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Barriers to Sustainable Construction Implementation in Makassar: A Comparative Study of State-Owned and Private Contractors

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A B S T R A C T

Achieving sustainability in construction projects requires active involvement from all stakeholders in implementing environmentally responsible techniques and materials throughout the project lifecycle. This study aims to identify and analyze the barriers to sustainable construction implementation from the perspectives of both state-owned and private contractors. A purposive sampling technique was employed to determine the study participants. Using the Interpretive Structural Modeling (ISM) approach, this research reveals key hierarchical barriers within each contractor group. For state-owned contractors, the most prominent barriers include A1 (Lack of knowledge and standards), A5 (Project manager incompetence), and A6 (Limited access to sustainable materials and technology). In contrast, private contractors identified A1 (Lack of knowledge and standards), A2 (Poor design practices), and A4 (Lack of communication between project stakeholders) as the most critical barriers. These findings suggest that different strategies and policy interventions are needed to address context-specific barriers in order to accelerate the adoption of sustainable construction practices across sectors.

1. Introduction

The construction sector plays a crucial role in driving economic growth globally. Well-developed buildings and infrastructure created by this industry are essential for achieving key national objectives such as social progress, industrial growth, efficient freight movement, sustainable development, and urban expansion[1]. The growing economic, social, and environmental impact of the construction industry has led to the importance of sustainable construction [2].

Sustainability of construction projects necessitates the involvement of all project stakeholders in adopting techniques and materials for fostering sustainability across all stages of the project as well as the product lifecycle[3][4]. The integration of value engineering and lean construction can significantly improve cost performance while reducing environmental

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impacts in the Indonesian construction industry. In a case study of a high-rise building project, implementing the reuse of concrete waste as a substitute for formwork, along with lean construction practices, resulted in a 55.83% cost savings compared to the initial project plan [5].

Sustainable construction is a solution to minimize the impact of using large amounts of raw materials [6]. Implementing sustainable construction improves the quality of human life, optimizes the use of resources, and improves the natural environment and social community[2], [7].

Construction development can reduce resources due to the use of large amounts of energy and the consequent emission of greenhouse gases, indirectly contributing to climate change and degradation of air and water quality[8][9]. There are 5 variables that affect the achievement of sustainable construction, namely social, environmental, economic, disaster and technical[10]. Construction projects also contribute to environmental degradation by 25% air pollution, 40% water pollution, and 50% landfill waste due to the overuse of raw materials [11].

The increase in construction projects in Indonesia is carried out to support economic growth, equitable development, and community welfare. This reached 9.8% of total GDP and made it the fifth largest contributor to the national economy[8], [12].

In every construction project, contractors are required to carry out work effectively and efficiently and with high quality. There is a crucial role of the Contractor in carrying out the work[13].Within the framework of "Indonesia Emas 2045," State-owned Contractors in the construction sector are anticipated to play a leading role in the implementation of national infrastructure projects [14].

Overall, these firms demonstrated a relatively strong performance in SDG-related disclosures, achieving an average disclosure index of 74%. While private firms led in terms of SDG transparency, SOEs outperformed in several aggregated aspects, suggesting the influence of legitimacy pressures and coercive isomorphism—especially relevant for state entities [15]

Multi-story building construction projects are growing in implementation, where buildings are the most accessible object for implementing sustainable construction because they are easier to control in every activity stage[16][7]. The three biggest barriers to sustainable practices in Indonesia are a lack of knowledge and standards, poor design practices, and financial constraints [2].

Moreover, other obstacles to the execution of sustainable building encompass the inadequate skills and experience of laborers, insufficient communication among stakeholders, and minimal enforcement of legislation that promotes training in skills and knowledge to facilitate sustainable construction [17][18]. There is an absence of institutions that provide certification for eco-friendly materials and equipment, financial constraints stemming from the elevated costs of sustainable construction, and a necessity for comprehensive regulations governing the implementation of sustainable construction in Indonesia [19][20].

The supplier's competency and technical understanding provide a difficulty during the technical planning phase of sustainable construction implementation. The outcomes of planning frequently diverge from the stakeholders' anticipations [21][17]. It is essential to enhance the proficiency of planning consultants and professionals. There is a necessity for increased financial assistance, a greater availability of experienced personnel proficient in utilizing these instruments, and a lack of data and information regarding sustainable construction[22] [12].

This study aims to identify priority obstacles in the implementation of sustainable construction aspects in Makassar City from both parties that are key to construction implementation, namely state-owned contractors and private contractors. From these obstacles, it is hoped that there will be alternative strategies to overcome these obstacles for both contractors.

ISSN (Online) 2620-7222
ISSN (Print) 2503-2399

2. Research Method

The research strategy begins with preparing the research questions to be used. Several formulations describe the formulation of research questions, which then become the basis for determining the research methods to be used, as stated in **Figure 1**.

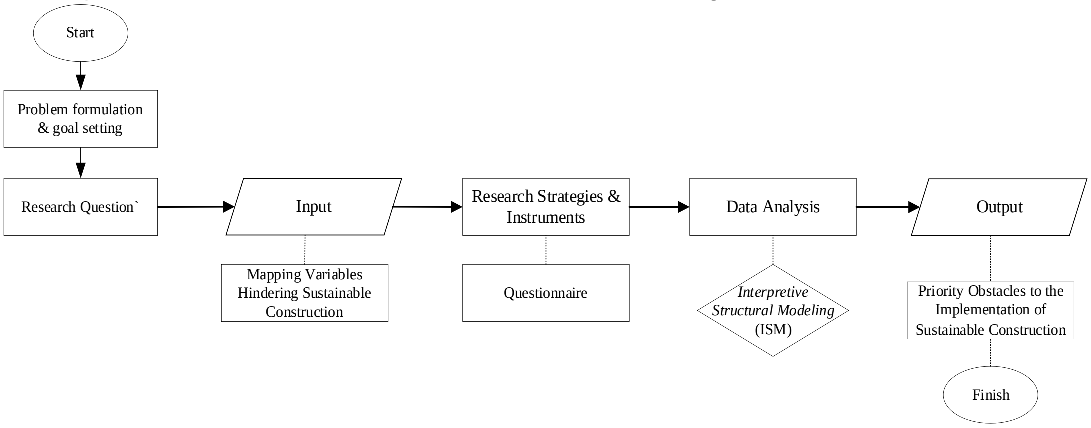

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Figure 1. Research Strategy

The flowchart presented in this study illustrates the overall research framework applied to investigate the barriers to sustainable construction. The process begins with problem formulation and goal setting, which is essential for defining the scope and objectives of the study. At this stage, the research question is developed to provide a clear direction for the investigation.

The next step involves the input stage, where the focus is on mapping the variables hindering sustainable construction. These variables are identified through a review of relevant literature and preliminary observations, ensuring that the study captures the key factors affecting the implementation of sustainability principles in construction practices.

Following this, the research proceeds to the phase of developing research strategies and instruments. Here, a questionnaire is developed and distributed to practitioners, experts, and stakeholders in the construction sector. This instrument serves as the primary data collection tool, enabling the systematic gathering of opinions and experiences related to the identified variables.

The data collected is then analyzed using Interpretive Structural Modeling (ISM). This analytical method is particularly useful in structuring complex problems, as it allows researchers to explore the interrelationships among the barriers and to establish a hierarchy of their influence. Through ISM, the study can determine which barriers act as driving factors and which are dependent factors within the system.

Ultimately, the research yields an output that highlights the primary obstacles to implementing sustainable construction. These findings offer valuable insights into the most critical challenges that policymakers, practitioners, and researchers must address to foster the successful adoption of sustainable construction practices.

3. Description and Technical

1. Population and Samples.

   The study's population consisted of contractors working on building construction in Makassar. This research involved analyzing four building projects regarding the application of sustainable construction especially in building construction projects.

ISSN (Online) 2620-7222
ISSN (Print) 2503-2399

2. Sampling Techniques.

   The sample was determined using purposive sampling, a non-probability sampling technique that emphasizes the selection of samples according to specific characteristics/considerations. Eight respondents were determined in this study through sampling techniques and respondent criteria. The selection of respondents involved representatives from state-owned contractors and private contractors.
3. Definition of Variable Operations.

   The variables in this study refer to the mapping of previous research variables related to obstacles in the implementation of sustainable construction. These variables then become inputs for ISM analysis in determining priority obstacles from State-Owned Contractors and Private Contractors.
4. Instrument Analysis Tool.

   The analytical instruments used in this study include mapping of previous research variables regarding obstacles to the implementation of sustainable construction. In addition, variables were also found from the results of interviews with respondents who have experience in implementing sustainable construction, particularly in the city of Makassar.
5. Data Analysis Techniques.

   Data analysis in this study utilized Interpretive Structural Modelling (ISM). Interpretive Structural Modelling (ISM) is an analytical method used to identify and map relationships between elements in a complex system in a systematic and structured manner. This method is often used in management research, decision making, and systems engineering. Data analysis using ISM consisted of several stages, including:
   1. Structural Self Interaction Matrix (SSIM)
   2. Reachability Matrix (RM)
   3. Conical Matrix
   4. Model Interpretive Structural Modelling (ISM)
   5. Matrix of Cross Impact Multiplications Applied to Classification (MICMAC)

4. Results and Discussions

The ISM analysis aims to determine the priority barriers to implementing sustainable construction. Barriers obtained from the results of literature studies and interviews with project parties who are handling the implementation of building construction are used as input in analyzing priority barriers.

Table 1. Variables hindering the implementation of sustainable construction

Variables	Barriers	Source
A1	Lack of knowledge and standards	[23], [24] [25], Interview
A2	Poor design practices	[23], [26], Interview
A3	Financial constraints	[23] [16], [26], [25], Interview
A4	Lack of communication between parties involved in the project	[24]
A5	Project manager incompetence	[27]
A6	Limited sustainable materials and technology	[27], [26], Interview
A7	Lack of incentives from the government	[27]
A8	Low level of implementation of sustainable practices	[27], [24]
A9	Longer payback period	[25]
A10	Lack of professional expertise in sustainability	[25]

ISSN (Online) 2620-7222
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Variables	Barriers	Source
A11	Sustainability criteria not considered in bid evaluation	[25], Interview

Source: Mapping of previous research variables

Data from the questionnaire was then processed using Interpretive Structural Modelling (ISM) analysis to interpret the position of each obstacle in the quadrant and rank (level) of obstacles to the implementation of sustainable construction. Data processing of Interpretive Structural Modelling (ISM) analysis using the ISM-PROFESSIONAL 2.0 application. The results of the analysis are as follows:

4.1 Structural Self-Interaction Matrix (SSIM)

The results of filling out the questionnaire on the relationship between obstacle variables can be used as input in creating a Structural Self-Interaction Matrix (SSIM). In this process, the variables are made in contextual relationships by making one variable i and the other variable j. Where the relationship between the two variables is described by:

V = Element-i affects Element-j,
A = Element-j affects Element-i,
X = Both elements (i-j) equally affect/influence each other,
O = Both elements (i-j) are equally unaffected

Tables 2 and 3 show the relationship matrix of each element of the state-owned contractor and the private contractor, respectively. This matrix examines how the obstacle variables interact with each other. These variables are then defined as numerical values in the Reachability Matrix (RM).

Table 2. Structural Self-Interaction Matrix (SSIM) by State-Owned Contractors

A	1	2	3	4	5	6	7	8	9	10	11
1		V	O	X	V	V	O	V	X	X	A
2			O	X	X	X	O	V	X	X	A
3				O	O	V	V	V	O	V	V
4					X	O	O	X	X	X	X
5						X	O	X	X	X	X
6							X	O	V	X	V
7								A	O	O	O
8									O	X	X
9										O	X
10											X
11											

Source: ISM Professional 2.0

Table 3. Structural Self Interaction Matrix (SSIM) by Private Contractors

X	1	2	3	4	5	6	7	8	9	10	11
1		V	O	X	V	V	O	V	X	X	A
2			O	X	X	X	O	V	X	X	A
3				O	O	V	V	V	O	V	V
4					X	O	O	X	X	X	X
5						X	O	X	X	X	X
6							X	O	V	X	V
7								A	O	O	O
8									O	X	X
9										O	X

ISSN (Online) 2620-7222
ISSN (Print) 2503-2399

X	1	2	3	4	5	6	7	8	9	10	11
10											X
11											

Source: ISM Professional 2.0

4.2 Reachability Matrix (RM)

The Reachability Matrix (RM) was created based on the output of the Structural Self-Interaction Matrix (SSIM). Making the Reachability Matrix (RM) is done by changing the symbols V, A, X, O in SSIM to “0” or “1”. Table 4 shows the values of each obstacle variable summarized in the RM table, specifically for state-owned contractors. Meanwhile, Table 5 shows the values of each variable in the RM table found among private contractors.

Table 4. Reachability Matrix (RM) by State-Owned Contractors

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	1	1	1	1	1	1	1	1	1	1
A2	0	1	1	1	1	1	1	1	1	1
A3	0	1	1	1	1	1	1	1	1	1
A4	0	1	1	1	1	1	1	1	1	1
A5	0	1	1	1	1	1	1	1	1	1
A6	1	0	1	1	1	1	1	1	1	1
A7	1	0	1	1	0	1	1	1	1	1
A8	1	0	1	1	0	1	1	1	1	1
A9	0	0	0	1	0	0	0	0	1	1
A10	0	1	1	1	0	1	1	1	1	1

Source: ISM Professional 2.0

Table 5. Reachability Matrix (RM) by Private Sectors

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11
A1	1	1	0	1	1	0	1	1	1	1	1
A2	0	1	0	1	1	1	0	1	1	1	1
A3	0	0	1	0	1	0	1	1	1	1	1
A4	1	1	0	1	1	1	0	1	1	1	1
A5	0	1	1	0	1	1	0	1	1	1	1
A6	0	1	0	1	1	1	0	0	1	1	1
A7	0	0	0	0	0	0	1	1	0	1	0
A8	1	0	1	1	1	1	0	1	1	1	1
A9	1	1	1	1	1	1	0	0	1	1	1
A10	1	1	0	1	1	0	0	1	1	1	1
A11	1	1	0	1	1	1	1	1	1	1	1

Source: ISM Professional 2.0

4.3 Conical Matrix

A conical matrix is used to form an Interpretive Structure Modelling (ISM) model by ranking the obstacle variables. The conical matrix is created by looking at the results of the driven power and dependence values in the reachability matrix. The value of driven power will be sorted based on the largest value. The highest rank in the conical matrix has a greater value of driven power which means it has a large influence of strength between obstacle variables.

Table 6 shows variable A1 (Lack of knowledge and standards), A5 (Project manager incompetence) and A6 (Limited sustainable materials and technology) ranked highest among

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ISSN (Print) 2503-2399

the priority barriers to the implementation of sustainable construction aspects in Makassar City found by state-owned contractors. Meanwhile, the lowest barrier found by contractors was variable A9 (Longer payback period).

Table 6. Conical Matrix by State-Owned Contractors

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Driver Power	Rank	Dependence	Hirarki
A1	1	1	1	1	1	1	1	1	1	1	1	11	1	5	6
A2	0	1	1	1	1	1	1	1	1	1	1	10	2	8	4
A3	0	1	1	1	1	1	1	1	1	1	1	10	2	9	3
A4	0	1	1	1	1	1	1	1	1	1	1	10	2	11	1
A5	1	1	1	1	1	1	1	1	1	1	1	11	1	6	5
A6	1	1	1	1	1	1	1	1	1	1	1	11	1	9	3
A7	0	0	1	1	0	1	1	1	1	1	1	8	4	9	3
A8	1	0	1	1	0	1	1	1	1	1	1	6	5	10	2
A9	0	0	0	1	0	0	0	0	1	1	1	4	6	11	1
A10	0	1	1	1	0	1	1	1	1	1	1	9	3	11	1
A11	1	1	1	1	0	1	1	1	1	1	1	10	2	11	1

Source: ISM Professional 2.0

Meanwhile, **Table 7** shows the Conical Matrix values from the Private Contractor. This table shows that the priority barriers are found in A1 (Lack of knowledge and standards) and A4 (Lack of communication between parties involved in the project). Meanwhile, the lowest barrier in the implementation of sustainable construction aspects found by the Private Contractor is in variable A7 (Lack of incentives from the government).

Table 7 Conical Matrix by Private Contractors

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	Driver Power	Rank	Dependence	Hirarki
A1	1	1	0	1	1	1	0	1	1	1	1	9	1	5	5
A2	0	1	1	1	0	1	1	0	1	1	1	8	2	8	3
A3	0	0	1	0	1	0	1	1	1	1	1	6	4	1	7
A4	1	1	0	1	1	1	0	1	1	1	1	9	1	8	3
A5	0	1	1	1	1	1	0	1	1	1	1	8	2	9	2
A6	0	1	0	1	1	1	0	0	1	1	1	7	3	6	4
A7	0	0	0	0	0	0	1	1	0	1	0	1	6	2	6
A8	1	0	1	1	1	1	0	1	1	1	1	5	5	8	3
A9	1	1	1	1	1	1	0	0	1	1	1	6	4	8	3
A10	1	1	0	1	1	0	0	1	1	1	1	6	4	8	3
A11	1	1	0	1	1	1	1	1	1	1	1	8	2	10	1

Source: ISM Professional 2.0

4.4 Model Interpretive Structural Modelling (ISM)

An analysis of barriers to the implementation of sustainable construction by state-owned contractors was conducted using the Interpretive Structural Modelling (ISM) approach. The ISM method was used to identify and organize the relationships between barriers hierarchically, thereby providing a deeper understanding of the key elements that need to be addressed to promote the implementation of sustainable construction.

Based on the results of the ISM analysis visualized in **Figure 2**, the barriers are organized into six hierarchical levels, from Level 1 (most influential) to Level 6 (most influenced). This

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hierarchical structure illustrates the cause-and-effect relationships among the identified barriers.

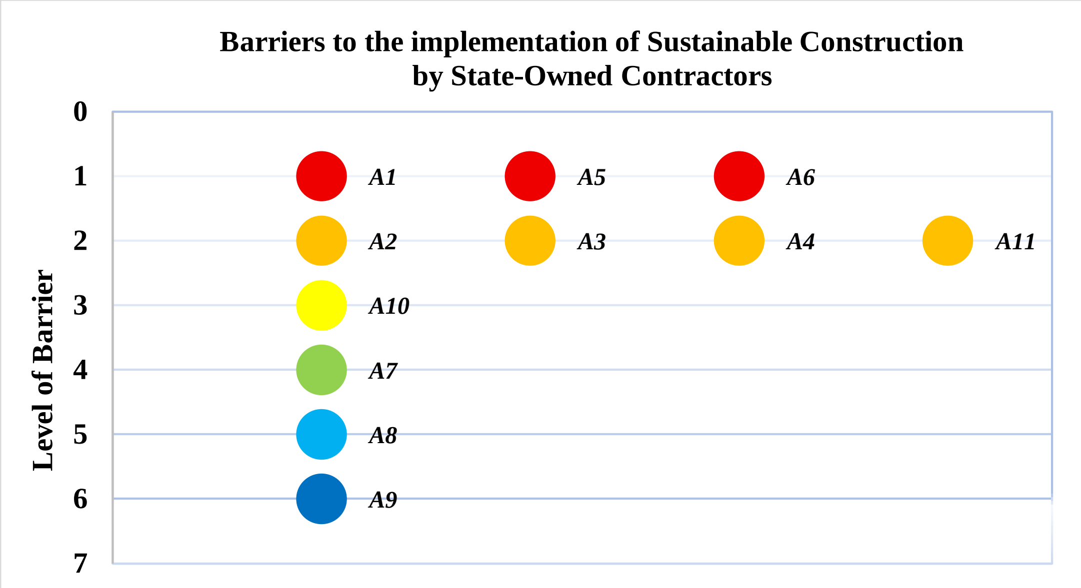

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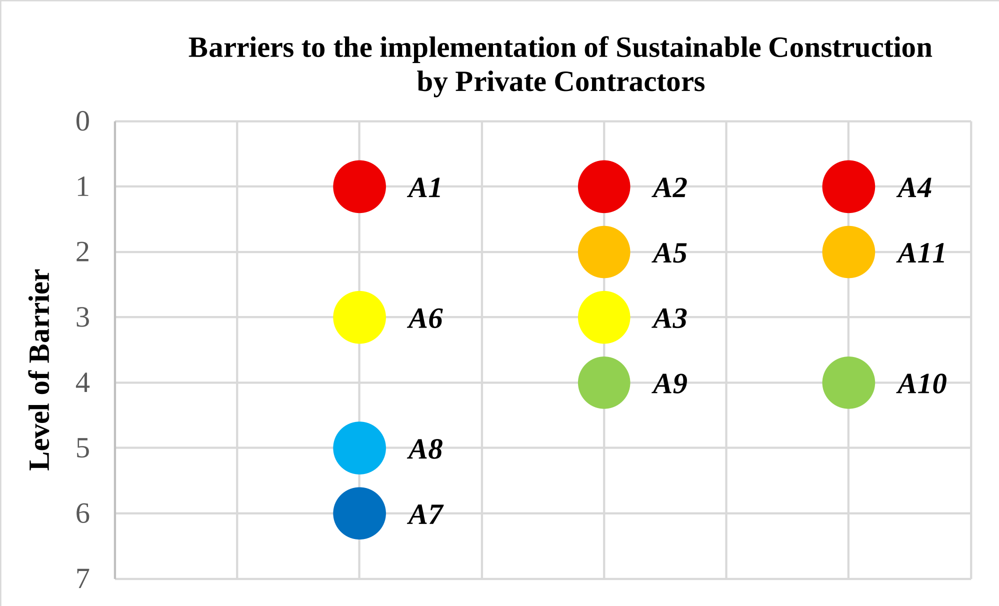
Figure 2. Level of Barriers by State-Owned Contractors

The findings from interpretive structural modelling (ISM) on the challenges faced by state-owned contractors in adopting sustainable construction reveal a layered structure that outlines how these challenges are connected to one another. This hierarchy consists of six levels, which represent the extent to which a barrier influences or is influenced by other barriers.

- At Level 1, there are three dominant barriers, namely A1 (Lack of knowledge and standards), A5 (Project manager incompetence), and A6 (Limited sustainable materials and technology). All three are fundamental structural and strategic barriers. Barrier A1 indicates that understanding and standards regarding sustainable construction are still low at the state-owned contractor level. The unpreparedness of project managers (A5) in managing sustainability aspects further exacerbates the situation. Meanwhile, limitations in sustainable technology and materials (A6) also hinder implementation in the field.
- Moving on to **Level 2**, there are obstacles A2 (Poor design practices), A3 (Financial constraints), A4 (Lack of communication between parties), and A11 (Sustainability criteria not considered in bid evaluation). These obstacles arise as a consequence of obstacles at the previous level. The lack of standards and managerial competence has resulted in design practices that do not adopt sustainability principles. Similarly, the low level of sustainability integration in the project evaluation system (A11) indicates that this aspect has not yet become a priority in the procurement process.
- At **Level 3**, barrier A10 (Lack of professional expertise in sustainability) describes the limitations of human resources in understanding and applying sustainability principles technically. This barrier is a transition between systemic and operational barriers.
- At **Level 4**, A7 (Lack of incentives from the government) emerges, indicating that while external incentives are important, they are more of a consequence than the primary cause. In other words, without internal readiness, incentives will not effectively drive change.

ISSN (Online) 2620-7222
ISSN (Print) 2503-2399

- Next, A8 (Low level of implementation of sustainable practices) at Level 5, and A9 (Longer payback period) at Level 6, show the final impact of all the barriers. Practices in the field are very limited because they are not supported by adequate systems, capacity, and policies. Barrier A9 emphasises that from a business perspective, the long payback period makes investment in sustainability less profitable.



Source :Research Result 2025

Figure 3. Level of Barriers by Private Contractors

On the other hand, the ISM analysis results visualised in **Figure 3**, the barriers are organised into six hierarchical levels, from Level 1 (most influential) to Level 6 (most influenced).

- At Level 1, there are three fundamental obstacles, namely: **A1** (Lack of knowledge and standards), **A2** (Poor design practices), dan **A4** (Lack of communication between parties involved in the project). These three obstacles are internal root causes that significantly affect other obstacles. Obstacle A1 shows that many private contractors still lack adequate understanding and standard references regarding sustainable construction. Obstacle A2 shows that weaknesses in design planning are an important factor that needs to be addressed immediately. Meanwhile, A4 highlights communication misalignment among stakeholders involved in the project, which impacts the effectiveness of cross-functional collaboration.
- At **Level 2**, obstacles A5 (Project manager incompetence) and A11 (Sustainability criteria not considered in bid evaluation) emerge as a result of obstacles at the upper level. Both are closely related to project management; neither is yet trained in integrating sustainability principles and a procurement system that does not yet support sustainability as an important criterion.
- **Level 3** is characterised by obstacles A3 (Financial constraints) and A6 (Limited sustainable materials and technology). Financial constraints in this context are primarily the result of insufficient institutional support and weaknesses in project management systems. Similarly, limited access to sustainable materials and technology stems from low awareness, poor design, and weak communication.

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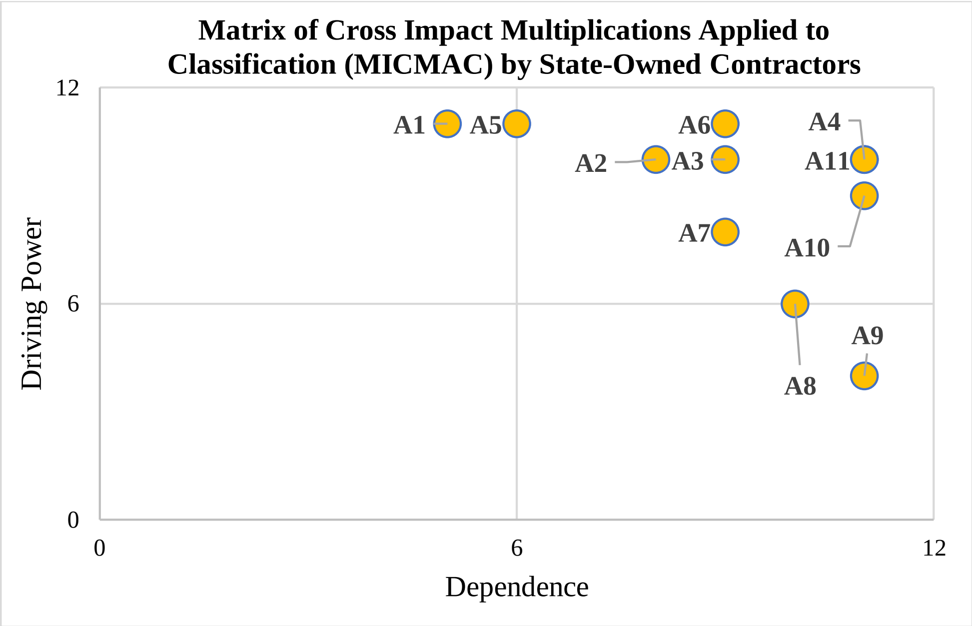
ISSN (Print) 2503-2399

- At **Level 4**, barriers A9 (Longer payback period) and A10 (Lack of professional expertise in sustainability) are significant issues, particularly because the return on investment in environmentally friendly technology is considered uneconomical. On the other hand, the availability of experts in sustainability is still very limited.
- **Level 5** is occupied by A8 (Low level of implementation of sustainable practices), which represents the weakness of sustainable practices in project implementation. This barrier is a tangible manifestation of the accumulation of problems at higher levels—when poor design, weak communication, incompetent management, and lack of incentives are present, sustainable practices cannot be implemented effectively.
- Finally, **Level 6** shows A7 (Lack of incentives from the government) as the most influential obstacle. This indicates that government incentives are not the root of the problem in the private sector, but rather a form of external support that will only have an impact if internal obstacles have been overcome first.

4.5 Matrix of Cross Impact Multiplications Applied to Classification (MICMAC)

The creation of MICMAC is based on the value of driven power and the dependence of each obstacle variable output from the reachability matrix process. This matrix shows what obstacle variables are included in the sector or quadrant.



Source :Research Result 2025

Figure 4. MICMAC Matrix by State-Owned Contractors

Following the structural mapping of interrelationships among the identified barriers using the Interpretive Structural Modeling (ISM) approach, a classification analysis was subsequently performed through the application of the MICMAC (Matrice d'Impacts Croisés Multiplication Appliquée à un Classement) method. This analysis was designed to categorize the barriers according to their driving power and dependence level relative to other factors within the system.

The results of the MICMAC mapping are presented in Figure 4. Based on the positional distribution of each barrier within the matrix, several key insights and classifications can be inferred as follows:

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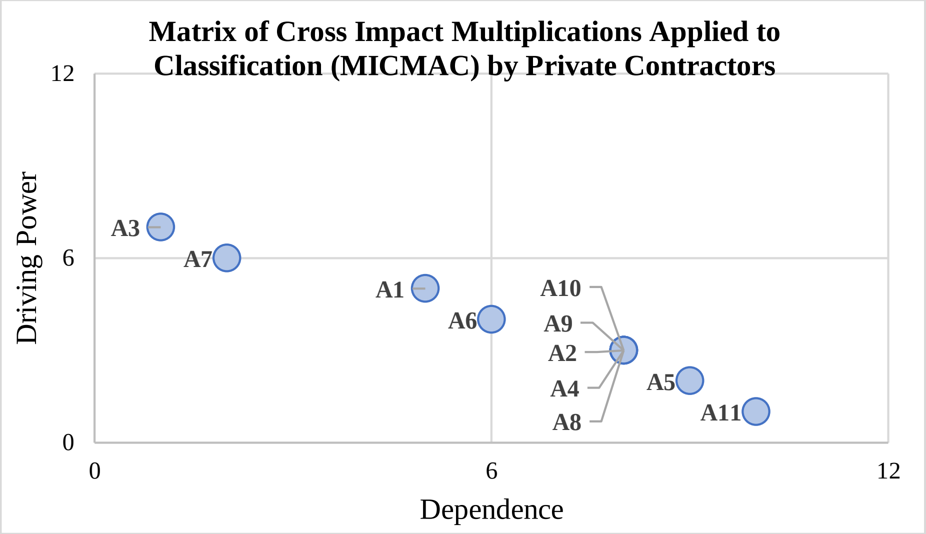
- Barriers A1 (Lack of knowledge and standards) and A5 (Absence of binding regulations) are in the independent quadrant (driving variables), indicating that these barriers are root causes that greatly influence other barriers, but are not greatly influenced themselves. Therefore, policy intervention on these barriers is very important as an initial strategy.
- Barriers A8 (Technological limitations) and A9 (High initial costs) are in the dependent quadrant, meaning these barriers arise as a result of other barriers. Addressing these barriers must be preceded by resolving barriers in the independent or linkage quadrants.
- Barriers such as A3 (stakeholder perceptions), A4 (lack of communication between parties), A6 (lack of incentives), A7, A10, and A11 are in the linkage quadrant, indicating complex relationships between mutual influence and mutual dependence. Changes to these obstacles will have a broad effect, but they are also susceptible to changes in other variables. Therefore, these obstacles need to be addressed with a systemic and sustainable approach.
- There are no obstacles in the autonomous quadrant, which indicates that all identified obstacles are closely related to the system of obstacles to sustainable construction implementation.



Source :Research Result 2025

Figure 5. MICMAC Matrix by Private Contractors

The MICMAC analysis in **Figure 5** for private contractors reveals that the majority of barriers—namely A2, A4, A5, A8, A9, A10, and A11—are positioned within the dependent quadrant, characterized by low driving power and high dependence. This placement suggests that these barriers tend to emerge as consequences of other, more influential barriers within the system.

In contrast, barriers A3 and A7 are situated in the linkage quadrant, indicating a moderate level of both influence and dependence, and therefore representing variables that are both affected by and exert influence on other factors. Barriers A1 and A6 appear near the central axis of the matrix, suggesting a moderate role in the system's dynamics.

Notably, the analysis does not identify any barriers occupying the independent quadrant, which typically consists of highly influential, foundational drivers. This contrasts with the pattern observed in state-owned contractors, where clear independent barriers are present. These findings imply that, within the context of private contractors, barriers tend to be more dispersed and interconnected, with internal organizational factors emerging as the primary root causes of challenges in implementing sustainable construction practices.

ISSN (Online) 2620-7222
ISSN (Print) 2503-2399

5. Conclusion and Suggestion

5.1 Conclusion

The hierarchical analysis of barriers to sustainable construction implementation, conducted through the Interpretive Structural Modeling (ISM) methodology, demonstrates marked disparities between state-owned contractors and private contractors with respect to the prioritization, nature, and structural interrelations of the barriers encountered.

In the case of state-owned contractors, the most prominent barriers identified within the hierarchical structure include A1 (Lack of knowledge and standards), A5 (Project manager incompetence), and A6 (Limited sustainable materials and technology). Unlike private contractors, whose primary challenges are predominantly internal and operational, the barriers confronting state-owned contractors are more deeply embedded in institutional complexity, fragmented coordination mechanisms, and underdeveloped governance frameworks with respect to sustainability. These findings underscore the necessity of adopting a systemic and integrative approach as a critical prerequisite for facilitating the transition toward sustainable construction practices within the public contracting sector.

Conversely, in private contractors, barriers A1 (Lack of knowledge and standards), A2 (Poor design practices), and A4 (Lack of communication between parties involved in the project) were identified at the highest level of the hierarchy (Level 1). This position indicates that these barriers have high driving power and act as the main causal factors triggering other barriers within the system. The dominance of internal aspects and external policies as the main barriers indicates that the private sector faces fundamental issues in terms of resource readiness and accessibility to policy instruments supporting the implementation of sustainability.

5.1 Suggestion

This study investigates the priority barriers encountered by two key stakeholder groups—state-owned and private contractors—who play a pivotal role in advancing the construction sector. The findings reveal substantial differences in the nature and structure of barriers faced by these two categories of contractors with regard to the implementation of sustainable construction practices. Such divergence underscores the necessity for differentiated strategic approaches tailored to the specific challenges inherent within each stakeholder group.

Building upon these findings, future research may focus on the formulation of alternative intervention strategies aimed at addressing the distinct barriers identified, particularly within the context of Indonesia’s construction sector and, more specifically, in urban areas such as Makassar. The insights generated from this study are expected to serve as a practical reference for project executors, especially contractors, in designing appropriate risk mitigation frameworks to effectively manage potential obstacles to the realization of sustainable construction goals.

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