	Implementation of sustainable labels	[15]
6	Implementation of energy conservation	[2], [9], [11], [17]–[19]
7	Implementation of water resources conservation	[2], [9], [17], [19], [20]
8	Tax on waste disposal	[21]
9	Forest management	[13], [20]
10	Management of the environment	[2]
11	Pollution prevention	[5], [17]
12	Procurement and social responsibility	[2], [11], [12], [14], [17]
13	Implementation of Corporate Social Responsibility (CSR)	[2], [9], [11]
14	Job creation	[2]
15	Occupational Health and Safety	[2], [9], [11], [14], [20]
16	Minimum remuneration of labor	[9], [17]
17	Human rights	[2], [9], [12], [14], [17]
18	Project security	[2], [12], [14], [19]
19	Philanthropy or social assistance	[12], [14]
20	Improvement of the surrounding environment	[5]
21	Crime reduction	[5]
22	Social welfare	[2], [19]
23	Implementation of a circular economy	[15]
24	Use of Life-Cycle Cost (LCC)	[9]
25	Implementation of quality management	[9]
26	Bank support	[9]
27	Implementation of cost effectiveness	[19], [20]
28	Application of business benefits	[9], [13], [22]
29	Government policy	[2], [19], [22]
30	Regulations and legislation	[13], [19]

B. COLLECTION OF TECHNIQUE DATA

Data collection in this research was carried out by distributing questionnaires given to respondents using Google Forms. The first survey or preliminary survey was conducted to verify the relevance of variables from the previous research. The results of the preliminary survey were analyzed using the binomial test. A variable is considered relevant in the context of statistics or scientific

research if it has a significant influence or relationship with other variables being studied.

The results of the preliminary questionnaire survey will be followed by the preparation of the main questionnaire survey. This main questionnaire survey was conducted to assess the extent to which sustainable procurement is implemented in Indonesia. Measurements in this study used a 5-point Likert scale because it is relatively easier for respondents to understand. The Likert scale is a tool for measuring attitudes, values and opinions. The Likert scale does not only express agreement but also includes variations such as frequency[23]. A five-point Likert scale was applied, ranging from 1 (never) to 5 (always). Questions were asked to assess the frequency of implementation of sustainable procurement carried out by the public sector of the construction industry.

RESULTS AND DISCUSSIONS

The results of the preliminary survey were analyzed using a binomial test to determine which variables were relevant. This analysis involved calculating the p-value for each variable. If the p-value was less than 0.5, the variable was considered relevant. The value (α) used was 15% because the desired level of inaccuracy or sampling error in this research was 15%. The analysis of the preliminary survey, which included 30 sustainable procurement variables, found 2 variables that were not relevant: including tax on waste disposal and philanthropy elements in procurement documents. An additional new indicator was identified, requiring service providers to have an environmental management certificate. The total number of relevant variables used in the main questionnaire is 29.

A. VALIDITY AND RELIABILITY TEST RESULTS

The validity test is carried out by comparing the calculated r-value with the table r-value. The calculated r-value is obtained from the results of the statistical program. Research variables are considered valid if the calculated r-value is greater than the table r-value. Validity tests were conducted on 50 research respondents. The r-table value for the 50 research samples is 0.279. Additionally, the validity of the variable can be determined from the Pearson product moment value. Research variables are considered valid if the Pearson value is less than 0.05 (p-value < 0.05). The results showed that all variables related to the implementation of sustainable procurement have a r-value greater than the r-table value and a Pearson value less than 0.05. Therefore, all variables related to the implementation of sustainable procurement are considered valid and can be carried out further analysis.

Reliability testing is used to determine the consistency of measuring instruments, ensuring that the instruments are reliable and remain consistent if measurements are repeated. The level of consistency is measured using the Cronbach's alpha value. A variable is said to be reliable if the Cronbach's alpha value is greater than 0.60. The research results show that the Cronbach's alpha value for the variable related to the implementation of sustainable procurement is 0.958. This indicates that the variable has a very high level of reliability.

B. EXPLORATORY FACTOR ANALYSIS

This stage involves analyzing all variables and grouping them into factors that represent multiple variables. The exploratory factor analysis begins with testing sample adequacy using the Kaiser-Meyer-Olkin (KMO) test. A KMO value greater than 0.5 is necessary, indicating better and more reliable data. For all variables related to sustainable procurement, a KMO value of 0.783 was obtained, confirming suitability for exploratory factor analysis as the KMO value exceeds the threshold of 0.5.

Sphericity testing with the Bartlett test is conducted to ascertain the existence of relationships between variables in a multivariate context. This test ensures that the measured variables are interconnected and suitable for factor analysis. Table 2 presents the Bartlett test of sphericity with a value of 1362.354 and a significance (Sig.) of 0.000, indicating significant interrelationships among the variables, thereby supporting their use in factor analysis.

Subsequently, a Measure of Sampling Adequacy (MSA) examination was performed to determine the appropriateness of the variables for exploratory factor analysis. All variables showed an MSA value greater than 0.5, confirming their suitability for exploratory factor analysis.

Table 2 Results of the KMO Test and Barlett Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.783
Bartlett's Test of Sphericity	Approx. Chi-Square	1362,354
	df	406
	Sig.	0,000

Factor extraction involves grouping variables into distinct factors that represent similarities among the variables being analyzed. The extraction method employed is Principal Component Analysis (PCA), which relies on variance percentage, eigenvalues, and cumulative total percentage. The number of factors formed is determined by components with eigenvalues greater than 1. From the factor extraction there are 5 components with a total eigenvalue greater than 1, resulting in the formation of 5 new factors. The first factor percentage of variation is 46.359%, the second factor 10.812%, the third factor 6.254%, the fourth factor 5.251%, and the fifth factor 4.421%. These five factors explain 73.097% of the variation, which is sufficient to explain the total variation.

Subsequently, factor rotation was conducted to simplify the variables and achieve a clearer factor structure. This process involves rotating the factor loadings. In table 3, variables are grouped into specific factors based on their highest factor loadings. Factor loading indicates the relationship between each variable and the factors identified. Variables are grouped according to these factors, and factor names are derived based on the variables within each factor.

Factor 1 is named Environmental Purchasing. This factor is named due to the presence of several variables that are inclined towards environmental purchasing. The variables consist of 15 items: implementation of energy conservation, CDW recycling, circular economy practices, forest management, water resource conservation, pollution

prevention, environmental purchasing, environmental improvement, sustainable design implementation, LCC usage, environmental management, sustainable labeling, project safety, procurement and social responsibility, and social welfare. Factor 2 is called Implementation of Management System. This factor is called due to the presence of several variables that are inclined towards management systems. The variables consist of 5 items: implementation of quality management, occupational health and safety, minimum labor remuneration, BIM usage, and service providers with environmental management certification. Factor 3 is designated as Implementation of Economic Benefit. This designation is due to the presence of several variables inclined towards the economic benefits derived from sustainable procurement. The variables consist of 4 items: implementation of business benefits, human rights, cost-effectiveness implementation, and bank support. Factor 4 is referred to as Implementation of Government Regulation. This classification is due to the presence of several variables inclined towards government regulations. The variables consist of 3 items: government policies, regulations and legislation, and crime reduction. Factor 5 is termed as Social Procurement. This factor is named due to the presence of several variables inclined towards social procurement. The variables consist of 2 items: job creation and CSR implementation. The following is a discussion of each factor.

Table 3 Factor Rotation Results

Code	Variable Name	Component				
		1	2	3	4	5
Environmental Purchasing						
P6	Implementation of energy conservation	0.835				
P2	Implementation of (CDW) recycling	0.831				
P21	Implementation of a circular economy	0.816				
P8	Forest management	0.810				
P7	Implementation of water resources conservation	0.809				
P10	Pollution prevention	0.806				
P1	Environmental purchasing	0.794				
P18	Improvement of the surrounding environment	0.763				
P3	Implementation of sustainable design	0.758				
P22	Use of LCC	0.752				
P9	Management of the environment	0.736				
P5	Implementation of sustainable labels	0.688				
P17	Project security	0.687				
P11	Procurement and social responsibility	0.654				
P20	Social welfare	0.574				
Implementation of management systems						
P23	Implementation of quality management		0.686			
P14	Occupational Health and Safety		0.622			
P15	Minimum remuneration of labor		0.577			
P4	Use of BIM		0.562			
P29	The service provider has an environmental management certificate		0.528			
Application of economic benefits						
P26	Application of business benefits			0.796		
P16	Human rights			0.751		
P25	Implementation of cost effectiveness			0.690		
P24	Bank support			0.653		
Implementation of government regulations						
P27	Government policy				0.750	
P28	Regulations and legislation				0.703	
P19	Crime reduction				0.595	
Social procurement						
P13	Job creation					0.790
P12	Implementation of CSR					0.655

1. Factor 1: Environmental purchasing

The environmental purchasing factor has the greatest influence among the five factors identified. This is because it has the largest variance value, explaining 46.359% of the total variation and comprising 15 variables. The variable with the highest loading factor (0.835) is the

implementation of energy conservation. Greenhouse gas emissions resulting from the construction sector are higher than those form other sector, necessitating energy conservation to reduce energy consumption[20]. Implementing energy conservation in procurement involves selecting service providers who use construction materials and technology that enhance energy efficiency, such as fuel-efficient and low-emission engine technology, to mitigate greenhouse gas effects.

The variable with the second highest loading factor is the application of construction and demolition waste (CDW) recycling. CDW implementation involves selecting service providers capable of processing the types of construction waste produced, typically concrete, ceramic materials, mortar, masonry, and wood. Regulations on construction waste processing are a key driver in minimizing construction waste[21]. Effective construction waste management can reduce the negative environmental impact of construction activities and boost the economy. This aligns with the third highest loading factor, which is the implementation of a circular economy. This includes systematically and repeatedly reusing as much material as possible to prevent resource wastage.

Sustainable forest management in procurement involves setting requirements for service providers to manage forests responsibly, such as replacing trees cut down during the construction process and ensuring that wood is sourced from legally logged forests[20]. This ensures logging is conducted responsibly and in accordance with forest sustainability principles.

Implementing water resource conservation in sustainable procurement involves reducing water use, increasing water use efficiency, and maintaining water quality. Effective water management can save water and contribute positively to water conservation and sustainability[20]. Service providers should also make efforts to prevent air pollution, such as controlling dust during construction.

Environmental purchasing can be achieved by selecting materials with a low environmental risk[12]. Empirical studies on effective environmental purchasing in construction projects suggest selecting low-risk materials, adopting eco-friendly practices, using green specification model clauses, assessing the environmental performance of buildings, and designing products to minimize environmental impact during construction[13]. Including sustainable design indicators in procurement is crucial to meet high environmental standards. Organizations might also require products to have specific sustainability labels in contract specifications. Using eco-labeled materials can promote eco-friendly procurement[13].

Life Cycle Costing (LCC) variables in sustainable procurement ensures that decisions consider not only initial costs but also costs incurred over the project's entire life cycle. Sustainable procurement involves purchasing goods and services in a manner that minimizes the impact on society and the environment throughout the project's life cycle[24]. Implementing sustainable procurement in construction projects can lead to savings and cost reductions during the project life cycle.[22]. Environmental management can be facilitated by requiring service providers to make efforts to protect and manage the environment. Environmental control can be achieved by communicating sustainability requirements through LEED (Leadership in Energy and Environmental Design) documents, which serve as an initiative for environmental sustainability management[2].

The project safety variable addresses the actions taken by service providers to ensure the safe operation of supplier locations and the safe movement of materials into project facilities. This aligns with research findings in Malaysia regarding the safe operation of supplier locations[14]. An easily accessible location can also speed up delivery times and reduce the likelihood of accidents during the delivery process. Ensuring safety is linked to social welfare by requiring service providers to manage the social impacts arising from the project, such as minimizing disruptions to local community traffic and preventing noise disturbances from construction operations. The benefits of implementing sustainable procurement include guaranteeing the safety and security of workers[2].

2. Factor 2: Implementation of Management System

The second factor identified is the implementation of a management system, which includes variables such as the implementation of a quality management system, occupational health and safety, remuneration, the use of BIM (Building Information Modeling), and service providers having an environmental management certificate. This factor represents 10.812% of the total variation. The variable with the highest loading factor is the implementation of quality management, with a loading factor value of 0.686. This requires service providers to fulfill quality management system requirements. Service users can request proof of the service provider's track record or experience, environmental performance records, and technical equipment records to ensure quality and environmental management certificates.[9]. Public procurement in Indonesia requires an environmental management certificate, quality management requirements and several commonly used technical requirements related to the quality of materials, construction methods, laboratory tests and construction equipment that must be fulfilled in the procurement documents. Employee health and safety is the most frequently applied factor in both the public and private sectors in Malaysia[14]. To ensure the social welfare of workers, it is necessary to require service providers to provide minimum remuneration for construction workers[17]. Remuneration includes rewards such as bonuses, allowances, and health insurance for employees' contributions. However, providing this remuneration standard is still considered challenging because many service providers believe that it can increase costs[9].

Integrating BIM into a project management system is also an effort to implement sustainable procurement. The use of BIM technology during the construction process can help achieve sustainability[13]. Integrating BIM into a project management system enables more efficient and coordinated use of information, thereby improving overall project performance. The use of BIM can contribute to better scheduling of construction, labor, and equipment, as well as improved management quality.

3. Factor 3: Implementation of Economic Benefits

The third factor identified is the application of economic benefits, which includes variables such as the application of business benefits, human rights, cost-

effectiveness, and bank support. This factor represents 6.254% of the total variation. The variable with the highest loading factor is the application of business benefits, with a loading factor value of 0.796. This involves efforts to save and reduce costs in procuring goods and services. During the tender process, the working group can create criteria for selecting the most cost-efficient service provider or supplier. Conditions such as requiring service providers to provide employment guarantees from banks to demonstrate financial stability are applied to loan packages. A job guarantee from a bank is a document showing that the bank agrees to support or guarantee the service provider's finances in case of payment failure.

The human rights variable requires service providers to pay workers a living wage to ensure they are adequately compensated. Respecting human rights and providing fair wages is a key indicator of sustainable procurement.[14]. hen workers receive decent wages, they tend to be more motivated, which can increase productivity and improve the quality of work, resulting in social and economic benefits.

4. Factor 4: Implementation of Government Regulations

The fourth factor identified is the implementation of government regulations, which includes variables such as government policy, regulations and legislation, and crime reduction. This factor represents 5.251% of the total variation. The variable with the highest loading factor is government policy, with a loading factor value of 0.750. Government policies, laws and regulations can provide a legal basis for promoting sustainable procurement practices. The government plays an important role to encourage and provide awareness to the public sector to protect the environment[20]. Government regulations significantly influence the public sector in implementing sustainable procurement. In Indonesia, sustainable procurement policies generally refer to SNI ISO 20400:2017. Regulations on sustainable procurement are outlined in Presidential Decree No. 12 of 2021 concerning government procurement of goods and services. Having regulations on sustainable procurement can also help reduce crime. Previous studies reveal that crime reduction is a social value priority that can be incorporated into the procurement process[5]. This can be achieved by requiring service providers to implement an anti-bribery management system.

5. Factor 5: Social Procurement

The final factor identified is social procurement, which includes the variables of job creation and the implementation of CSR (Corporate Social Responsibility). This factor represents 4.421% of the total variation. The variable with the highest loading factor is job creation, with a loading factor value of 0.790. Public procurement can play a role in creating jobs and increasing the competency of construction workers through training and certification as part of a Corporate Social Responsibility (CSR) program[5]. Job creation aims to improve social welfare in communities affected by development projects. The Ministry of Public Works and Housing (PUPR) creates jobs for local communities through labor-intensive programs. Additionally, CSR programs aim to enhance social procurement by implementing education and training programs for local communities to improve their skills and abilities related to the construction industry.

C. PRACTICAL IMPLICATIONS

This study contributes to the literature on the implementation of sustainable procurement and offers practical implications for practitioners and decision-makers. Insights into sustainable procurement practices can serve as a guide for stakeholders, including company managers, procurement teams, and public procurement authorities, to enhance the adoption of sustainable procurement. Technologies need to be developed to support the implementation of sustainable procurement in the construction industry. This can be achieved through the development of more integrated applications for monitoring sustainability aspects. Additionally, the use of Building Information Modeling (BIM) in project management can support sustainable procurement practices.

Monitoring system is required to measure and evaluate the implementation of sustainable procurement in construction projects. This involves measuring various performance indicators, such as energy use, waste reduction, and other environmental impacts. By regularly monitoring the performance of construction projects, managers can identify the success of sustainable procurement implementation and track its progress.

The significant benefits of sustainable procurement are evident, as procurement activities not only aim to meet the needs of service users but also contribute to enhancing socio-economic impacts and reducing environmental impacts. By considering these practical implications, both service users and providers can improve the implementation of sustainable procurement in the public sector of the construction industry.

CONCLUSIONS

Public procurement has the potential to drive a country’s sustainability agenda. This research aims to analyse the dominant factors in the implementation of sustainable procurement in the public sector of the construction industry. Data collection techniques were carried out using questionnaire surveys to measure the level of implementation of sustainable procurement. Research measurements use a 5-point Likert frequency scale and the data is processed using exploratory factor analysis.

The research found five main factors in implementing sustainable procurement, namely: environmental purchasing, implementation of management systems, implementation of economic benefits, implementation of government regulations, and social procurement. Environmental purchasing has the greatest influence, explaining 46.359% of the total variation. Implementation of management systems accounts for 10.812% of the variation, economic benefits for 6.254%, government regulations for 5.251%, and social procurement for 4.421%. The study highlights that environmental purchasing emerges as the most influential factor, followed by the implementation of management systems, economic benefits, government regulations, and social procurement. These factors constitute a comprehensive approach to sustainable procurement, aimed at enhancing environmental protection, social welfare, and economic efficiency.

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