DEVELOPMENT OF POLICY INTERVENTIONS ON WOOD USE IN THE CONSTRUCTION SECTOR

ITTO PD 928/22 Rev.1 (I)
Development Of Sustainable Domestic Market
For Wood Products

Jakarta, February 2025



INTERNATIONAL TROPICAL TIMBER ORGANIZATION

JAPANGOV THE GOVERNMENT OF JAPAN

MAFF Ministry of Agriculture, Forestry and Fisheries

MINISTRY OF FORESTRY REPUBLIC OF INDONESIA

FINAL REPORT ACTIVITY 2.2

DEVELOPMENT OF POLICY INTERVENTIONS ON WOOD USE IN THE CONSTRUCTION SECTOR

Prepared by:
Irfan Kemal Putra - National Consultant of ITTO Project PD 928/22 Rev.1 (I)

Editor:
Dr. Rina Kristanti - Project Coordinator ITTO Project PD 928/22 Rev.1 (I)

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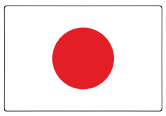

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MAFF
Ministry of Agriculture,
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Executing Agency

Mr. Erwan Sudaryanto

Krisdianto, Ph.D. (former)

Dr. Drasospolino (former)

Dr. Ristianto Pribadi (former)

Director of Forest Product Processing and Marketing,
Directorate General of Sustainable Forest Management, Ministry of Forestry

Dr. Deden Nurochman

Dr. Sudarmalik (former)

Deputy Director of Forest Product Processing Planning
Directorate General of Sustainable Forest Management, Ministry of Forestry

Project Coordinator

Dr. Rina Kristanti
Policy Analyst of Sustainable Forest Management,
Directorate General of Sustainable Forest Management, Ministry of Forestry

Address: Manggala Wanabakti Building, Block I, 11th Floor,
Jl. Gatot Subroto, Jakarta 10270
Phone number: +62 21 5704618
Fax number: +62 21 5704618
Email: itto.woodproduct@menklhk.org
Website: https://sihutanku.phl.menlhk.go.id/

EXECUTIVE SUMMARY

The policy on the use of construction materials in Indonesia has generally balanced the obligation to use materials with technical quality standards, such as SNI; and ethical standards that take into account the principle of environmental sustainability. As a policy instrument, several SNI standards have been adopted into formal regulations that must be referred to by relevant stakeholders. These regulations are the embodiment of Law Number 20 of 2014 concerning Standardization and Conformity Assessment which states that SNI is mandatory if it is related to safety, security, health, and environmental preservation. In the construction sector, the obligation to use SNI standard materials is strengthened through the enactment of the Ministerial Regulation (Peraturan Menteri – Permen) PUPR Number 22 of 2018 concerning the Construction of State Buildings.

On the other hand, policies related to ethical standards in the context of wood material use have also been made available through various policies that regulate environmentally friendly labels (through Ministerial Regulation of the Environment and Forestry Number 5 of 2019 concerning Procedures for Applying Environmentally Friendly Labels for Procurement of Environmentally Friendly Goods and Services) and SVLK (Ministerial Regulation of the Environment and Forestry Number 8 of 2021 concerning Forest Management and Preparation of Forest Management Plans, as well as Forest Utilization in Protected Forests and Production Forests) in the environmental and forestry sector. Although for the domestic market, the implementation of Timber Legality Verification System (Sistem Verifikasi Legalitas Kayu – SVLK) is still voluntary, the obligation to procure goods and services that have an environmentally friendly label as stipulated in Presidential Regulation (Peraturan Presiden - Perpres) Number 12 of 2021 concerning Amendments to Presidential Regulation Number 16 of 2018 concerning Government Procurement of Goods/Services has limitedly increased the voluntary nature of the use of SVLK-certified wood to mandatory. In line with these efforts, the construction sector supports these efforts by ratifying PUPR Ministerial Regulation Number 14 of 2020 concerning Standards and Guidelines for Procurement of Construction Services Through Providers which emphasizes the Principles of Sustainable Construction.

Unfortunately, there is currently no push towards mainstreaming bio-based materials for the construction sector, while Indonesia is currently developing the National Capital City (Ibu Kota Negara – IKN) with massive construction activities. The lack of these efforts is reflected in the absence of coordinated and cross-sectoral policies prioritizing the use of SVLK-certified wood materials on a national scale and many wood and wood construction standards that need to be updated. Because this issue is closely related to the policy of not requiring SVLK for domestic wood products, this problem requires the role of the Coordinating Ministry, both the Coordinating Ministry for Maritime Affairs and Investment and the Coordinating Ministry for Economic Affairs.

Another gap is Government Regulation (Peraturan Pemerintah – PP) Number 16 of 2021 concerning the Implementing Regulations of Law Number 28 of 2002 concerning Building Construction which only requires the obligation to use environmentally friendly materials in the Technical Requirements regulations in the construction sector only for green buildings (Bangunan Gedung Hijau – BGH). Where the criteria for mandatory BGH buildings are very loose and do not comply with the Principles of Sustainable Construction.

Gaps were also found related to the implementation of regulations that were not running well at the sub-national level and the lack of understanding of stakeholders in the construction sector

regarding sustainable principles. Findings on the implementation of policies related to the rules that apply in the construction sector show that the implementation of the rules-in-use that were implemented deviated from the applicable rules-in-form. Many Regional Government Organizations (OPD) still require the use of wood materials based on PKKI NI-5 of 1961 in their standard procedures instead of using SNI 7973:2013 which is currently stated to replace the old rules. Based on the various findings above, this study found at least four typologies of gaps, namely: the existence of policy gaps, lack of socialization of national regulations at the regional level, the need to increase the knowledge capacity of stakeholders in the construction sector, and the urgent need for cross-sector collaboration efforts.

To address the various gaps identified as outlined, this study recommends the following (but not limited to):

1. Increasing the role of the Coordinating Ministry through immediate consolidation efforts to formulate policies related to wood and the use of SVLK-certified bio-based materials in government procurement, including government building construction activities. This includes the preparation of a National Strategy document related to wood and other bio-based materials;

2. Careful tightening of mandatory green buildings criteria to prevent policy disincentives, and considering the existence of the following:
   a. Only applicable to government building construction;
   b. The proposed regulation has an alternative clause that provides dispensation until the institutional architecture at the subnational level is ready;
   c. Encourage the use of bio-based materials;
   d. There is a clause providing certain incentives based on a percentage of the use of ecolabel-certified biomaterials, and
   e. Involve cross-sector stakeholders in policy formulation;

3. Encourage collaboration between stakeholders through:
   a. Partial implementation of mandatory use of SVLK-certified wood (only applied to some stakeholders), especially for the construction of government buildings;
   b. Synchronization of policies and policy instruments and their renewal with the involvement of cross-sector stakeholders;
   c. Encourage the formation of aggregators for MSMEs engaged in the construction wood (wood entrepreneurs who sell wood materials for construction) and wood construction (entrepreneurs who work in the field of building construction using wood as the main material). Through this kind of conglomerate system, micro, small, and medium business actors can overcome financial limitations and production capacity that generally prevent them from participating in the procurement of goods and/or services at LPSE. This aggregator can be formed, either by the government (in the form of a cooperative) or the private sector (in the form of a cooperative or consortium);
   d. Formation of a working group to accelerate, both the preparation of the National Strategy document and the use of bio-based materials that are certified environmentally friendly;

4. Intensifying efforts to socialize regulations and increase the capacity of stakeholders in the construction sector related to the relevance of this sector to environmental sustainability, climate change mitigation, and the Principles of Sustainable Construction, as well as

5. Updating standardization related to outdated wood and wood construction specifications as well as efforts to improve the implementation of these standards domestically.

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ABBREVIATIONS

ANSI : American National Standards Institute
AWC : American Wood Council
BSLHK : *Badan Standardisasi Lingkungan Hidup dan Kehutanan* (Environmental and Forestry Standardization Agency)
BSN : *Badan Standardisasi Nasional* (National Standardization Agency)
ECHA : European Chemical Agency
FMU : Forest Management Units
GDP : Gross Domestic Product
GHG : Greenhouse gas
HSD : *Harga satuan dasar* (basic unit price)
IKN : *Ibu Kota Negara* (National Capital City)
JCC : Jakarta Convention Center
Kepmen LHK : *Keputusan Menteri Lingkungan Hidup dan Kehutanan* (Decree of the Minister of Environment and Forestry)
KLHK : *Kementerian Lingkungan Hidup dan Kehutanan* (Ministry of Environment and Forestry)
LPSE : *Layanan Pengadaan Secara Elektronik* (Electronic Procurement Services)
LPVI : *Lembaga Penilai dan Verifikasi Independen* (Independent Assessment and Verification Institution)
MoE : Modulus of Elasticity
MSME : Micro, small, and medium enterprises
NDC : Nationally Determined Contribution
NDS : National Design Specification
NSPK : *Norma, Standar, Prosedur, dan Kriteria* (Norms, Standards, Procedures, and Criteria)
NTFP : Non-timber forest product
Permen LHK : *Peraturan Menteri Lingkungan Hidup dan Kehutanan* (Regulation of the Minister of Environment and Forestry)
Permendag : *Peraturan Menteri Perdagangan* (Regulation of the Minister of Trade)
Permen PUPR : *Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat* (Regulation of the Minister of Public Works and Public Housing)
Perpres: *Peraturan Presiden* (Presidential Decree)
PKKI : *Peraturan Konstruksi Kayu Indonesia* (Indonesian Timber Construction Regulations)
PP : *Peraturan Pemerintah* (Government Regulation)
PU : *Pekerjaan Umum* (Public Works)
PUPR : *Pekerjaan Umum dan Perumahan Rakyat* (Public Works and Public Housing)
RIL-C : Reduced Impact Logging-Carbon
ROCCIPI: Rule, opportunity, capacity, communication, interest, process, dan ideology
RSNI : *Rancangan Standar Nasional Indonesia* (Draft of Indonesian National Standards)
SMKK : *Sistem Manajemen Keselamatan Konstruksi* (Construction Safety Management System)

SNI	:	*Standar Nasional Indonesia* (Indonesian National Standards)
S-Legalitas	:	*Sertifikat Legalitas* (Certificate of Legality)
S-PHL	:	*Sertifikat Pengelolaan Hutan Lestari* (Sustainable Forest Management Certificate)
SVHC	:	Substance of Very High Concern
SVLK	:	*Sistem Verifikasi Legalitas Kayu* (Timber Legality Verification System)
TKDN	:	*Tingkat Kandungan Dalam Negeri* (Domestic Content Level)
TOR	:	Terms of References
UU	:	*Undang-undang* (Law)

I. INTRODUCTION

1.1. Backgrounds

The wood industry is generally a potential market in Indonesia. This prospect arises from Indonesia's population growth with an average rate of 1.26% over the past 10 years[1]. Rationally, population growth will also increase the need for property that requires various construction raw materials, including wood. Based on data from Sunarsip (2024), the projected growth of the property sector in Indonesia in 2024 is 5 – 10%. This figure is based on calculations of the projected need for 700 – 800 thousand housing units each year. According to the same source, this figure has the potential to be higher considering the vision and mission documents of the new Indonesian government which seeks to encourage the construction of 2 million housing units per year.

The projection of increasing housing needs and the growth of the construction market is an opportunity for the wood industry, including construction wood in Indonesia. Through the support of appropriate policy incentives, the wood industry can generate various economic benefits, not only in the form of Gross Domestic Product (GDP) but also from other multiplier effects such as labor absorption and local economic movements. Not only to improve the performance of the processed wood industry, policy optimization is also needed by business actors in this sector as an effort to mitigate threats that arise along with technological developments. Some of these threats include the availability of various substitute products on the market, including construction wood, as well as the abundance of imported wood at competitive prices in Indonesia.

Until now, the processed wood industry in Indonesia has contributed greatly to the economy. Data of BPS (2013) shows that the wood industry contributed more than IDR 82 trillion to Indonesia's Gross Domestic Product (GDP). Although it is of great value, this contribution is only equivalent to 4% of the total GDP in that year. Moreover, based on the 2022 wood export data issued by (OEC 2024)[2] shows that Indonesia is still ranked 10th among the world's processed wood exporters with a transaction value of IDR 90.23 trillion, below China (ranked 1; IDR 333.19 trillion), and Vietnam (ranked 7; IDR 107.37 trillion). This means that there is still room for improving the performance of this industry which can be pursued by the government through various interventions and policy incentives. Moreover, several of the top 10 exporting countries have much smaller wood-producing areas compared to Indonesia, such as Germany, Poland, Vietnam, Austria, and Sweden.

1 Based on data from the Central Statistics Agency (*Badan Pusat Statistik* – BPS), where the 2024 data was last updated on June 28, 2024. Available at: https://www.bps.go.id/id/statistics-table/2/MTk3NiMy/laju-pertumbuhan-penduduk.html

2 This site provides downloadable statistical data tabulations in various versions, including Excel: https://oec.world/olap-proxy/data?cube=trade_i_baci_a_92&Section=9&Year=2022&drilldowns=Exporter+Country&locale=en&measures=Trade+Value&parents=true&sparse=false&properties=Exporter+Country+ISO+3

This explanation is the basis for the implementation of this study entitled "Development of Policy Interventions for the Use of Wood Materials in the Construction Sector". This study will discuss various possible efforts to increase the contribution of the construction wood industry, as part of the overall wood industry, to the economy in Indonesia through a policy implementation approach. The success of increasing the role of the construction wood industry in the economy in Indonesia is expected to provide a similar domino effect on all sub-sectors of the wood industry.

1.2. Formulation of the Problems

The wood industry, including construction wood, in Indonesia has contributed greatly to the economy. However, efforts to improve the performance of the industry can still be improved as an effort by the government to support construction wood industry players. The need for this optimization is evident from Indonesia's processed wood export capacity which is still lower compared to several countries with smaller wood-producing areas, such as Vietnam and Poland for example (OEC 2024).

Not only the need for optimization, the construction wood industry is currently also facing challenges from the flood of construction wood substitute products available in the domestic market. The development of technology and construction design that exists today has made various products such as gypsum board, light steel, glass, concrete, plastic, and wood composites, to aluminum as choices for consumers that have the potential to suppress sales of construction wood products.

The explanation shows the need for government policy intervention in the wood industry, including construction wood, in Indonesia. Industry optimization through this policy approach is important for business actors in terms of, among others (but not limited to):

1. As a guide for business actors in implementing the construction wood administration mechanism;
2. Availability of various policy incentives that can encourage industry sustainability, such as:
    a. Assurance of sustainable raw material supply;
    b. Improvement of construction wood administration;
    c. Compliance with various prerequisites applied by several countries;
    d. Ease of access to various components in the construction wood industry (e.g. certification, wood processing equipment, market access, etc.), and
3. Certainty of the business climate.

By the main topic of the study and the formulation of the problem above, the questions raised in this study are:

1. What are the policy incentives currently available in Indonesia for the construction wood industry?
2. What policies are considered necessary to be implemented in Indonesia related to the construction wood industry? This question is also to find out what kind of policy updates are needed to adjust to the current conditions of the construction wood market.

1.3. Study Objectives

Relevant to the background and formulation of the problem above, the purpose of this study is to optimize the construction wood industry in Indonesia by providing analysis-based recommendations for policy implementation. To achieve this goal, this study has intermediate objectives to obtain various analysis results, as follows:

1. The need for intervention and implementation of policies relevant to the wood and construction wood industry in Indonesia, and
2. The need for policy reforms required to optimize the domestic construction wood industry.

1.4. Expected Outputs

Specifically, this research is expected to be a scientific recommendation for the preparation of policy incentives needed by decision-makers, both at the regional and central levels related to the development of the construction wood industry. In addition, other expected outputs from the results of this study are an enrichment of scientific knowledge related to policies in the primary and tertiary wood industry (advanced).

1.5. Scope of the Study

Under the objectives and background of the study, the focus of this study is to analyze the policies currently available for the construction wood industry in Indonesia. These policies will then be compared for their suitability with the factual conditions in the field. This study will limit the focus of the study only to policies, both formal and factual, related to the use of wood materials in the construction sector.

As a disclaimer, to comply with the objectives stating that this study is an effort to provide recommendations based on the results of the analysis of the implementation of construction wood industry policies and because this study focuses on the availability of policies related to the construction wood industry and their factual implementation, the content of this study can be input for various relevant stakeholders. Therefore, openness to receiving input is expected from various parties regarding the potential sensitivity that arises from the results of the gap analysis of policies and their implementation in this study.

1.6. Framework

The framework of thought in this study departs from the supply chain of wood raw materials needed for industry which is highly dependent on policies, markets, and market share. Where the interrelationships will return as a form of learning and the basis for decision-making and/or the preparation of policies/regulations. The depiction of the framework of thought is presented in Figure 1.

This study only focuses on the development of policy incentives related to construction wood, with a focus on the use of wood materials in the construction sector. Based on this framework of thought, this policy is expected to have an impact on the wood market and industry. Depending on the scope of the policy produced from this manuscript, the impact of the policy on the market has the potential to occur, both in export and/or domestic share.

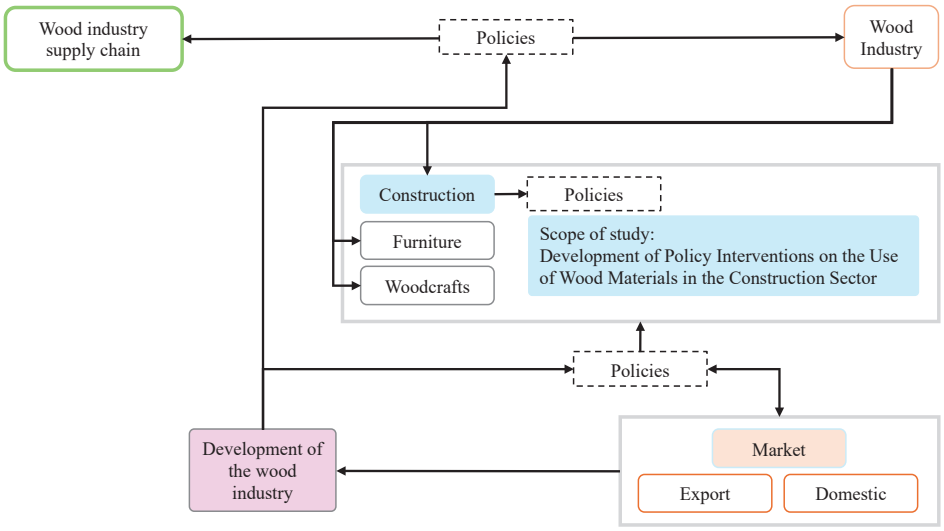

Figure 1. Study framework

II. METHODS

2.1. Location and Time of Research

This study was conducted in several locations, both at the central and sub-national levels. The selection of the study locus was based on the premise that the policies related to the use of wood materials in the construction sector implemented by the Central Government were well implemented in various regions in Indonesia, including at the sub-national level. Relevant to the context of wood raw materials, the involvement of respondents from the regions was carried out based on the assumption that the existence of forest areas, as a source of wood raw materials, is more widely available outside Java. In addition, by involving respondents from outside Java, this study is also expected to reveal institutional and architectural capacities that correlate with readiness to implement policies at the national level.

This study is designed for the implementation of activities for three months starting from July 2024 and is expected to be completed in September 2024. Details of the study implementation timeline are presented below (Table 1).

Table 1. Research timeline

No.	Activities	Month 1				Month 2				Month 3			
		W1	W2	W1	W2	W3	W4	W3	W4	W1	W2	W3	W4
1.	Drafting Inception Report												
2.	Data collection												
3.	Writing												
4.	Reporting, revision, and approval												

2.2. Data Collection Methods

This study uses primary and secondary data as the basis for analysis of the topic being studied. Primary data were collected through various semi-structured interview sessions, both face-to-face and by telephone, with construction wood industry players at the research locus. Meanwhile, secondary data collection was carried out through literature studies of various appropriate data sources such as research journals, regulatory documents, articles, and journalistic publications.

2.3. Data Analysis dan Study Methods

This study uses two different analysis methods on existing policies with factual policy incentives needed by actors in the construction wood industry, namely: gap analysis and ROCCIPI (rule, opportunity, capacity, communication, interest, process, and ideology). The ROCCIPI method was chosen because it can comprehensively analyze and view the failure of regulatory implementation from various aspects (Putra 2018). The ROCCIPI theory suggests the use of seven broad categories to help generate all possible hypotheses regarding the causes of a series of relevant social actor behaviors, such as: rules, opportunities, capacity, communication, interests, processes, and ideology (Seidman, Seidman, and Abeysekere 2003). The implementation also aims to explore the suitability between policies and their implementation in the field. Meanwhile, gap analysis is used to identify the difference between what is happening (current state) and what should happen (desired state), and is used to design organizational implementation plans and to improve institutional effectiveness (Kim and Ji 2018). Most of these activities use secondary data, except for observations of factual policy needs by industry actors which are carried out directly through a semi-structured interview process.

All information collected in this study will go through a data validation process. Data validation is useful as a mechanism for checking data accuracy, thereby reducing the potential for analysis bias. Data validation activities are carried out using several methods, i.e.:

1. Data triangulation: by cross-checking data through several sources (Putra 2018);
2. Discrepant Information: by providing a different perspective on a topic, and
3. *Peer Debriefing*: by discussing with fellow researchers to get alternative interpretations related to a topic (Kristanti 2020).

After undergoing the validation process, all data and information collected will go through the assumption analysis process. This activity is carried out to identify the role of policy actors from the formal legal aspect and identify the realization or implementation of these roles at the study location (Kristanti 2020). The stages of assumption analysis are as follows:

1. Identification of policy actors based on the stakeholder map that has been prepared;
2. Identification of important assumptions based on regulations that regulate the division of roles of actors;
3. Comparison between the rules written in the regulations (rules-in-form) with the implementation of regulations in the field (rules-in-use) at the study location;
4. Conducting a gap analysis between assumptions and implementation, and
5. Synthesis of the issues.

III. ON THE USE OF WOOD MATERIALS IN THE CONSTRUCTION SECTOR

The use of wood materials in the construction sector has developed through various innovations. The form of innovation that has been carried out, is not only through wood material engineering, diversification of wood material types, and various wood products but also through expanding the use of wood in the construction sector.

3.1. The Innovation in the Use of Wood in Buildings

As a material that is easily found in nature, the use of wood as a construction material itself has been used since the prehistoric era. For example, the European Neolithic longhouse that has been used since 6000 BC is a wooden building that can accommodate up to 30 people (Woods 2016). The same source also states that the use of wood as a construction material continues into the modern era. Although the discovery of various elements such as bronze and steel has changed and improved the way wood is applied to building construction, wood continues to be used to make simple buildings such as log cabins, and other buildings such as houses of worship.

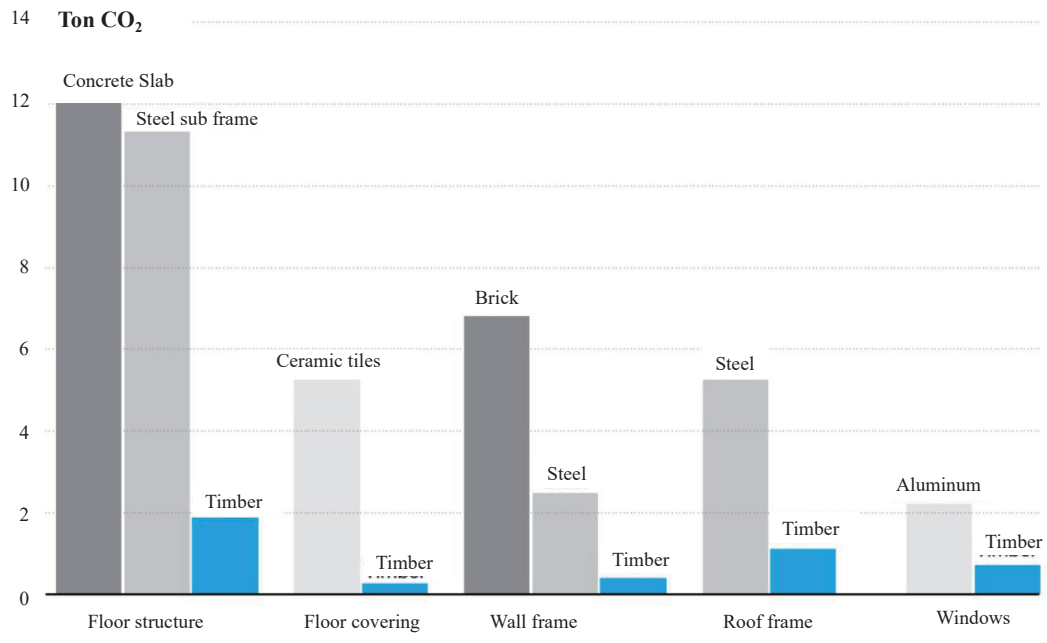

Figure 2. CO_2 emissions from various construction materials (Hadi 2024)

In buildings that use geo-based materials (concrete and/or brick) as the main raw material, wood is generally still used as a roof frame, windows, doors, or carpentry tools during the simple construction phase. However, with the increasing human consideration of emissions caused and the low sustainability factor of raw material availability, many innovations have now emerged related to building designs using bio-based materials as the main raw material, such as wood or bamboo. Based on Auclair (2023), CO_2 emissions from every $1m^3$ of wood material can absorb 960kg of CO_2, inversely proportional to construction materials made from steel (6,800kg of CO_2) or concrete (1,700kg of CO_2) (Figure 3). Moreover, wood also has a combination of strength, stiffness, and aesthetics, has relatively high compressive and tensile stress, is durable, acts as a damper, and can absorb energy in earthquake areas (Nugroho 2024). This explanation makes bio-based construction materials need to be encouraged to ensure environmental sustainability. One of the efforts is to encourage the use of biomaterials such as wood and/or bamboo as the main raw materials in the construction sector.

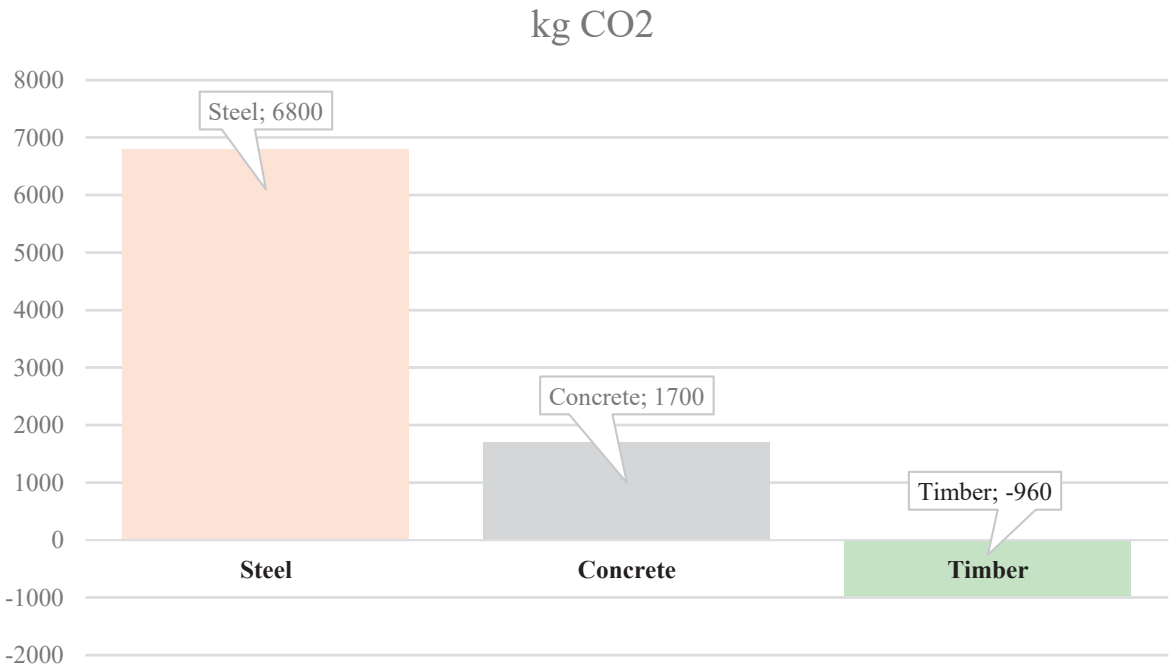

Figure 3. CO_2 emissions per $1m^3$ of construction materials (Auclair 2023)

In line with the issue of emissions in the construction sector, the construction sector currently has various designs of wooden structure buildings, both houses and buildings. Such wooden building construction has various advantages that are not/less possessed by buildings with non-wooden construction materials due to wood materials such as (Nugroho 2024):

1. Renewable natural resources;
2. Relatively easy to form into other products;
3. Strong, lightweight, easy to work with, and easy to form construction materials according to needs;
4. Has elastic, ductile, and load-resistant properties at certain points;
5. Aesthetic;
6. Highly durable when used in protected areas;
7. Relatively inexpensive;

8. Resistant to chemicals and electric currents;
9. Soundproof, and
10. Can be naturally decomposed.

The various advantages offered by wood materials as explained above, as well as the high diversification of wood product types, have encouraged the expansion of wood use as a raw material for mass timber construction. The term mass timber construction refers to a frame style that is usually characterized by the use of large solid wood panels for wall, floor, and roof construction (How 2021). Furthermore, the same source also states that such construction mechanisms are classified as a new category of wood products consisting of several solid wood panels glued or nailed together.

3.1.1. Modular House

Some mass timber construction products that are currently commonly available in Indonesia include wooden houses and modular houses. Wooden houses are commonly found in buildings that use traditional designs in various cultures in Indonesia. Meanwhile, modular houses have begun to be built in large cities in Indonesia. Modular or prefabricated house design refers to the use of the same module in different configurations, allowing for design variations without using many types of components (Adriana 2024). This system is also an action of making building components in a factory which are then sent to the construction site to be assembled or constructed on-site until ready for occupancy according to the intended design concept (Tanaya 2021). This means that this type of house uses a building construction method by uniting or assembling house components that have previously been made in the factory. This means that the components of the house, often referred to as modules, are made in the factory, and then assembled on the land where the residence is located (Laksono 2023).

Modular houses have several disadvantages, namely: limited design options, high transportation costs, inability to be built in locations with limited access (Sanny 2024), and there is possibility that it is more difficult to resell (Fadli and Alexander 2022). Despite its disadvantages, according to (Sanny 2024), this type of house has several advantages that are much more, including:

1. Short construction time

   The assembly process of the modules on the construction site is much faster than traditional construction methods. This allows residents to occupy their homes faster.

2. Cost efficiency

   Modular homes are generally more cost-effective because they are mass-produced in factories, reducing labor and material costs.

3. Precision construction

   Modular home modules are manufactured to controlled quality standards in the factory, resulting in more precise and accurate construction results.

4. Flexible design

   Modular homes offer high design flexibility. Buyers can choose from a variety of module models and sizes to create a home that suits the needs and preferences.

The materials that can be used to make modular houses are quite varied, they can be concrete panels with bolts or wood. For houses made from concrete panels, the Ministry of Public Works and Public Housing (*Pekerjaan Umum dan Perumahan Rakyat* – PUPR) has innovated by providing modules for Simple and Healthy Instant Houses (*Rumah Instan Sederhana dan Sehat* – RISHA). This house uses knock-down construction technology that can be built quickly, using reinforced concrete as its main structure, has the Indonesian National Standard (*Standar Nasional Indonesia* – SNI), and is affordable. This innovation is based on the need to accelerate the provision of affordable housing while maintaining building quality according to standards (SNI)[3]. Meanwhile, for wood materials, several well-known mass timber construction products are common on the market. These products include glued-laminated components (glulam), laminated veneer lumber (LVL), nail-laminated timber (NLT), dowel-laminated timber (DLT), and cross-laminated timber (CLT) (How 2021).

Figure 4. Modular house and its construction processes[4]

3.1.2. Mass Timber Construction

Although modular houses have begun to be commonly available in Indonesia, however, several cities abroad have now built high-rise buildings using mass timber construction (Figure 4 and Table 2). The existence of buildings with this kind of construction, especially those that are residential-oriented, is expected to solve problems in big cities related to land limitations (Melati, Pinassang, and Suwarlan 2024).

Table 2. List of buildings that use mass timber construction (Adriana 2023)

Building Name	Height (m)	Number of Floors	Location	Year of Built
Badenerstrasse Mixed-Use Building	N/A	6	Switzerland	2010
Bridport House	27	8	UK	2011
Earth Sciences Building	N/A	5	Canada	2012
LCT One	27	8	Austria	2012
Strandparken Hus B	N/A	9	Sweden	2012

3 As described in the official PUPR open data website. Can be accessed at: https://data.pu.go.id/visualisasi/rumah-instan-sederhana-sehat-risha

4 As explained by Dr. Maryoko Hadi in the Wood and Bamboo Seminar, Ministry of PUPR, April 25, 2024.

Woodcube	N/A	6	Germany	2013
Tamedia Head Office	N/A	7	Switzerland	2013
Via Cenni Social Housing	27	9	Italy	2013
Bullitt Center	N/A	6	US	2013
T3 Minneapolis	26	7	US	2014
Wood Innovation and Design Centre	29,5	8	Canada	2014
Puukuokka Housing Block	N/A	8	Finland	2015
Wenlock Road Mixed-Use Building	30	10	UK	2015
Treet Apartment Building	52,8	14	Norway	2016
Brock Commons Tallwood House	53	18	Canada	2017
25 King Street Office Building	52	10	Australia	2019
Mjostarnet	85,4	18	Norway	2019
HoHo Wien	84	24	Austria	2019

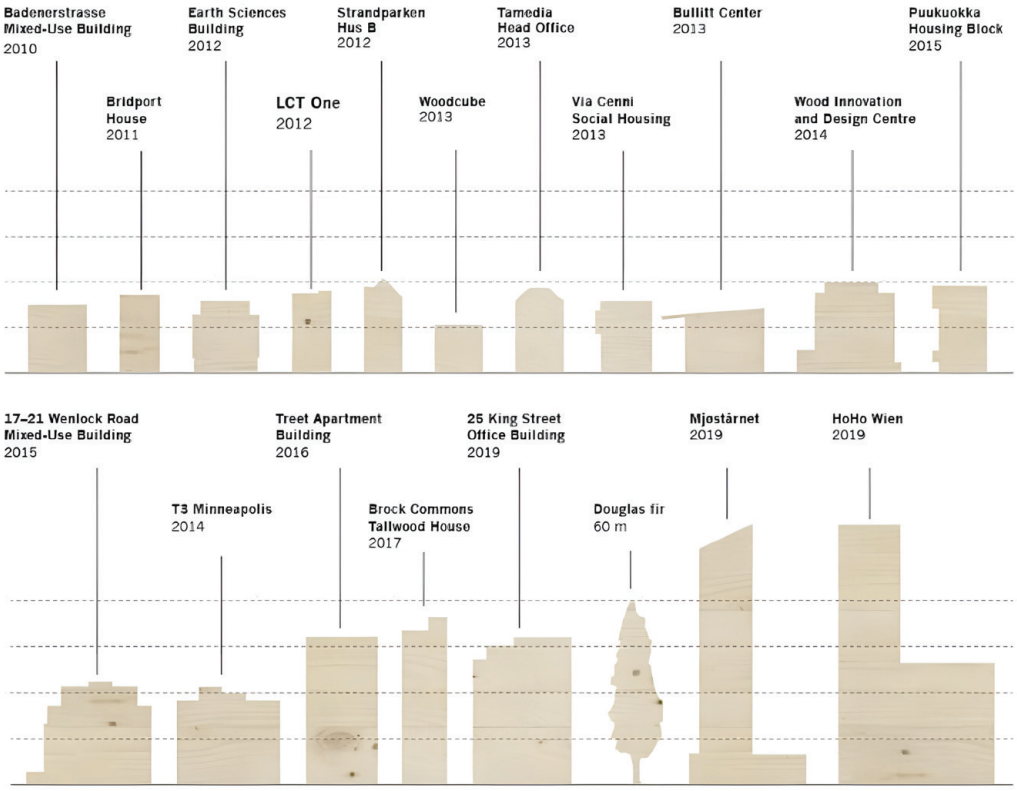

Figure 5. Some buildings that apply mass timber construction (Adriana 2023)

However, the construction of vertical buildings generally requires a fairly long time in the construction process. Based on census data in the United States in 2022, the average time required for the construction process of 5 – 9 building units takes 15.5 months, while for 10 – 19 units it is 17.3 months[5]. Meanwhile, more detailed data is provided by (Cunningham

5 Census data is available at: https://www.census.gov/construction/nrc/pdf/avg_starttocomp.pdf

and Orlando 2024) who found that the average construction time for multifamily housing in several regions in the United States is 12.3 months. The length of the completion period has the potential to cause high greenhouse gas (GHG) emissions in the construction sector. Based on a case study in China, the contribution of emissions in the construction phase is quite large, i.e. 210.93 tons of CO_2 equivalent emissions (tCO_2eq), or 2.42% of the total emissions released by a building (Hong et al. 2014). With the large potential for emissions, accelerating the construction duration is worth considering.

Figure 6. Centre Pompidou-Metz, France which uses glulam material (left) and Ascent Apartment, USA, which uses LVL material (right)[6]

One of the efforts that can be made to shorten the construction duration is by using modular or prefabricated materials. This is because by using raw materials that have been partially assembled beforehand, the acceleration of the construction process becomes possible – and has the potential to reduce the GHG emissions produced. This is per the research results of Putri, Tjandrawira, and Handayani (2021) which stated that the results of the emission analysis of the modular building project only produced emissions of 124,882.7 $kgCO_2eq$ or 283.18 $kgCO_2eq$ GHG per m^2 of building. The contribution of emissions from materials, modular material transportation components, and installation of precast components were 119,649 $kgCO_2eq$ (95.81%), 632.41 $kgCO_2eq$ (0.51%), and 4,599.30 $kgCO_2eq$ (3.68%) respectively.

Therefore, combining the use of wood materials with modular construction in development can encourage the implementation of sustainable construction, not only in terms of raw materials but also in terms of environmental sustainability – including low carbon emission levels. This means that this prospect needs to be encouraged through policies to be an incentive for players in the construction sector so that it can be in line with the national emission reduction program.

3.2. Innovation and Engineering of Wood Products

From the perspective of wood material usage, modular construction applications in the sector require proper safety standards. Some of the standards required include the resistance of wood materials to wood-destroying organisms, weather, and fire. However, the need for proper safety standards need to be applied widely for various types of potential risks. Therefore, this section of the paper will briefly discuss some examples of relevant innovations and standardization.

6 As explained by Dr. Maryoko Hadi in the Wood and Bamboo Seminar, Ministry of PUPR, April 25, 2024.

3.2.1. Durability Protection of Wood Materials

To ensure the suitability of materials, including for mass timber construction, wood requires certain standards. One of the standards required is related to the durability of the wood material used, where the term durability can refer to the durability of wood against various external factors such as wood-destroying organisms and weather. Assurance of the quality of this kind of durability in wood can increase the attractiveness of this material and affect its selling value. With the increasing consumer appeal to wood materials, it is hoped that it will change the trend of using geo-based materials to bio-based materials that are more environmentally friendly.

The resistance of wood material to termite attacks can be one of the attractions of wood products for consumers. This is rational considering that there are at least approximately 200 types of termites in Indonesia that caused economic losses of 1.67 trillion rupiah in 1995; 1.87 trillion rupiah in 1996; 2.79 trillion rupiah in 2000; 5.17 trillion rupiah in 2010, and 8.68 trillion rupiah in 2015 (Jasni and Rulliaty 2015). Regarding the resistance test of wood material types to termite attacks, the standardization of the test method has been available through SNI 01-7207-2006, where each type of wood will be categorized into several different classes based on their resistance (class I – V) to termite attacks. The standard has now also been updated through SNI 7207:2014 regarding the wood resistance test to wood-destroying organisms.

However, with the development of current science, the class of wood resistance to termite attacks can be increased through certain engineering. Some engineering that can be done include certain engineering on wood, such as heat treatment, furfurylation, acetylation, melamine treatment, and coating wood with wax (Scholz et al. 2010). Similar to increasing the strength of wood against termite attacks, equivalent engineering against fungal attacks has been widely carried out with a wide diversification of methods, such as the application of preservatives (both chemical and natural), coloring, including through carbonization (Wang et al. 2018). Not only that, currently Indonesia also has similar test standards for fungal attacks, such as in SNI 7207: 2014 regarding wood resistance tests against wood-destroying organisms and SNI 01-5010.6-2003 regarding the prevention of blue mold on round wood and sawn timber.

In fact, there are various other engineering efforts to increase the durability of wood against external disturbances such as weather factors, air humidity, and wood service life. However, this article will not discuss further and only provide some examples of innovations that have been made to prevent deviations from the focus of the study.

3.2.2. Fire Protection for Wooden Buildings

To encourage policies that support the use of bio-based materials such as wood, a little discussion about innovations related to safety becomes necessary. In addition to considerations of the mechanical strength of wood that has been commonly used in the selection of construction wood materials, fire resistance is also crucial. The significance of this need increases for buildings with mass timber construction. This is due to bio-based materials that tend to be flammable, thus compromising building safety.

One of the common innovations used to enhance wood fire resistance is by wood impregnation[7] with fire retardants, such as aluminum, boron, halogens (e.g. bromine), and

7 Wood impregnation is the application of an impregnating agent (usually fine substances) that diffuses into the cell walls of the wood. This treatment is often followed by polymerization to change the desired properties (Augustina et al. 2023).

more recently phosphorus and nitrogen, which are effective fire retardants on wood (Sauerbier et al. 2020). However, the same source states that some wood impregnation agents, such as bromine and boron, are included in the category of substances of very high concern (SVHC) by the European Chemical Agency (ECHA), therefore requiring tightening of regulations for their use.

Regarding the resistance of wood material to fire, Indonesia currently has its testing regulations in SNI 7973:2013. Not only the treatment of wood, this fire resistance test standardization also applies to fire-resistant designs and assemblies with various prerequisite specification settings in it. However, the standardization document does not mention the substances that can be used as impregnation agents. Therefore, the use of these chemical substances as wood impregnation agents needs to be returned to the relevant regulations.

IV. POLICIES ON THE USE OF WOOD MATERIALS IN THE CONSTRUCTION SECTOR IN INDONESIA

In recent decades, the construction sector at the global level has begun to show a shift in trend from previously using geo-based materials, such as steel and concrete, to bio-based materials derived from natural materials. This, as explained in the previous section, can be seen from the increasing use of mass timber construction in high-rise buildings in several developed countries, where wood is the dominant material used.

The shift in the use of these materials is motivated by the increasing awareness of stakeholders in the construction sector in several developed countries regarding the concept of sustainable development, including efforts to reduce GHG emissions. This is inseparable from the manufacturing process of geo-based materials used in the construction sector which tends to emit higher GHG emissions when compared to the harvesting process through sustainable forest management. In the sustainable forest management process that prioritizes a combination of low-impact logging methods on carbon emissions (Reduced Impact Logging-Carbon – RIL-C) and replanting, for example, GHG emissions from harvesting activities have the potential to be reabsorbed into the soil due to the metabolic process of plants that absorb CO2. Thus, there is a potential for equilibrium between the amount of carbon emissions produced in the harvesting process and the carbon absorption carried out by plants (carbon neutral). This assumption is per Subarudi et al. (2018) who stated that RIL-C can contribute to a reduction in emissions of 24 million tons of CO2/year. In contrast, the process of extracting and manufacturing geo-based materials can only produce carbon emissions without any emission reversal process as in reforestation.

The explanation above shows the importance of policies to encourage the expansion of the use of bio-based materials in the domestic construction sector, including mass timber construction. Through such policies, it is hoped that the construction sector can make a higher contribution to national efforts to reduce GHG emissions. Not only that, the expansion of the use of wood-based materials in the construction sector is expected to encourage the absorption of local wood products which indirectly have a positive impact on the economy. This need is increasing considering that Indonesia is currently also building the National Capital City (*Ibu Kota Negara* – IKN) with massive construction activities.

4.1. Regulations and Legislation Review on the Use of Wood Materials

As a set of rules, various forms of policies, both in the form of formal regulations (rules-in-form) and their implementation in the field (rules-in-use) can affect the action situation in the action arena[8]. Therefore, policy analysis is important to ensure the effectiveness and

8 Quoting Ostrom (2005), the action arena is an imaginary location where participants (stakeholders) position themselves and can make decisions.

improve the implementation of existing rules. Therefore, this study will examine various rules that apply in the construction sector, especially formal policies. By understanding the gap between rules and practices, we can identify potential problems and find solutions to improve compliance with regulations and the sustainability of wood material used in the construction sector.

4.1.1. Relationship between Regulations and Indonesian National Standards

The use of wood materials in the construction sector cannot be separated from the need for technical standards to ensure the quality and safety of a building. In addition, the ratification of the Regulation of the Minister of Public Works and Public Housing (Permen PUPR) No. 22/2018 concerning the Construction of State Buildings which requires the use of materials that comply with SNI is also an important reason for the discussion of policies in this sector, including its relation to SNI.

Based on Law (*Undang-undang* – UU) No. 20/2014 concerning Standardization and Conformity Assessment, SNI is definitively a standard set by National Standardization Agency (*Badan Standardisasi Nasional* – BSN) and applies in the territory of the Republic of Indonesia[9]. Rather than being a policy, SNI is developed as a market reference whose implementation is voluntary (Pusdatin BSN 2021). This standard is the only standard that applies nationally in Indonesia. SNI is formulated by the Technical Committee (BSN 2017; Jasni and Rulliaty 2015). Although SNI is not a policy, it can be used as a policy instrument when its implementation is required by government regulations to protect the community, safety, and national interests. Therefore, SNI can be seen as part of the government's efforts to regulate the quality, safety, and competitiveness of products within the framework of national policy.

As a standard that can be adopted voluntarily or mandatorily, SNI is positioned within the framework of technical regulations. These technical policies can be implemented through Ministerial Regulations, Government Regulations, or Presidential Decrees that make the application of SNI mandatory for certain products or sectors. Article 24 paragraph (1) of Law No. 20/2014 explains that voluntary SNI can be mandatory if it relates to safety, security, health, and environmental preservation. Based on data from BSN (2024), until July 2024, there were a total of 311 SNI that had been enforced mandatorily and/or referred to in regulations (Table 3).

Table 3. List of SNI recapitulations that have been required or referred to in regulations from each sector as of July 2024 (BSN 2024)

No.	Name of Technical Agency	The number of SNIs that have been adopted in regulations
1.	Ministry of Industry	129
2.	Ministry of Energy and Mineral Resources	88
3.	Ministry of Agriculture	6
4.	Ministry of Marine Affairs and Fisheries	2
5.	Ministry of Transportation	9
6.	Ministry of Public Works and Public Housing	44
7.	Ministry of Trade	22

9 Article 1 paragraph 7 of Law no. 20 of 2014.

No.	Name of Technical Agency	The number of SNIs that have been adopted in regulations
8.	Ministry of Communication and Information	5
9.	National Cyber and Cipher Agency	1
10.	Geospatial Information Agency	5

Regarding SNI in the forestry sector, proposals for standardization emerged from technical committees managed by the Environmental and Forestry Standardization Agency (BSLHK). The committees prepared various Draft Indonesian National Standards (*Rancangan Standar Nasional Indonesia* – RSNI) required by the forestry sector which were then submitted to the National Standardization Agency (BSN) after being approved internally. The latter institution then ratified the RSNI submitted as SNI through a Determination Letter from the Head of BSN (BSN 2020). The SNI document regulates the details of technical standards, one of which is related to wood specifications and types of wood products, wood testing methods, wood quality and types of wood products, and wood material characteristics related to wood materials. It should be understood that based on Table 3, there is no SNI from a technical agency in the forestry sector that is categorized as mandatory and has been referred to in regulations. Details of the list of various standardizations that have been produced by BSN are presented in Table 4 below[10].

Table 4. Various standards related to wood materials available in Indonesia

No.	SNI Code	Information	Reference/Number of Decree
Indonesian Wood Testing or Testing Methods			
1	SNI 01-7205-2006	Preservatives on wood and wood products testing	18/KEP/BSN/2/2007
2	SNI 7207:2014	Wood resistance to wood destroying organisms testing	08/KEP/BSN/1/2014
3	SNI ISO 3133:2010	Determination of ultimate strength in static bending. Adopted from: Wood – Determination of ultimate strength in static bending (ISO 3133:1975, IDT).	143/KEP/ BSN/12/2010
4	SNI ISO 3132:2010	Testing in compression perpendicular to the grain. Adopted from: Wood – Testing in compression perpendicular to grain (ISO 3132:1975, IDT).	143/KEP/ BSN/12/2010
5	SNI ISO 3129:2011	Sampling methods and general requirements for physical and mechanical tests	10/KEP/BSN/1/2011
Logs			
6	SNI 7533.1:2010	Log – Part 1: Terms and definitions	16/KEP/BSN/3/2010
7	SNI 7533.2:2011	Log – Part 2: measurements and table of contents	235/KEP/ BSN/12/2011
8	SNI 7533.3:2011	Log – Part 3: Inspection	240/KEP/ BSN/12/2011

10 The content in Table 2 is based on data from the official BSN website. Available at: http://sispk.bsn.go.id/SNI/DaftarList

No.	SNI Code	Information	Reference/Number of Decree
Other standards			
9	SNI 01-0193-2006	Ebony logs	88/KEP/ BSN/09/2007
10	SNI 01-5010.6-2003	Prevention of blue mold on logs and sawn woods	10/KEP/ BSN/03/2003
Broad Leaf Logs			
11	SNI 7534.1:2010	Broadleaf logs – Part 1: Classification, requirements and marking	16/KEP/BSN/3/2010
12	SNI 7534.2:2010	Broadleaf logs – Part 2: Testing methods	16/KEP/BSN/3/2010
Teak Logs			
13	SNI 7535.1:2010	Teak logs – Part 1: Classification, requirements, and marking	16/KEP/BSN/3/2010
14	SNI 7535.2:2010	Teak logs – Part 2 : Testing methods	16/KEP/BSN/3/2010
15	SNI 7535.3:2016	Teak logs – Part 3: Measurement and Table of Contents	145/KEP/ BSN/6/2016
Coniferous Logs			
16	SNI 7536.1:2010	Coniferous logs – Part 1: Classification, requirements, and marking	16/KEP/BSN/3/2010
17	SNI 7536.2:2010	Coniferous logs – Part 2: Testing methods	16/KEP/BSN/3/2010
Sawn Woods			
18	SNI 7537.1:2010	Sawn timber – Part 1 : Terms and definitions	16/KEP/BSN/3/2010
19	SNI 7537.2:2010	Sawn Lumber – Part 2: Dimensional Measurements	16/KEP/BSN/3/2010
20	SNI 7537.3:2011	Sawn Lumber – Part 3: Inspection	240/KEP/ BSN/12/2011
Other Standards			
21	SNI 0674:2017	Preserved sawn timber with boron compounds	117/KEP/ BSN/5/2017
The Test Method or Test Method of Sawn Wood			
22	SNI ISO 8905:2012	Determination of ultimate shear strength parallel to the grain. Adopted from: Sawn timber – Test methods – Determination of ultimate strength in shearing parallel to grain (ISO 8905:1988, IDT)	N/A[11]
23	SNI ISO 8906:2011	Determination of resistance to perpendicular pressure. Adopted from: Sawn timber – Test methods determination of resistance to local transverse compression (ISO 8906 – 1988, IDT)	10/KEP/BSN/1/2011
Standardization In Other Types Of Sawn Woods			
24	SNI 01-7255-2006	Formed wood	107/KEP/ BSN/12/2007
25	SNI 01-2028-1990	Processed ebony wood	472/IV.2.06/ HK.01.04/ 09/1992

11 The official BSN website states that the SNI status is still valid, but the documents are not available. It can be checked independently at: http://sispk.bsn.go.id/SNI/DetailSNI/9209

No.	SNI Code	Information	Reference/Number of Decree
26	SNI 0197:2013	Railway wooden sleepers	187/KEP/ BSN/7/2013
27	SNI 0608:2017	Furniture-purposed woods	116/KEP/ BSN/5/2017
28	SNI 01-5008.6-1999	Sandalwood	1386/BSN-I/ HK.71/09/1999
29	SNI 7210:2017	Types of wood for shipbuilding	115/KEP/ BSN/5/2017
Broad Leaf Sawn Woods			
30	SNI 7538.1:2010	Broadleaf sawn timber – Part 1: Classification, requirements and marking	16/KEP/BSN/3/2010
31	SNI 7538.2:2010	Broadleaf sawn timber – Part 2: test methods	16/KEP/BSN/3/2010
Teak Sawn Woods			
32	SNI 7539.1:2010	Teak sawn timber – Part 1: Classification, requirements and marking	16/KEP/BSN/3/2010
33	SNI 7539.2:2010	Teak sawn timber – Part 2: test method	16/KEP/BSN/3/2010
Coniferous Sawn Woods			
34	SNI 7540.1:2010	Needleleaf sawn timber – Part 1: Classification, requirements and marking	16/KEP/BSN/3/2010
35	SNI 7540.1:2010	Needleleaf sawn timber – Part 2: Test Methods	16/KEP/BSN/3/2010
Plywood			
36	SNI ISO 2074:2008	Plywood – Terms and definitions	113/KEP/ BSN/12/2008
Other Standards of Plywood			
37	SNI 01-4240-1996	Container bottom plywood	1181/IV.2.06/HK/ 09/1996
38	SNI 01-4448-1998	Film-faced plywood	102/BSN-I/ HK/05/1998
39	SNI 01-5008.7-1999	Structural plywood	1386/BSN-I/ HK.71/09/1999
40	SNI 01-7201-2006	Beautiful paper-faced plywood and blockboards	107/KEP/ BSN/12/2007
41	SNI 01-7211-2006	Plywood for ships and boats	107/KEP/ BSN/12/2007
42	SNI 5008.2:2016	General purpose plywood	145/KEP/ BSN/6/2016
43	SNI 8386:2017	Aesthetic plywood	118/KEP/ BSN/5/2017
44	SNI 01-2025-1996	Aesthetic plywood and blockboards	1337/IV.2.06/HK/ 01/1996
45	SNI 7731.1:2011	Aesthetic teak plywood – Part 1: Classification, requirements and marking	235/KEP/ BSN/12/2011
Veneer			
46	SNI 7836.1:2012	Veneer – Part 1: Classification, requirements, and marking of peeled veneer	196/KEP/ BSN/12/2012

No.	SNI Code	Information	Reference/Number of Decree
47	SNI 01-6240-2000	Laminated Veneer	1705.A/BSN-I/ HK.24/06/2000
48	SNI ISO 10033-2:2013	Laminated veneer lumber (LVL) – Bonding quality – Part 2: Requirements. Adopted from: ISO 10033-2:2011 Laminated veneer lumber (LVL) – Bonding quality – Part 2: Requirements, IDT)	158/KEP/ BSN/6/2013
Other Wood Panel Standards			
49	SNI 01-6243.2-2000	Connecting boards and connecting bars for tables	1705.A/BSN-I/ HK.24/06/2000
50	SNI 01-5008.12-2002	Blockboards – common uses	15/KEP/ BSN/03/2002
51	SNI 01-5008.13-2002	Tropical jungle wood flooring	15/KEP/ BSN/03/2002
52	SNI 01-4449-2006	Fiberboards	88/KEP/ BSN/09/2007
Wood Panel Testing			
53	SNI 01-6020-1999	Quality and test methods of decorative connecting boards	637/BSN-I/ HK.55/06/1999
54	SNI 01-7140-2005	Formaldehyde emission testing method for wood panels using gas desiccator method	113/KEP/ BSN/12/2005
55	SNI 01-7141-2005	Testing methods of formaldehyde emissions for wood panels using the room method	113/KEP/ BSN/12/2005
56	SNI 01-7142-2005	How to test formaldehyde levels in wood panels using the perforator method	113/KEP/ BSN/12/2005
57	SNI 01-7205-2006	Testing of preservatives on wood and wood products	18/KEP/BSN/2/2007
Wood Chips			
58	SNI 7835.1:2012	Wood chips – Part 1: Terms and definitions	196/KEP/ BSN/12/2012
59	SNI 7835.2:2012	Wood chips – Part 2: Classification and requirements of pulp raw materials	196/KEP/ BSN/12/2012
60	SNI 7835.3:2012	Wood chips – Part 3: Test methods for wood chips as pulp raw materials	196/KEP/ BSN/12/2012
Other Wood Type Standards			
61	SNI 8021:2014	Wood pellets	106/KEP/ BSN/8/2014
62	SNI 7945:2014	Coconut wood (*Cocos nucifera Linn.f.*)	08/KEP/BSN/1/2014
63	SNI 8351:2016	Name of traded woods	217/KEP/ BSN/9/2016
64	SNI 8350:2016	Name of wood forest product	217/KEP/ BSN/9/2016
65	SNI 8274:2016	Four-sided planed wood	139/KEP/ BSN/6/2016
66	SNI ISO 5326:2010	Solid wood paving blocks	143/KEP/ BSN/12/2010

No.	SNI Code	Information	Reference/Number of Decree
67	SNI ISO 5328:2013	Coniferous wood paving blocks – Quality requirements	158/KEP/ BSN/6/2013
68	SNI 01-5010.6-2003	Prevention of blue mold on logs and sawn woods	10/KEP/ BSN/03/2003
69	SNI 7207:2014	Wood resistance tests to wood-destroying organisms	08/KEP/BSN/1/2014
SNI Synchronization with International Standards			
70	SNI ISO 2426.1:2008	Plywood – Classification based on surface appearance – Part 1: General	113/KEP/ BSN/12/2008
71	SNI ISO 2074:2008	Plywood – Terms and definitions	113/KEP/ BSN/12/2008
72	SNI ISO 16979:2008	Wood panels – Determination of moisture content	113/KEP/ BSN/12/2008
73	SNI ISO 2426.2:2008	Plywood – Classification based on surface appearance – Part 2: Broadleaf wood	113/KEP/ BSN/12/2008
74	SNI ISO 2426.3:2008	Plywood – Classification based on surface appearance – Part 3: Coniferous wood	113/KEP/ BSN/12/2008
75	SNI ISO 9427:2008	Wood panels – Density determination	113/KEP/ BSN/12/2008
76	SNI ISO 9426:2008	Wood panels – Determining panel dimensions	113/KEP/ BSN/12/2008
77	SNI ISO 3133:2010	Wood – Determination of maximum (ultimate) strength in static bending	143/KEP/ BSN/12/2010
78	SNI ISO 3132:2010	Wood – compressive strength test perpendicular to grain	143/KEP/ BSN/12/2010
79	SNI ISO 1096:2010	Plywood – Classification	143/KEP/ BSN/12/2010
80	SNI ISO 16978:2010	Wood panels – Determination of flexural modulus of elasticity and flexural strength	143/KEP/ BSN/12/2010
81	SNI ISO 16983:2010	Wood panels – Determination of thickness expansion after immersion in water	143/KEP/ BSN/12/2010
82	SNI ISO 17064:2010	Wood panels – Fiberboard, particleboard, and OSB – Terms and definitions	143/KEP/ BSN/12/2010
83	SNI ISO 12466-1:2010	Plywood – Bonding Quality – part 1: Test methods	143/KEP/ BSN/12/2010
84	SNI ISO 12466-2:2010	Plywood – Bonding quality – part 2: Requirements	143/KEP/ BSN/12/2010
85	SNI ISO 16985:2010	Wood panels – Determination of dimensional changes related to changes in relative humidity	143/KEP/ BSN/12/2010
86	SNI ISO 12460-4:2010	Wood panels – Determination of formaldehyde emissions – Part 4: Desiccator method	143/KEP/ BSN/12/2010
87	SNI ISO 16998:2010	Wood panels – Determination of moisture resistance – boiling test	143/KEP/ BSN/12/2010
88	SNI ISO 5326:2010	Solid wood paving blocks – wide leaf wood paving blocks – quality requirements	143/KEP/ BSN/12/2010

No.	SNI Code	Information	Reference/Number of Decree
89	SNI ISO 12460-3:2010	Wood panels – Determination of formaldehyde emissions – Part 3: Gas analysis methods	143/KEP/BSN/12/2010
90	SNI ISO 4471:2011	Wood – Sample taking of trees and logs from homogeneous stands to determine the physical and mechanical properties of wood	10/KEP/BSN/1/2011
91	SNI ISO 2036:2011	Wood for making wooden floors – Marking symbols by type	10/KEP/BSN/1/2011
92	SNI ISO 5327:2011	Solid wood paving blocks – General characteristics	10/KEP/BSN/1/2011
93	SNI ISO 3129:2011	Wood – Sampling methods and general requirements for physical and mechanical tests	10/KEP/BSN/1/2011
94	SNI ISO 3397:2011	Wide leaf wood block parquet raw materials – General characteristics	10/KEP/BSN/1/2011
95	SNI ISO 631:2011	Mosaic parquet panels – General characteristics	10/KEP/BSN/1/2011
96	SNI ISO 1072:2011	Solid wood parquet – General characteristics	10/KEP/BSN/1/2011
97	SNI ISO 5327:2011	Solid wood paving blocks – General characteristics	10/KEP/BSN/1/2011
98	SNI ISO 8905:2012	Sawn timber – Test method – Determination of ultimate shear strength parallel to the grain	N/A[12]
99	SNI 7835.1:2012	Wood chips – Part 1: Terms and definitions	196/KEP/BSN/12/2012
100	SNI ISO 16999:2012	Wood panels – Sampling and test samples	N/A[13]
101	SNI ISO 16981:2012	Wood panels – Determination of surface adhesion strength	N/A[14]
102	SNI ISO 9086-1:2012	Wood – Physical and mechanical properties testing–Terms and definitions–Part 1: General concepts and macrostructures	N/A[15]
103	SNI 7835.2:2012	Wood chips – Part 2: Classification and requirements	196/KEP/BSN/12/2012
104	SNI ISO 10033-2:2013	Laminated veneer lumber (LVL) – Bonding quality-Part 2: Requirements (ISO 10033-2:2011)	158/KEP/BSN/6/2013
105	SNI ISO 18776:2013	Laminated veneer lumber (LVL) – Requirements (ISO 18776:2008)	158/KEP/BSN/6/2013
106	SNI ISO 7900.1:2013	Laminated veneer lumber (LVL) – Bonding quality-Part 1: Test methods (ISO10033-2:2011)	182/KEP/BSN/7/2013
107	SNI ISO 5328:2013	Solid wood paving blocks – Coniferous wood paving blocks – Quality requirements	158/KEP/BSN/6/2013

12 The official BSN website states that the SNI status is still valid, but the documents are not available. Can be independently checked at: http://sispk.bsn.go.id/SNI/DetailSNI/9209

13 *idem.* Can be independently checked at: http://sispk.bsn.go.id/SNI/DetailSNI/9212

14 *idem.* Can be independently checked at: http://sispk.bsn.go.id/SNI/DetailSNI/9211

15 *idem.* Can be independently checked at: http://sispk.bsn.go.id/SNI/DetailSNI/9210

No.	SNI Code	Information	Reference/Number of Decree
108	SNI ISO 12460-1:2014	Wood panels – Determination of formaldehyde emissions – Part 1: Formaldehyde emissions per cubic meter room method	106/KEP/BSN/8/2014
109	SNI ISO 12460-5:2014	Wood panels – Determination of formaldehyde emissions – Part 5: Extraction method (perforator method)	106/KEP/BSN/8/2014
110	SNI ISO 16984:2016	Wood panels – Determination of tensile strength perpendicular to the plane of the panel	160/KEP/BSN/7/2016
111	SNI ISO 16987:2016	Wood panels – Determination of moisture resistance under cyclic test conditions	160/KEP/BSN/7/2016
112	SNI ISO 20585:2016	Wood panels – Determination of wet flexural strength after immersion in water at 70°C or 100°C (boiling temperature)	160/KEP/BSN/7/2016
113	SNI ISO 9424:2016	Wood panels – Determination of dimensions of test samples	160/KEP/BSN/7/2016
114	SNI ISO 8906:2011	Sawn timber – Test methods – Determination of resistance to perpendicular tension	10/KEP/BSN/1/2011

All standards listed in Table 4 focus on specifications, measurements, and technical design of wood materials. It should be noted that, based on the ISO code in the SNI numbering as in column two of the Table, it can be seen that the references used as the basis for standardization are old and may require renewal. The absence of such update may indicate two things, namely: low urgency for updates due to the lack of use of these standards by stakeholders and/or new references are not yet available. In addition to the technical standards as mentioned, the forestry sector also has standardization related to environmental management and preservation, such as:

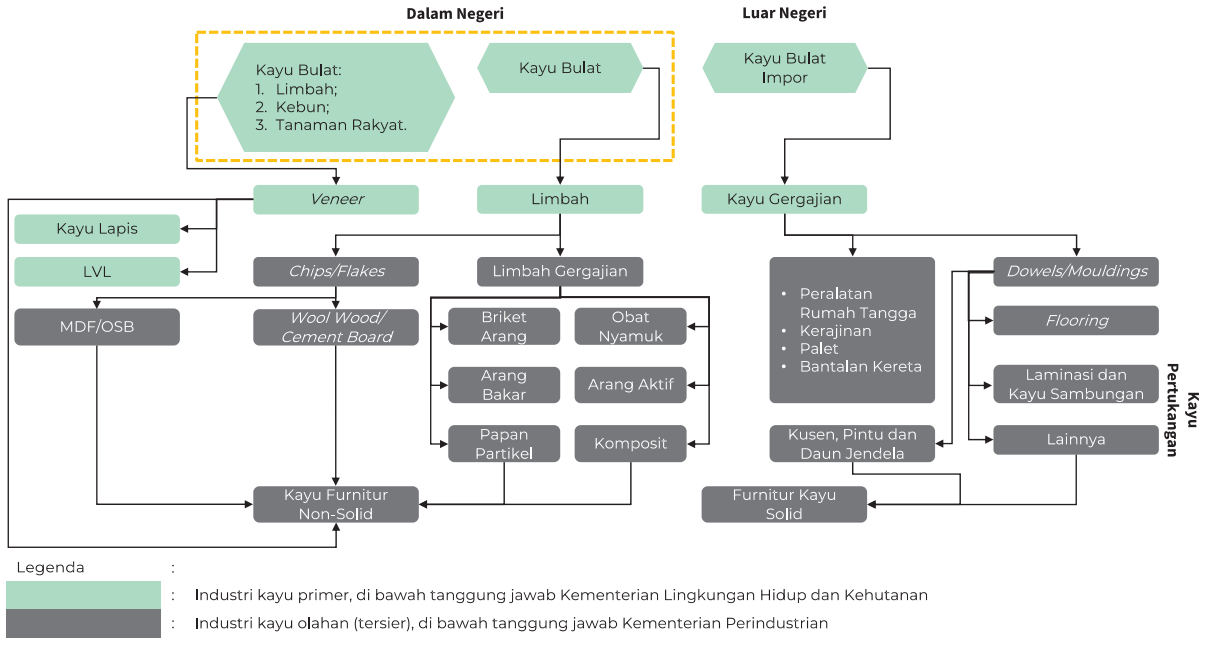

Figure 7. Wood processing industry flow chart with adjustments (Putra 2024)

1. **8156:2015**: Principles, criteria, and framework for developing indicators for sustainable production forest management. The standard revises three old SNIs, namely: 1) SNI 19-5000-1998, Sustainable production forest management system; 2) SNI 19-5000.1-1998, Sustainable production natural forest management system; and 3) SNI 19-5005-1999, Terms and definitions related to sustainable production forest management certification[16];
2. **SNI ISO 14034:2017**: Environmental management – Environmental technology verification (ISO 14034:2016, IDT). This standard is legalized through the Decree of the Head of BSN No. 298/KEP/BSN/9/2017;
3. **SNI ISO 14024:2018**: Environmental labels and declarations – Type I environmental labeling – Principles and procedures (ISO 14024:2018, IDT). This standard establishes principles and procedures for developing a type I environmental labeling program, including the selection of product categories, product environmental criteria, and product functional characteristics, and for assessing and demonstrating compliance. It also establishes certification procedures for labeling. This standard is legalized through the Letter of Determination of the Head of BSN No. 608/KEP/BSN/12/2018;
4. **SNI ISO 20400:2017**: Sustainable procurement - Guidance (ISO 20400:2017, IDT). This document guides organizations, regardless of their activities or size, to integrate sustainability into procurement, as described in ISO 26000. It is intended for stakeholders involved in, or affected by, procurement processes and decisions. This standard is legalized through the Letter of Determination of the Head of BSN No. 137/KEP/BSN/4/2019;
5. **SNI ISO 14015:2009**: Environmental management – Environmental Assessment at Site and Organization (EASO). This standard is legalized through the Decree of the Head of BSN No. 117/KEP/BSN/12/2009;
6. **SNI 19-14004-2005**: Environmental management system – General guidance on principles, systems, and supporting techniques. This standard is legalized through the Decree of the Head of BSN No. 54/KEP/BSN/05/2005, and
7. **SNI 19-14001-2005**: Environmental management system – Requirements and guidelines for use. This standard is legalized through the Decree of the Head of BSN No. 54/KEP/BSN/05/2005.

Meanwhile, unlike the forestry sector, the construction sector has regulated several mandatory SNIs so that they become part of its policies. Specific discussions regarding mandatory SNIs related to wood materials that have been regulated in the construction sector are further described in Sub-chapter 4.1.3.

4.1.2. Policies, Regulations, and Legislation Regarding the Use of Wood Materials in the Forestry Sector

Discussions on policies related to the use of wood products cannot be separated from policies that regulate sources of wood raw materials in the forestry sector. As an upstream sector, many regulations related to the use of wood raw materials and their mechanisms will have an impact on downstream sectors, such as construction. The forestry sector itself has various regulatory documents that regulate the use of wood, including for construction, which generally guide stakeholders in ensuring the management of forest areas as a source of wood raw materials in a sustainable manner. One form of this manifestation is through the legalization of policies related to the governance of wood forest products.

16 As available on: http://sispk.bsn.go.id/SNI/DetailSNI/10229

Currently, the formal rules that apply regarding policies governing the mechanism for managing wood raw materials are regulated in the Regulation of the Minister of Environment and Forestry (*Peraturan Menteri Lingkungan Hidup dan Kehutanan* – Permen LHK) No. 8 of 2021 concerning Forest Management and Preparation of Forest Management Plans, as well as Forest Utilization in Protected Forests and Production Forests. The regulation comprehensively regulates various provisions in the forestry sector, which include (Putra 2024):

1. Forest inventory;
2. Forest planning and block division in forest areas;
3. Forest boundary and mapping arrangements;
4. Preparation and assessment, ratification, and changes to forest area management plans;
5. Regulation of forest management organizations;
6. Criteria and directions for forest utilization;
7. Creation and use of corridors for transportation facilities for timber transportation in forest areas;
8. Governance of business permits for the utilization of timber and non-timber forest products in forest areas;
9. Forest management planning in various types of forest areas and preparation of relevant documents;
10. Implementation of partnerships for each forest management;
11. Regulation of forest utilization, up to
12. Regulation of verification, certification, and audit of timber legality which regulates in detail the implementation mechanism of the Timber Legality Verification System (SVLK).

Ministerial Regulation of the Environment and Forestry No. 8 of 2021 aims to ensure that forest product management is carried out sustainably with minimal impact on the environment and the wood processing industry. This regulation regulates the planning, management, utilization, and licensing mechanisms for annual volumetric-based wood businesses to ensure the availability of sustainable wood raw materials. One of the mechanisms regulated is the SVLK, which ensures that wood is extracted legally and sustainably. The SVLK process involves stages of verification, issuance of legality certificates, re-certification, inspection, and special audits with validity periods that vary according to the type of certificate. The implementation of the SVLK allows wood exporters to expand their markets to regions with strict environmental regulations, such as Europe and America. This is related to the threat of a boycott of wood products by the European Union after the issuance of the Minister of Trade Regulation (*Peraturan Menteri Perdagangan* – Permendag) No. 15/2020 which removed the V-Legal[17] obligation. However, this regulation was later revoked by Permendag No. 45/2020. Unfortunately, for business actors with a domestic market orientation, SVLK certification has not provided benefits from the cost burdens arising in the certification process, such as an increase in the price of certified wood products (Suryandari et al. 2017).

Related to its connection with the use of wood materials in the construction sector, the government through the Ministry of Environment and Forestry (*Kementerian Lingkungan Hidup dan Kehutanan* – KLHK) has encouraged the implementation of SVLK for the public through the application of environmentally friendly labels. This policy was ratified through Permen LHK No. 5/2019 concerning Procedures for Applying Environmentally Friendly Labels for Procurement of Environmentally Friendly Goods and Services which then received an additional list of

17 Based on the SILK KLHK website, the V-Legal document is an Indonesian wood export permit that proves the legality of the source of its wood products based on the results of independent assessment and verification. Accessed on: September 6, 2024. Available at: https://silk.menlhk.go.id/index.php/article/vnews/21

references through the Decree of the Minister (*Keputusan Menteri* – Kepmen) of Environment and Forestry No. 1207/2021. Furthermore, there is a clause in Article 19 paragraph (4) of Permen LHK No. 5/2019 which states that registered environmentally friendly goods and services are used as the basis for procurement of environmentally friendly goods and services by ministries/institutions/regional work units/institutions. Thus, this policy can be a basis for other ministries/sectors, including construction, in procuring goods and services to have ethical standards related to environmental sustainability.

Not only related to sustainability, policies in the forestry sector also include efforts to meet the supply of raw materials for the national wood industry - policies needed by downstream sectors, such as industry and construction. The policy emerged from the 2020-2024 National Medium-Term Development Plan document which is regulated through Presidential Regulation (Perpres) No. 18/2020 concerning the 2020-2024 National Medium-Term Development Plan. The document targets log production of 60 million m3/year from industrial forests[18] to meet industrial needs. The plan was then realized by the Directorate General of Sustainable Production Forest Management of the Ministry of Environment and Forestry through various strategies to achieve its goals (Direktorat Jenderal PHPL 2020), i.e.:

1. Improvement of national forest governance:
    a. Institutional improvements in the Directorate General of PHPL by the directions in the Omnibus Law;
    b. Integration of information systems;
    c. Implementation of post-audits/compliance audits for Forest Product Management Business Permit actors;
    d. Encouraging operational management of Forest Management Units (FMU);
2. Increased investment:
    a. Integrated spatial forest planning;
    b. Simplification of licensing;
3. Increasing the productivity of production forests:
    a. Implementation of Intensive Silviculture, Multisystem Silviculture, and RIL-C;
    b. Diversification of forest product businesses other than wood (non-timber forest products (NTFPs), environmental services, food, and energy);
    c. Mini Industrial Plantation Forests/Community Plantation Forests and Forestry Partnerships;
4. Increasing the competitiveness of the forestry industry and exports:
    a. Facilitation of SVLK certification for MSMEs;
    b. Revitalization of forestry industry machinery;
    c. Increasing the added value of forestry products;
    d. Optimization of raw materials integrated with the wood forest product processing industry, NTFPs, and environmental services;
    e. Development of Exclusive Economic Zones;
    f. Upstream-downstream-market integration, and
    g. Expansion of export wood cross-section.

Details of policies in the forestry sector relating to wood materials for construction and efforts to promote sustainability are presented in Table 5.

18 Available in Table 2.1. page II.20 Attachment 1 of Presidential Decree No.18/2020.

Table 5. Rules regarding the use of wood and environmentally friendly certification of wood products in the forestry sector

No.	Regulation Name	Rules Explanation
1.	Perpres 18/2020	The log production target to meet industrial needs is 60 million m^3/ year.
2.	Permen LHK 8/2021	Article 217 – 225: Article 217 paragraph (2) explicitly explains that the guarantee of legality of forest products is carried out through SVLK. Assessment of the legality of forest products is carried out through verification by an accredited independent assessor institution (*Lembaga Penilai dan Verifikasi Independen* – LPVI). Based on the assessment carried out, LPVI can issue S-PHL (Sustainable Forest Management Certificate) or S-Legality (Legality Certificate) for wood products extracted from forest areas.
3.	Permen LHK No. 5/2019	Article 19: Goods and services that have met the criteria requirements and obtained an environmentally friendly label are used as the basis for the Procurement of Environmentally Friendly Goods and Services by ministries/institutions/regional work units/institutions.
4.	Kepmen LHK No. SK.1207/Menlhk/ Setjen/ Kum.1/12/ 2021	Annex: The use of processed wood materials for construction that are labeled environmentally friendly using the SVLK criteria based on Permen LHK No. 8/2021 with the label below: Indonesian® LEGAL Wood
5.	Regulation of the Director General of Sustainable Production Forest Management No. P.4/PHPL/ SET.5/ REN.0/9/2020	To implement the Presidential Regulation 18/2020 by preparing the 2020-2024 Directorate General of PHPL Strategic Plan document to meet the log production target of 60 million m^3/year for the downstream sector, including construction.

4.1.3. Policies, Regulations, and Legislation on the Use of Wood Materials in the Construction Sector

Policies related to the use of wood materials in the construction sector in Indonesia began to be regulated through the Indonesian Wood Construction Regulation (PKKI) NI-5 in 1961. The regulation was issued by the Directorate of Building Problem Investigation, Directorate General of Human Settlements, and Department of Public Works (Direktorat Penyelidikan Masalah Bangunan 1961). The regulation became a mandatory guideline that regulates the standards of materials, specifications, and quality of wood used as retaining construction in various types of buildings. Throughout its preparation, the PKKI document adopted wood construction guidelines from various countries, such as Germany, Sweden, the United States, and Norway[19]. These guidelines were used by Indonesia for decades without significant updates even though developments in wood construction technology and the diversity of wood types used continued to grow.

19 As explained in the introduction to the 1961 PKKI document.

Despite the stagnation of guideline updates, Indonesia has made several attempts to update and revise PKKI NI-5. One of these attempts was made based on the Decree of the Minister of Public Works No. 609/KPTS/1990 concerning the Ratification of 41 SNI Concept Standards in the Public Works Sector. The regulation includes at least two SNI-based guidelines that update the technical rules of PKKI NI-5 as attachments related to the use of wood materials, namely: 1) Specification of Wood Size for Buildings (SNI 03-2445-1991), and 2) Type 30/6 Nail Beam Trusses (SNI 03-2450-1991). Furthermore, in 1994 Indonesia through BSN issued SNI 03-3527-1994 concerning Wood Quality for Building Construction. Furthermore, in 2002, several Indonesian wood engineering experts prepared an RSNI document entitled "Procedures for Planning Indonesian Wood Construction" to encourage consensus for a new standardization of construction wood to replace PKKI NI-5.

Although there was a stagnation of renewal, Indonesia through BSN issued new construction wood guidelines in 2013 entitled "SNI 7973:2013 Design Specifications for Wood Construction." The document itself was designed as a wood construction planning regulation to replace PKKI NI-5 1961 (BSN 2013) which is considered no longer relevant to the development of science. Although there is no direct reference from the regulation to SNI 7973:2013.

As an SNI related to construction safety, the standard is included in the mandatory category as regulated by Article 24 of Law No. 20/2014. This means that in carrying out construction activities, SNI 7973:2013 must be a reference. From an engineering perspective, this guidance document is comprehensive, where various technical considerations of wood are described in detail from design requirements, and supervision, to technical standards for each type of wood use. However, it should be understood that SNI 7973:2013 still uses the National Design Specification (NDS[20]) document issued by the American Wood Council (AWC) in 2012 as explained in the foreword of the SNI manuscript, while currently, the latest NDS document is the 2024 version (Stephens 2024). Therefore, updating is crucial to ensure the conformity of Indonesian standardization with current knowledge and needs.

These various standardizations are strengthened through Government Regulation (*Peraturan Pemerintah* – PP) No. 16/2021 concerning Implementing Regulations of Law No. 28/2002 concerning Building Construction. Article 14 of the regulation strictly regulates what planning standards must be followed in building construction, namely provisions regarding building layout, reliability, provisions for the location of the building (above ground, and/or underground, and/or in water), and provisions for its prototype design. Based on the results of the interviews conducted, updates to the standardization in the SNI need to be carried out every 10 years. This has encouraged the government, through the Ministry of PUPR, to begin the process of compiling SNI for new construction wood. The standard is planned to be compiled based on United States standards, but without sacrificing the needs of wood entrepreneurs who have markets in the European region. Thus, the new SNI that applies will also have tagging that explains the conversion of wood specifications so that it can be used for the European market.

Although not directly related to the construction sector, Indonesia also has other environmentally friendly regulations that apply, especially at the stage of government procurement of goods and/or services. This regulation is indirectly related because procurement of goods/services is a vital component, including in the construction sector. This regulation emerged through the ratification of Presidential Regulation (*Peraturan Presiden* – Perpres) No. 12 of 2021 concerning Amendments to Presidential Regulation Number 16

20 The NDS is a guideline document for various standardizations of wood products and tests in the United States. The document is published by the AWC which has been accredited by the American National Standardization Institute (ANSI) to implement wood standardization (AWC 2018).

of 2018 concerning Government Procurement of Goods/Services. Article 19 of the Perpres emphasizes the obligation to prepare technical specifications for the goods/services needed using environmentally friendly products (Article 19 paragraph (1) letter d). This obligation is then detailed in Article 19 paragraph (4) by explaining that the environmentally friendly products in question are various products that have an environmentally friendly label.

Furthermore, the Ministry of PUPR, as the overseeing institution in the construction sector, details the Laws and Government Regulations in more specific policies for the construction sector. Some of these regulations include Regulation of the Minister of Public Works and Public Housing (*Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat* – Permen PUPR) No. 22/2018 concerning the Construction of State Buildings and Permen PUPR No. 14/2020 concerning Standards and Guidelines for Procurement of Construction Services Through Providers. Permen PUPR No. 22/2018 expressly stipulates that state building construction must meet administrative and technical requirements. The technical prerequisites required as stated in Article 12 of Permen PUPR No. 22/2018, include: building layout and building reliability. An explanation of all these technical prerequisites has been further described in the appendix to the regulation that requires standardization according to SNI. Meanwhile, Permen PUPR No. 14/2020 also includes ethical obligations in the implementation of construction.

PUPR Ministerial Regulation No. 14/2020 is generally a guideline for implementing construction services through providers (Article 2), wherein the planning stage, construction must refer to the Sustainable Construction approach by implementing the principles of Sustainable Construction (Article 14 paragraph (4)). Furthermore, the regulation further explains the components of the Sustainable Construction Principles in Article 27, including protection and management of the environment through conservation efforts (Article 27 letter f) and mitigation of safety, health, climate change, and disaster risks (Article 27 letter g). These sustainable construction principles are then explained in detail through PUPR Ministerial Regulation No. 9/2021 concerning Guidelines for Implementing Sustainable Construction. Several rules regarding the Sustainable Construction Principles in the regulation include:

1. Sustainable Construction has three basic pillars which include (Article 3 paragraph (2)):
    a. economically feasible and can improve community welfare;
    b. maintain environmental preservation, and
    c. reduce social disparities in society;
2. The principles of Sustainable Construction include (Article 4 paragraph (2)):
    a. common goals, understanding, and action plans;
    b. compliance with safety, security, health, and sustainability standards;
    c. reduction in resource use, whether land, materials, water, natural resources, or humans;
    d. reduction of waste, both physical and non-physical;
    e. reuse of previously used resources;
    f. use of recycled resources;
    g. protection and management of the environment through conservation efforts;
    h. mitigation of safety, health, **climate change**, and disaster risks;
    i. orientation towards the life cycle;
    j. orientation towards achieving desired quality;
    k. technological innovation for continuous improvement, and
    l. institutional, leadership, and management support in implementation;
3. Contents of the Construction Consultancy report (Appendix 2.3. No. 6):
    a. conceptual design of the Construction Safety Management System (*Sistem Manajemen Keselamatan Konstruksi* – SMKK);

b. design of the use of lightning rods for buildings according to the Norms, Standards, Procedures, and Criteria (*Norma, Standar, Prosedur, dan Kriteria* – NSPK);
c. efforts to efficiently use land and reduce changes in land conditions;
d. efforts to conserve/energy efficiency;
e. design of efficient water use;
f. design of water absorption space;
g. design of the use of environmentally friendly construction materials;
h. design of the use of local construction materials;
i. design of efficient use of construction materials (reduce);
j. design of the use of recycled construction materials (recycle);
k. design of the use of prefabricated construction materials;
l. design of maintaining air quality;
m. design of noise reduction;
n. design of solid and liquid waste management (for buildings);
o. design of providing a drainage system for the building area;
p. design of disaster adaptation;
q. involvement of community participation;
r. design of facilities that are responsive to gender, the disabled, and the marginalized;
s. design of providing access and community interaction space;
t. design of providing access and facilities for public transportation users;
u. design of providing access and facilities for pedestrians and cyclists; and
v. compliance with the design and technical requirements and criteria for construction buildings.
w. Additional information when compiling:
    i. building design that avoids reducing the area and capacity of natural/artificial lakes/situs;
    ii. building design that avoids loss of habitat and/or protected areas;
    iii. use of technology and innovation;
    iv. building design that takes into account the preservation of cultural heritage and/or traditional areas; and
    v. building design that supports the preservation of local culture.

PUPR Regulation No. 14/2020 is generally a guideline for the implementation of construction services through providers (Article 2), wherein the planning stage, construction must refer to the Sustainable Construction approach by implementing the principles of Sustainable Construction (Article 14 paragraph (4)). Furthermore, the regulation further explains the components of the Sustainable Construction Principles in Article 27, including protection and management of the environment through conservation efforts (Article 27 letter f) and mitigation of safety, health, climate change, and disaster risks (Article 27 letter g).

The long explanation above has shown that from the perspective of rules-in-form, policies related to the use of wood materials in Indonesia from upstream (forestry sector) to downstream (construction sector) have been synergistic and comprehensive. The current formal policies have included technical aspects, through the SNI obligation, and ethical aspects, through the obligation to use environmentally friendly raw materials. Not only that, both standardization instruments (such as SNI) and environmentally friendly policies (such as SVLK) that are enforced do not target all stakeholders, thus causing disincentives for the business climate. Details of the interconnectedness between policies related to the use of wood materials for the construction sector are presented in Table 6.

Table 6. Rules regarding the use of wood, standardization, and environmentally friendly certification of wood products relevant to the construction sector

No.	Regulation Name	Rules Explanation
1.	UU No. 20/2014	Article 24 paragraph (1): Affirming that SNI, which is voluntary, becomes mandatory if it is related to safety, security, health, or environmental preservation. This article also states that ministries/non-ministerial institutions have the authority to determine the implementation of mandatory SNI through Ministerial Regulations/Head of Institution Regulations.
2.	PP No. 16/2021	Article 14: Setting the standards for planning and designing building structures must include provisions for building layout, building reliability, building provisions both above and below ground or water, to building prototype provisions. Fulfillment of all these standards is proven by the use of materials and processes that comply with SNI. Notes: Unfortunately, this regulation is also one of the causes of policy gaps because the technical planning regulations that require the use of environmentally friendly materials only apply to green buildings. An explanation of this is available in the next Sub-chapter which discusses the findings of the gap analysis.
3.	Perpres No. 12/2021	Article 19 paragraph (1): Regulates that the preparation of technical specifications for goods/services, which in this case includes construction activities, must use SNI products and environmentally friendly products. Article 19 paragraph (4): Emphasizing that products considered environmentally friendly have an environmentally friendly label. Related to the context of wood materials used in the construction sector, this indicates the obligation to use SLVK-certified wood in line with similar regulations in the forestry sector.
4.	Permen PUPR No. 1/2022 on Guidelines for Compiling Cost Estimates for Construction Work in the Public Works and Public Housing Sector	Article 9 paragraph (3): Require the preparation of basic unit prices (*Harga Satuan Dasar* – HSD) in construction activities to prioritize the use of several domestic products, domestic component levels (*Tingkat Kandungan Dalam Negeri* – TKDN), and environmentally friendly products. This shows that the rules in this regulation are in line with the rules on the use of other environmentally friendly labeled products in the construction sector.
5.	Permen PUPR No. 14/2020	Article 14 paragraph (4): Require an approach to Sustainable Construction Principles at the procurement planning stage. This obligation is in line with the direction in Article 19 paragraph (4) of Presidential Decree No. 12 of 2021. Article 27 letter f and g: This article emphasizes its connection with Article 14, where protection and management of the environment through conservation efforts and risk mitigation, including against climate change, is part of the Principles of Sustainable Construction.

No.	Regulation Name	Rules Explanation
6.	Permen PUPR No. 22/2018	Article 12 paragraph (1): Affirming the technical requirements required in the construction of state buildings including building layout and reliability. Furthermore, an explanation of this reliability is further described in the appendix of the regulation by stating the obligation to use SNI standard materials.

4.2. Gap Analysis of the Available Regulations on Construction Wood Materials Utilization

The results of the review of policies related to the use of construction wood materials in Indonesia, as explained in the previous Sub-chapter, show that the regulations currently available already cover both technical and ethical aspects (from an environmental perspective). Efforts to implement standardization from a technical aspect are by enforcing mandatory SNI, including for the use of wood materials, if related to safety, security, health, preservation of environmental functions, and/or specifically regulated by the ministry or authorized non-ministerial government agency. The basis of the policy for enforcing the SNI obligation is regulated by Law No. 20/2014. Furthermore, the legislation is further detailed through various derivative regulations, both through Government Regulations, Presidential Regulations, Ministerial Regulations in related sectors, and other regulations at the regional level.

In the ethical aspect, where environmental sustainability is the focus of the use of wood materials in the construction sector, the government has aligned the SVLK certification policy managed by the forestry sector by encouraging its use for other sectors. In the construction sector, this alignment is shown by the ratification of Presidential Regulation No. 12 of 2021 concerning Amendments to Presidential Regulation No. 16 of 2018 concerning Government Procurement of Goods/Services and PUPR Ministerial Regulation No. 14/2020 concerning Standards and Guidelines for Procurement of Construction Services Through Providers, where both policies encourage the implementation of sustainable and environmentally friendly principles.

In addition, with the prerequisite for the use of environmentally friendly products in Presidential Regulation No. 12/2021, it has indirectly referred to the use of SVLK-certified wood materials in this context. If the policy is implemented well at each administrative level, it will not only ensure alignment between formal regulations and their implementation in the field but can also expand the benefits of SVLK certification which is currently considered not yet focused on the needs of domestic market-oriented business actors (Putra 2024; Suryandari et al. 2017). However, there is still room for optimization for the implementation of these policies in Indonesia.

4.2.1. Key Findings on Policy Gaps

4.2.1.1. The Absence of a Policy for Mainstreaming the Use of Ecolabel Certified Construction Wood Materials for Government Construction Activities

Expanding the use of wood materials, especially those with ecolabel certification, in construction activities can support government efforts to reduce GHG emissions. The urgency of reducing emissions from the construction sector is increasing along with the government's target to build two million housing units per year Sunarsip (2024) and the development of the IKN. Meanwhile, the emphasis on environmentally friendly certification, such as SVLK, on the wood used guarantees the legality of raw material sources and environmentally friendly extraction methods.

Unfortunately, the current implementation of SVLK is only for exported wood products, not for products sold in the domestic market. This is logical considering the extra costs that must be incurred in managing wood certification have the potential to increase production costs which have an impact on increasing the selling price of wood which has not been appreciated by wood consumers in the domestic market. Thus, the obligation to implement SVLK indiscriminately for the domestic market has the potential to cause negative impacts such as the death of the domestic wood market due to high wood product prices; the closure of micro, small, and medium enterprises (MSMEs) in the wood industry; or as Suryandari et al. (2017) stated that this obligation has the potential to increase the circulation of illegal wood. On the other hand, the implementation of SVLK only for export-oriented wood is also not a wise step when associated with the sustainability of raw materials and national emission reduction targets. Ignoring SVLK for the domestic wood market also has the potential to have negative implications because it has the potential to pass wood that comes from unsustainable activities domestically.

Therefore, the middle way that the government can take is to start encouraging the use of SVLK-certified wood products in various government development projects. With these efforts, the government can not only progressively encourage the use of bio-based materials in the construction sector, but can also encourage the growth of the domestic wood industry. In the long term, these efforts also have the potential to increase awareness of actors in the wood industry and construction sector towards the use of sustainable raw materials, the resilience of wood industry players towards the many wood substitute materials, and the readiness of their coping strategies in facing the global market.

It should be understood that the policies in force in the current global market system emphasize the principle of reciprocity, where policies imposed on imported products will also have an equal impact on local products (Tomiura et al. 2021), even if the imported products disrupt local products, such as substitute wood. Therefore, with the gradual implementation of SVLK, the government indirectly helps increase the capacity of wood business actors and can also impose certain standards, such as SVLK, on imported wood products to protect them from the onslaught of products that are detrimental to the domestic market.

Unfortunately, currently, the government has not emphasized the policy of mainstreaming the use of bio-based materials, such as wood, in its development planning even though on the other hand there is a large target for reducing emissions. This indication emerged from the results of the discussion at the "*Mass Timber Construction in Indonesia Workshop*" at the Ministry of PUPR on September 24, 2024, which found that currently, Indonesia does not have the specific policies needed to encourage the consumption of construction wood products in the domestic market. Such a policy itself requires cross-sector collaboration where the upstream sector (KLHK) requires coordination with various downstream sectors (such as the Ministry of PUPR) in decision-making. The need for this collaboration is due to the limitations of tasks and functions in each ministry as regulated by relevant regulations. This means that here the role of the Coordinating Ministry is crucial in encouraging the priority of the use of ecolabel-certified wood materials in the domestic construction sector, especially for government buildings.

Based on Article 5 letter a of Presidential Regulation No. 92/2020 concerning the Ministry of Environment and Forestry, the functions of the Ministry of Environment and Forestry related to the wood industry only include the formulation, determination, and implementation of increasing the competitiveness of the primary industry (see Figure 5 for reference to the scope and limitations of the primary industry). Meanwhile, Porter (1985) explains that increasing product competitiveness can be driven through innovation, technology adoption,

human resource development, and efforts to pursue efficiency and quality in the production process. This means that according to these limitations, the Ministry of Environment and Forestry as the upstream sector supervisor is only responsible for policies related to product development, wood production efficiency, improvement and standardization, marketing, technology application, certification (including eco-labels), and human resource development.

Similar to the Ministry of Environment and Forestry, the Ministry of Public Works and Public Housing cannot unilaterally formulate policies that require the use of ecolabel-certified bio-based materials in government construction activities. Although based on Article 3 letter a of Presidential Regulation No. 135/2018 concerning Amendments to Presidential Regulation No. 15 of 2015 concerning the Ministry of Public Works and Public Housing, this institution has the authority to formulate, determine, and implement policies related to the development of residential areas and building arrangements; however, forcing the ratification of the policy has the potential to cause more negative impacts than positive impacts due to the unpreparedness of supporting infrastructure in the regions. This issue was reported by almost all respondents from outside Java where SVLK-certified wood products, which are indeed only required for export wood, are often not available on the LPSE[21] website. This means that enforcing the obligation to use SVLK-certified wood in government building construction activities, can hinder the development process in the regions.

The situation as explained above also shows the need for policy coordination with the Ministry of Trade and/or Ministry of Industry which regulates the domestic trade of SVLK-certified wood. Thus, the a need for the role of the Coordinating Ministry, such as the Coordinating Ministry for Maritime Affairs and Investment or the Coordinating Ministry for Economic Affairs, to synchronize policies.

4.2.1.2. Non Optimal Prioritization of Sustainable Construction Principles and Implementation of National Level Construction Policies in the Subnational

Although based on the results of the review of the policy on the use of wood materials, both in the forestry and construction sectors, all available regulations appear to be synergistic with each other, in reality, several gaps have an impact on the implementation of these regulations in the field. These gaps were found during interviews with various respondents, both at the central and regional levels regarding the construction of government buildings, where the wood materials used as raw materials for government buildings often do not consider the requirements, environmentally friendly products, such as SVLK, as regulated in Article 14 paragraph (4) of PUPR Regulation No. 14/2020.

It should be conceived that the reason this study emphasizes the use of SVLK-certified wood only in government building construction is to prevent the emergence of disincentives for the wood business climate if SVLK is enforced as mandatory for all parties in the domestic market. As the implementation of SNI is not entirely mandatory, the implementation of SVLK is required only for export-oriented wood products due to the extra processes and costs incurred in the fulfillment effort have not provided additional benefits for domestic market-oriented business actors. Therefore, by focusing only on fulfilling policies related to government building construction, the expansion of SVLK benefits for domestic market-oriented wood business actors can grow, while the potential for policy disincentives can be avoided.

The results of the study of the content of regulations and legislation found several policy gaps related to the use of wood materials in the construction sector. These gaps appear

21 Based on the official LPSE website, Electronic Procurement Services (*Layanan Pengadaan Secara Elektronik* – LPSE) is an information technology management service to facilitate the implementation of electronic Procurement of Goods/Services. As explained in: https://lpse.kominfo.go.id/eproc4/publik/tentangkami.

in several regulations in the construction sector, including PP No. 16/2021 concerning the Implementing Regulations of the Law on Technical Requirements in No. 28 of 2002 concerning Building Construction, and PUPR Ministerial Regulation No. 21/2021 concerning the Assessment of Green Building Performance which revokes PUPR Ministerial Regulation No. 02/2015 concerning Green Building Construction (Table 7). In PP No. 16/2021, this gap arises due to differences in provisions in technical planning between public buildings and Green Building Construction, where the use of environmentally friendly certified materials is only required for green buildings (Article 112 paragraph (1)). Such specific requirements indicate a conflict with other regulations that are still in effect, such as Article 19 paragraph (1) of Presidential Regulation No. 12 of 2021 which requires environmentally friendly procurement - in addition to SNI standards. Not only that, the overly specific requirements for the use of environmentally friendly materials in PP No. 16/2021 also make PUPR Ministerial Regulation No. 14/2020, which requires the following of the Sustainable Construction Principles, contradictory. Furthermore, the policy gap in PP No. 16/2021 is widened by the regulation regarding mandatory green building criteria in PUPR Ministerial Regulation No. 21/2021.

PUPR Ministerial Regulation No. 21/2021 regulates mandatory criteria for green buildings by loosening similar mandatory criteria regulated by the previous ministerial regulation, namely PUPR Ministerial Regulation No. 02/2015 concerning Green Buildings. In the previous regulation (PUPR Ministerial Regulation No. 02/2015), new buildings that must be categorized as green buildings were relatively strict. The regulation does not specify the total area of class 4, 5, 6, 7, 8, and 9 buildings. Likewise, class 6, 7, 8, 9a, and 9b buildings already have a mandatory green building category with a height of two floors and a building area of 5,000m2. Furthermore, other types of new buildings that are required to be green buildings are buildings that have a high level of resource consumption and/or are determined by the local government according to their urgency. This is in contrast to the new regulation in PUPR Ministerial Regulation No. 21/2021 which has a very high threshold to be included in the criteria for buildings that must be green. The criteria for new buildings that must be green as regulated in PUPR Ministerial Regulation No. 21/2021 are as follows (Table 8):

1. Class 4 and 5 buildings with a minimum height of four floors, and a minimum area of 50,000m^2;
2. Class 6, 7, and 8 buildings. Minimum height of four floors, and a minimum area of 5,000m^2;
3. Class 9a buildings with an area of more than 20,000m^2, and
4. Class 9a buildings with an area of more than 10,000m^2.

Relevant to the context of the use of wood materials in the construction sector, the relaxation in determining buildings with mandatory BGH criteria as regulated by PUPR Ministerial Regulation No. 21/2021 reduces the possibility of using environmentally friendly certified wood materials in building construction projects, especially government buildings. On the other hand, full implementation of the regulation has the potential to allow the construction of most buildings in Indonesia not to use SVLK-certified wood materials. As a comparison, based on the criteria in PUPR Ministerial Regulation No. 21/2021, the area of an office building (Class 5) that must be included in the mandatory BGH criteria must be at least twice the area of the Istiqlal Mosque building[22] - even though the mosque currently has seven floors; or 1.5 times the area of the Jakarta Convention Center (JCC) building[23]. Thus, the relaxation of the criteria indicates a lack of synergy between PUPR Ministerial Regulation No. 21/2021 and sustainable and low-emission development efforts in Indonesia.

22 Based on the BAZNAS Indonesia website, the building area of the Istiqlal Mosque is 24,200m^2. Available at: https://menara.baznas.go.id/n/9004585-masjid-istiqlal

23 Based on the official JCC website, the JCC building area is 30,000m^2. Available at: https://www.jcc.co.id/about-jcc/jcc-overview.html

Table 7. Summary of findings on gaps in policy implementation related to wood materials in the construction sector based on ROCCIPI analysis

No.	Policy/ Regulation	Content of Regulations	Gaps	Information
1.	PP No. 16/2021 – Article 112 paragraph (1)	The technical planning provisions for green building structures consist of several things, i.e.: a. site management; b. energy efficiency; c. water efficiency; d. indoor air quality; e. use of environmentally friendly materials; f. waste management, and g. wastewater management.	***Rule:*** 1. The technical planning provisions that require the use of environmentally friendly certified materials are only specific to BGH, which is contrary to the obligation to procure goods with similar certificates in Presidential Decree No. 12/2021. 2. These technical planning provisions also make several ministerial-level regulations irrelevant, including: – Article 27 of PUPR Ministerial Regulation No. 14/2020 requires the implementation of Sustainable Construction Principles, and – Article 9 paragraph (3) of PUPR Ministerial Regulation No. 1/2022 which requires the preparation of basic unit prices (HSD) which must prioritize several requirements, including the use of environmentally friendly materials. ***Opportunity***: The policy loopholes arising from the implementation of PP No. 16/2021 have the potential to be exploited by various parties to not use environmentally friendly materials in the construction of government buildings that do not meet the criteria for green buildings. ***Ideology***: The relaxation of the obligation to use environmentally friendly materials, especially for government buildings, is not under Indonesia's sustainable development principles which are included as a national strategy for controlling climate change in the Nationally Determined Contribution (NDC[24]) document.	The rules related to technical planning that require, among other things, the use of environmentally friendly materials only apply to green buildings. Other building categories do not have such clauses, even though they are government-owned buildings.

24 Nationally Determined Contribution (NDC) is a commitment submitted by countries that are parties to the Paris Agreement in 2015 to reduce GHG emissions and address climate change. Indonesia itself has renewed its GHG emission reduction target to 31.89% through its efforts and 43.20% with international assistance (Santoso 2024).

No.	Policy/ Regulation	Content of Regulations	Gaps	Information
2.	Permen PUPR No. 21/2021 – Article 2 paragraph (2)	This article regulates the criteria for new buildings that must comply with the technical requirements for green buildings, including: a. Class 4 and 5 buildings with a minimum height of four floors, and a minimum area of 50,000m^2; b. Class 6, 7, and 8 buildings. Minimum height of four floors, and a minimum area of 5,000m^2; c. Class 9a buildings with an area of more than 20,000m^2, and d. Class 9a buildings with an area of more than 10,000m^2.	***Rule:*** Similar to PP No. 16/2021, the technical planning provisions also make several ministerial-level regulations irrelevant, including: 1. Article 27 of PUPR Ministerial Regulation No. 14/2020 requires the implementation of Sustainable Construction Principles, and 2. Article 9 paragraph (3) of PUPR Ministerial Regulation No. 1/2022 which requires the preparation of basic unit prices which must prioritize several requirements, including the use of environmentally friendly materials. ***Interest:*** The ratification of this regulation which was carried out after the announcement of the plan to develop the National Capital City indicated the potential for an interest issue in the ROCCIPI analysis. The legalization of this regulation changed the old regulation (PUPR Regulation No. 02/2015 concerning Green Buildings) with simpler BGH criteria. In general, the relaxation of the green building criteria can reduce the state's financial burden, thereby facilitating the plan to move the capital city. ***Ideology***: Similar to PP No. 16/2021, the relaxation of the obligation to use environmentally friendly materials, especially for government buildings, is not per Indonesia's sustainable development principles which are included as a national strategy for controlling climate change in the NDC document.	For information, all new buildings with criteria other than those in Article 2 paragraph (2) are included in the 'recommended' category with the list as stated in Article 2 paragraph (1). This regulation also changes the old regulation in PUPR Ministerial Regulation No. 02/2015 which requires stricter BGH criteria. As a comparison, based on Article 5 paragraph (3) of PUPR Ministerial Regulation No. 02/2015, the criteria for buildings that require BGH in the old regulation are: a. Class 4, 5, 6, 7, 8, and 9 buildings that are complex with medium to high heights; b. Class 6, 7, 8, 9a, and 9b buildings with a height of up to 2 floors and a total floor area of more than 5,000 m2; c. Buildings with high consumption of energy, water, and other resources, and have potential savings; d. Buildings are determined by the regional government at the district/city level or the Special Capital Region of Jakarta Province based on urgency and the implementation of its policies.

No.	Policy/ Regulation	Content of Regulations	Gaps	Information
3.	– PP No. 16/2021 – Perpres No. 12/2021 – Permen PUPR No. 1/2022 – Permen PUPR No. 14/2020	Obligation to use SNI standard materials in construction work.	***Communication***: Findings from several respondents in the regions stating that the construction TORs are still using the rules as stipulated in PKKI NI-5 of 1961 indicate a lack of socialization of various rules that require the use of SNI standard materials in the construction sector. Not only that, another communication gap related to the implementation of policies in the construction sector is the continued assumption that regulations at the Ministerial Regulation level must be further translated by similar regulations at the regional level to be implemented, even though this is not the case.	

Table 8. Summary of building class description based on Decree of the Minister of Public Works No. 10/2000

Building Class	Class Description
Class 1	1a: Single residential buildings consisting of: – a single house, or – one or more attached dwelling buildings, each of which is separated by a fire-resistant wall, including row houses, garden houses, townhouse units, and villas.
	1b: A single residential building in the form of a dormitory/boarding house, guest house, hotel, or similar with a total floor area of less than 300 m^2 not occupied by more than 12 people permanently, and not located above or below another residential building or another class of building other than a private garage.
Class 2	A residential building consisting of 2 or more residential units, each of which is a separate residence.
Class 3	A residential building other than a Class 1 or 2 building, which is used as a permanent or temporary residence by several unrelated persons, including a boarding house, guest house, inn, the residential portion of a hotel or motel, the residential portion of a school, a nursing home for the aged, disabled, or children, the residential portion of a health care building housing employees.
Class 4	Mixed Residential Buildings are residences located in a class 5, 6, 7, 8, or 9 building and are residences within the building.
Class 5	Office buildings are buildings used for professional business purposes, administrative management, or commercial business, other than class 6, 7, 8, or 9 buildings.
Class 6	Commercial Building. A shop or other building used for the retail sale of goods or direct service to the public, including a dining room, cafe, restaurant, dinner room, bar, shop, or kiosk as part of a hotel or motel, barber shop or salon, public laundry, and market, sales room, showroom, or workshop.
Class 7	Storage Building or Warehouse. Buildings used for storage, including public parking lots, warehouses, or places to display manufactured goods for sale or warehouse clearance.
Class 8	Laboratory, Industrial, Factory Buildings. Laboratory buildings and buildings used for processing production, assembly, alteration, repair, packaging, finishing, or cleaning of production goods for trade or sale.
Class 9	Public Buildings. Buildings are used to serve the needs of the general public. 9a: Healthcare buildings, including those parts of the building that are laboratories.
	9b: Meeting buildings, including workshops, laboratories, or the like in elementary or secondary schools, halls, religious buildings, cultural buildings, or the like, but excluding any part of a building that is of another class.
Class 10	Non-residential buildings. 10a: Non-residential buildings which are private garages, carports, or the like.
	10b: Structures in the form of fences, posts, antennas, retaining walls or free-standing walls, swimming pools, or the like.

The impact of the looseness of the mandatory green building criteria in the policy is not only broadly impacted by the lack of use of environmentally friendly construction wood materials. This is considering the scope of the assessment of the fulfillment of BGH technical requirements is broad, including consideration of energy and water efficiency, waste and waste management, and site management. This means that there is the potential for other negative environmental impacts that may arise as compensation for the implementation of PUPR Ministerial Regulation No. 21/2021.

Another obstacle to the implementation of various policies related to the use of environmentally friendly materials in the regions is closely related to the gap in the communication process in the implementation of policies that are legalized based on the ROCCIPI analysis. From the results of interviews with several respondents in the regions, this study found that many sub-national stakeholders still use the strong class and/or durable class, as regulated in PKKI NI-5, in their construction TOR, instead of based on the Modulus of Elasticity (MoE) as regulated in SNI 7973:2013. It does not stop there, this study also found that several relevant Regional Apparatus Organizations at the sub-national level do not understand the various regulations related to green buildings as regulated by several regulations at the Ministerial Regulation level. This situation indirectly shows the lack of socialization of national-level regulations so that they can be implemented at the sub-national level.

4.2.2. Findings on Gaps in Environmental Knowledge Capacity

Obstacles related to optimizing the implementation of policies related to the use of wood materials were also found due to a lack of understanding of the definition of the term 'sustainable' in the construction sector. Discussion of this is important considering the many efforts that can be made by the construction sector to ensure the reduction of GHG emissions and environmental sustainability through the preparation and implementation of its policies. Moreover, the construction sector also contributes to GHG emissions in quite significant amounts in Indonesia. The contribution of construction sector emissions in 2020 reached 20% of the total GHG emissions in that year, where 4% was generated from the use of energy for building construction and operations, and indirectly and 16% due to the use of electricity for heating and cooling buildings (Yeremy and Wimala 2022). This means that in that year the total GHG emissions from the construction sector reached 149,515.8 million tCO_2e (tons of CO_2 equivalent emissions)[25]. Even in 2023, the contribution of this sector's emissions increased to 24.6% of Indonesia's total GHG emissions (Bahfein and Alexander 2023). Based on these data, maximum efforts are needed from the construction sector to reduce the impact of global warming, climate change, and environmental preservation in its activities.

One example of the lack of understanding of the construction sector's need to tighten regulations related to reducing GHG emissions and preserving the environment is seen in the laxity of mandatory criteria for green buildings as explained in the previous sub-chapter. The laxity of these criteria indirectly indicates a lack of concern from the construction sector in reducing GHG emissions.

This is reinforced by the statements of respondents at the national level who often receive inaccurate information about various construction raw material products that are considered environmentally friendly, even though they are not. Based on similar interview results, it was also found that currently most stakeholders in the construction sector consider that the term 'sustainable' only means that the raw materials used are durable, do not require much maintenance, or can reduce the resources needed in the use of buildings. Moreover, many stakeholders in the construction sector, both at the regional and central levels, still rely only on geo-based materials (materials extracted from the earth) while ignoring the use of bio-based materials (materials derived from biological raw materials, such as wood, bamboo, rattan, etc.).

In the construction sector, stakeholders' general understanding of the main sources of GHG comes from only three main stages. These stages consist of construction implementation, operation, and demolition of construction; where the operational phase contributes 80-90%

25 This figure is the result of the calculation of Indonesia's total emissions in 2020 which is based on BPS (2024) of 747,579 million tCO_2e.

(Saputri, Uda, and Lendra 2024). Although factual, limiting issuers to only these three stages underestimates the role of the use of materials used by this sector in increasing GHG emissions. This is because the construction sector is closely related to other sectors as sources of raw materials, for example, industry. This relationship can be seen from the construction sector's need for raw materials for steel, paint, cement, and various other raw materials in the industrial sector which contribute significantly to GHG emissions in the manufacturing process.

Referring to the correlation between the materials used - which are one of the GHG emitters with the relaxation of the mandatory BGH criteria in PUPR Ministerial Regulation No. 21/2021, the potential negative impacts are significant. For example, construction with a minimum area of 50,000m2 for the mandatory criteria for class 5 green buildings will logically use more steel materials, which produce high emissions in their manufacture, compared to environmentally friendly wood materials. On the other hand, simple office buildings with a small area and tend to use more wood materials than steel are not included in the mandatory green building criteria. Thus, instead of encouraging the Principles of Sustainable Construction as mandated in PUPR Ministerial Regulation No. 14/2020, the implementation of PUPR Ministerial Regulation No. 21/2021 is counterproductive. In addition, the regulation not only indicates a knowledge gap regarding the term 'sustainability' among decision-makers in the construction sector but also a lack of cross-sector collaboration in policy formulation.

4.2.3. Summary of Findings on the Gaps in the Use of Wood Materials in the Construction Sector

To simplify the discussion related to the gaps in the use of wood materials in the construction sector, and to avoid understanding due to the breadth of the discussion topic, this section of the paper will present the findings in brief. The summary of the findings as referred to is presented in Table 9.

Table 9. Summary of findings on policy gaps and their implementation related to the use of wood materials in the construction sector

No.	Policy(es)	Contexts	Gaps Found
1.	No policy encourages the mainstreaming of wood and other bio-based materials. Efforts to encourage this policy require collaboration between sectors (ministries) so that the role of the Coordinating Ministry becomes important.		
2.	PP No. 16/2021	Rules on mandatory green building criteria	Policy gaps based on ROCCIPI analysis: – Technical requirements considering environmental impacts that are only applied to green buildings contradict the Principles of Sustainable Construction, HSD which must prioritize environmentally friendly requirements, and the principles of sustainable development in Indonesia. – The implementation of this policy also has the potential to cause the use of materials, especially wood, that is not sustainable in construction activities due to the criteria given to buildings that are required to be green to be too laxious.
3.	Permen PUPR No. 21/2021		

No.	Policy(es)	Contexts	Gaps Found
4.	– PP No. 16/2021 – Perpres No. 12/2021 – Permen PUPR No. 1/2022 – Permen PUPR No. 14/2020	Obligation to use SNI standard products and ecolabel certified materials in the construction sector	Lack of socialization of regulations: – The continued use of standardization as regulated in PKKI NI-5 of 1961 in the regional construction KAK indicates a lack of socialization of various regulations that require the use of the latest SNI standard materials. – There is still an assumption at the regional level that regulations at the Ministerial Regulation level must be lowered as Regional Regulations to be implemented.
5.	Permen PUPR No. 14/2020	Obligations to implement the Sustainable Construction Principles	
6.	Permen PUPR 9/2021		
5.	Policy making from various regulations related to the use of environmentally friendly labeled materials issued in the construction sector		Lack of knowledge about sustainability concepts among stakeholders in the construction sector. Findings based on answers from several respondents indicate a gap in knowledge and understanding related to sustainability concepts needed in the construction sector, such as: 1. Some respondents still think that the meaning of sustainable materials is limited to durability and low maintenance costs; 2. The looseness of the criteria for mandatory BGH buildings is an indication of the lack of attention of the construction sector to environmentally friendly, low GHG emission, and sustainable material sources; 3. Not only from the very loose rules regarding the requirements for the use of labeled wood materials, the lack of focus on the use of bio-based materials in the construction sector also indicates similar issues.

4.3. Alternative Policy Option Recommendations

This section of the article attempts to provide alternative policy options related to the use of wood materials in the construction sector based on the findings of the gap. As reviewed in the previous section of the article, the discussion in this Sub-Chapter also only focuses on the construction of government buildings. The selection of this focus is to prevent the potential emergence of disincentives for wood certification policies if they must also be applied to the domestic market, while the benefits currently received by wood industry business actors are not considered appropriate to the extra costs they must incur for SVLK certification.

4.3.1. Cross-Sector Collaboration on the Use of Environmentally Friendly Materials in the Construction Sector

One of the key findings in the gap analysis is the lack of policies that prioritize the use of environmentally friendly wood construction materials in the construction of government buildings. This finding needs to be considered because the government is currently intensively carrying out construction activities in developing the IKN. In addition, Indonesia currently also has a big plan to build two million houses per year. Without policies that consider the use of environmentally friendly construction materials, these activities not only negate the Principles of Sustainable Construction but can also be a major source of GHG emissions.

The formulation of mainstreaming policies as needed cannot be done without cross-sector collaboration. The limitation of the tasks and functions of each ministry requires the role of the Coordinating Ministry, both the Coordinating Ministry for Maritime Affairs and Investment and the Coordinating Ministry for Economic Affairs, according to their functions, to encourage the priority of using bio-based materials, including wood, certified with ecolabels. Some of the roles expected from the Coordinating Ministry related to the above issues include:

1. Encourage regulations that require SVLK partially for wood products used for domestic needs;
2. Synchronize policies and policy instruments that are relevant to efforts to mainstream the use of bio-based materials in the construction of government buildings, such as:
    a. encouraging the renewal of outdated standardization as well as the gradual formulation of strategies to increase the use of wood standardization by involving various stakeholders;
    b. preparation of cross-study/cross-sector regulations to improve the alignment of regulations related to Sustainable Construction Principles with current science, environmental impact thresholds, and GHG emission reduction activities;
3. Encourage the formation of aggregators of construction wood products and wood construction, especially at the sub-national level. The aggregator as referred to is a group of wood industry and wood construction business actors to jointly bid on procurement activities through LPSE (Putra 2024). Through this kind of conglomerate system, micro, small, and medium business actors can overcome financial limitations and production capacity that generally prevent them from participating in the procurement of goods and/or services at LPSE. This aggregator can be formed, either by the government (in the form of a cooperative) or the private sector (in the form of a cooperative or consortium) according to their needs;
4. Establish a multi-purpose Working Group initiated by the Coordinating Ministry, to initiate the following (but not limited to):
    a. Preparation of a National Strategy document related to wood and wood products, both in the forestry, industrial, construction, and other related sectors;
    b. Encourage the availability of ecolabel-certified materials, including wood, at LPSE locations at the regional level, and/or
    c. Establish a Biomaterial-Based Development Acceleration Team for Sustainable Development.

4.3.2. Careful Tightening of Green Building Criteria

As explained in the previous section, one of the problems that arises related to the use of wood materials in the construction sector is the excessively loose criteria for mandatory green buildings, including for government buildings. The looseness of the policy not only has an impact on the small potential for the use of environmentally friendly wood - in this case, SVLK-certified wood but also increases the potential for the use of illegal wood in the construction of government buildings that do not meet the mandatory criteria for green buildings. In addition, based on ROCCIPI's analysis of relevant policies, this study found a lack of continuity between the rules in the policy, where on the one hand the construction sector requires the implementation of the Sustainable Construction Principles, while on the

other hand, the obligation to use environmentally friendly materials is only imposed on green buildings.

However, on the other hand, the scenario of tightening the criteria for mandatory green buildings does not necessarily eliminate potential problems that may arise in the implementation of the policy. This is because by applying strict criteria to buildings that are required to be categorized as green buildings, it can indirectly affect the obligation to use environmentally friendly construction wood materials in the construction of government buildings. Therefore, the policy as intended also requires careful consideration, especially regarding the readiness of the architecture in each region. This is important to prevent the implementation of alternative policies from actually creating obstacles to development at the sub-national level. The reason is, based on the results of interviews with several respondents in the regions, the availability of SVLK-certified wood is difficult to obtain outside Java, including on the LPSE site. A similar condition was also acknowledged by respondents in the central government, where much environmentally friendly construction wood is not available locally on the LPSE site. This explanation shows the importance of finding a middle ground between the current mandatory green building policy which is too loose and not in line with the principles of sustainable development with the limited capacity of stakeholders and the low availability of environmentally friendly wood in the regions.

Efforts to find a middle ground for the policy as intended can be achieved by drafting regulations on the use of wood materials in the construction sector which ensure the following:

1. The mandatory green building criteria requirements are strict enough to ensure the potential use of legal and environmentally friendly wood materials in the construction of government buildings is reduced. The tightening efforts as referred to can be carried out by reducing the mandatory green building area criteria currently regulated in PUPR Ministerial Regulation No. 21/2021 to be more realistic;
2. The enacted regulation has an alternative clause that provides a dispensation for the use of environmentally friendly labeled materials, including SVLK wood, in the construction of government buildings when there are limitations in locally available environmentally friendly labeled raw materials. To ensure that there is progress in institutional improvement in the future, the clause as referred to needs to provide a deadline for the government at the sub-national level to overcome the obstacles faced;
3. Embracing the regulation of the use of renewable bio-based materials instead of non-renewable geo-based materials in the construction sector;
4. Providing incentives for business actors in the construction sector for the percentage of use of environmentally friendly materials, including wood. Such policies are important to ensure the emergence of enthusiasm from all stakeholders in this sector to ensure the achievement of the objectives of the Sustainable Construction Principles can be achieved, and
5. Preparation of regulations that involve cross-sector stakeholders, which in this context are the environmental and forestry sectors. This is important considering that the environmental and forestry sectors already have various thresholds and provisions related to the environment that are actually in line with the Sustainable Construction Principles. This sector is also a guardian for sources of wood raw materials in Indonesia that are used by various sectors, including construction so that optimizing collaboration between the two sectors can encourage increased harmony between sectors.

For the environmental and forestry sectors themselves, synchronization between policies on the use of sustainable wood materials in the construction sector, as mentioned in the point above, is indeed necessary. This is because the expansion of the use of environmentally friendly wood in the domestic construction wood market also expands the benefits of SVLK wood certification which have so far been considered insignificant for domestic market-oriented wood industry players. This means that the implementation of policies that support the sale of SVLK-certified wood for the domestic market can not only encourage the use of local wood materials but can also gradually increase public awareness of environmental sustainability. Meanwhile, for the construction sector, ensuring that appropriate decision-making and policies related to the use of environmentally friendly materials can increase the sector's contribution to Indonesia's efforts to meet the NDC target. Furthermore, the policies referred to can be a milestone for the Indonesian construction sector to achieve sustainable development goals in the future.

However, to reach a consensus on the policy needs as recommended in this section, there needs to be a common understanding of the concept of sustainability among stakeholders in the construction sector. Therefore, the following recommendations will focus on efforts to improve understanding of the concept of sustainability.

4.3.3. Socialization of Regulations and Strengthening of Knowledge Capacity Related to Environmental Sustainability in the Construction Sector

Another obstacle faced by the construction sector in encouraging the optimization of Sustainable Construction Principles is the unequal understanding of the concept itself. The impact of the low understanding of sustainability relevant to environmental sustainability can be seen from various legal policies in the construction sector, where the encouragement to use environmentally friendly materials, especially wood, is very limited due to very loose regulations. This condition indirectly indicates the low understanding of stakeholders in the construction sector regarding the considerations and benefits of using sustainable materials. This unfavorable situation increases at the sub-national level, where many of the regional apparatus organizations relevant to the construction sector do not understand the existing regulations. This can be seen from the continued use of the 1961 PKKI NI-5 standard in various KAK construction of various government buildings, which should no longer be used after the enactment of PUPR Regulation No. 22/2018. The general reason put forward by respondents is that regulations at the Ministerial Regulation level must be lowered to regulations at the regional level before they can be implemented by sub-nationals. This less relevant fact has resulted in the low implementation of several key regulations related to the use of environmentally friendly materials in the regions.

The above issues indicate an urgent need for various outreach activities, both related to increasing the capacity of knowledge about environmental sustainability, and the socialization of laws and regulations in the construction sector. Paying more attention to outreach activities as intended, can not only ensure that the applicable formal legal policies can be implemented in the regions but can also gradually increase knowledge about the broad scope of Sustainable Construction Principles in Indonesia. With the increasing understanding of stakeholders in the construction sector regarding environmental sustainability and Indonesia's efforts to reduce GHG emissions, there will be many opportunities for this sector to improvise with the materials used in the construction process. It is hoped that in the future this sector will not only depend on non-renewable geo-based materials but can also encourage the application of bio-based materials. Meanwhile, ensuring the socialization of policies to the sub-national level can ensure the effectiveness and achievement of the objectives of implementing various

existing formal policies. Not only related to the use of environmentally friendly materials but also compliance with the SNI standard basis used to ensure the reliability of buildings.

Outreach actions can also be carried out in stages, starting with encouraging technical labeling policies (as in SNI) on various wood products sold in retail to increase consumer awareness of the wood products they buy. However, to ensure the goal of increasing public understanding of the technical specifications of wood in the domestic market, systematic follow-up efforts are needed through a study, such as:

1. Formulation of public education strategies related to wood specifications and labeling;
2. Targets for training required;
3. Appointment of leading sectors for educational actions, and
4. Various other issues based on the results of the study.

V. CONCLUSION

The policy on the use of construction materials in Indonesia has generally balanced the obligation to use materials with technical quality standards, such as SNI; and ethical standards that take into account the principle of environmental sustainability. For example, several SNI standards have been regulated into formal rules. However, many of these standards require updating. In the construction sector, the obligation to use SNI standard materials is regulated, among others, through the enactment of PUPR Ministerial Regulation No. 22/2018. Like SNI as a technical standard, policies related to ethical standards in the context of the use of wood materials are also available through various policies that regulate environmentally friendly labels (through LHK Ministerial Regulation No. 5/2019) and SVLK (LHK Ministerial Regulation No. 8/2021) in the environmental and forestry sectors.

Furthermore, the implementation of SVLK is further regulated in Presidential Regulation No. 12 of 2021 which requires the procurement of goods and services labeled environmentally friendly. In the construction sector, this regulation is in line with PUPR Ministerial Regulation No. 14/2020 which emphasizes the existence of Sustainable Construction Principles. However, this study found several gaps, both related to policy and its implementation, such as:

1. The use of SVLK wood for the domestic market has not been a national priority, including in the construction sector;
2. There are no policy incentives that encourage the mainstreaming of the use of environmentally friendly bio-based materials and this requires an increase in the role of the Coordinating Ministry;
3. Buildings with mandatory BGH criteria are too loose so that they are not under the Principles of Sustainable Construction;
4. Implementation of national-level regulations that are not running well at the regional level, such as the continued use of PKKI NI-5 of 1961 in the KAK of construction projects instead of using its replacement, namely SNI 7973:2013;
5. Many of the SNIs for wood and wood construction are outdated, including SNI 7973:2013, so they need to be updated, so.
6. The findings above indicate other gaps, namely the lack of socialization of national regulations at the regional level, stakeholder knowledge capacity, and minimal cross-sector collaboration.

To address the various findings described above, this study recommends several alternatives, as follows (but not limited to):

1. Increasing the role of the Coordinating Ministry through immediate consolidation efforts to formulate policies related to wood and the use of SVLK-certified bio-based materials in government procurement, including government building construction activities. This includes the preparation of a National Strategy document related to wood and other bio-based materials;
2. Careful tightening of mandatory BGH criteria to prevent policy disincentives, and considering the existence of the following:
    a. Only applicable to government building construction;

   b. The proposed regulation has an alternative clause that provides dispensation until the institutional architecture at the subnational level is ready;
   c. Encourage the use of bio-based materials;
   d. There is a clause providing certain incentives based on a percentage of the use of ecolabel-certified biomaterials, and
   e. Involve cross-sector stakeholders in policy formulation;
3. Encourage collaboration between stakeholders through:
   a. Partial implementation of mandatory use of SVLK-certified wood, especially for the construction of government buildings;
   b. synchronization of policies and policy instruments and their renewal with the involvement of cross-sector stakeholders;
   c. Encouraging the formation of an aggregator for MSMEs engaged in the construction wood and wood construction industry to be able to overcome their limitations in procurement involvement in LPSE;
   d. Formation of a working group to accelerate, both the preparation of the National Strategy document, the use of bio-based, environmentally friendly certified materials, and/or establishing a Biomaterial-Based Development Acceleration Team for Sustainable Development;
4. Intensify efforts to socialize regulations and increase knowledge related to environmental sustainability and the Principles of Sustainable Construction for stakeholders in the construction sector, and
5. Encourage renewal of standardization of wood, wood products, and wood construction and efforts to improve the implementation of these standards domestically.

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