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# Drivers, Barriers, and Strategies in the Community-Based Supply of Bamboo for Industrial-Scale Bamboo Utilization in Ngada Regency, East Nusa Tenggara, Indonesia

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**Abstract:** Bamboo has been part of the history and the socio-cultural and economic or livelihood aspects of Indonesia. Bamboo has been recommended as a potential species that could be utilized for community-based development in the rural part of the country as well as for utilization in various products, from traditional to modern and contemporary processes. However, there is a lack of integrated research on the community's bamboo for industrial-scale products. This study aimed to determine and assess drivers-barriers to enable the formulation of strategic recommendations aimed at promoting the success of community-based supply of the commodity for the modern bamboo industry in Ngada Regency in Indonesia. The methods were applied by collecting quantitative and qualitative data using literature reviews, questionnaires, interviews, focus group discussions, and direct field observations. Collected data were analyzed by descriptive analysis and assessing both for internal and external factors of drivers-barriers. Research findings showed that the community proceeds from a traditional mindset with regard bamboo resources and utilization but that the community actually already owned social capital to strengthen and drive modern bamboo utilization. However, there is still a lack of capacity building for bamboo management. This study also provides policymakers with strategic recommendations to develop integrated programs and regulations, support community-based bamboo utilization, improve livelihood, and support rural inclusive economic growth.

**Keywords:** community livelihood; bamboo resources; supply industry; rural development; development strategy



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## 1. Introduction

Bamboo is mainly distributed in tropical and semitropical belts and is a typical resource found in Asia, Central and South America [1]. The world's bamboo consists of 1662 species from consisting of 121 genera, which are naturally distributed in 122 countries. As a tropical country of South East Asia, Indonesia has significant potential bamboo resources to be developed. Widjaja [2] reported that Indonesia has recorded 176 bamboo species, of which 140 are considered native and 105 species known to be endemic, with 20 bamboo species yet to be scientifically described. However, only 108 of these bamboo species have been identified by the community for their usefulness, with 15 species regarded as most useful

and, thus, commonly traded commercially. These useful species are harvested both for their poles and for being sources of raw materials, as well as such as shoot, for bamboo products.

In general, bamboo has three groups of main uses: (1) for subsistence purposes, and domestic household use (e.g., house materials, cages, farm tools, as a vegetable trellis, trellis post, shade trellis, etc.); (2) commercial production use in construction, food, and arts (e.g., concrete, reinforcement, fishing rods, furniture, crafts, edible bamboo shoots, musical instruments, engineered bamboo products, etc.); and (3) ornamental, landscape, and conservation use (e.g., riparian buffers, plant specimens, screens, hedges) [3].

In Indonesia, bamboo has been an important part of history, socio-cultural tradition and activities, and community livelihood pursuits [4–6]. The bamboo plant is mainly found in the mixed garden where it grows with other flora such as trees, shrubs, palms, and understory vegetation [7–10]. The community utilizes it for daily needs, for crafts and weaving, and as traditional building material [11,12]. However, bamboo-related earnings and business types that were undertaken have failed to significantly increase the income of the people because the commodity's added value remain low and because bamboo processing continues to be regarded as a side job [13,14]. Rabik and Ekawati [15] write that community-based bamboo development could be the force for advancing the high-value-added bamboo industry through integrated cross-sectoral support in Indonesia. Using community bamboo as the supply of materials for the industry with appropriate processing and machinery for more value-added products can provide additional household income in rural areas [15].

Modern utilization on a community industrial-scale should create more opportunities for adding value to bamboo in order to increase the community's income. This has been proven in China as seen in the report of Flynn A et al. [15], and Ruiz-Perez M et al. [16] regarding how bamboo development increased farmers' income by 28.4% and played an important role in the industrial development of rural areas in Anji County, Zhejiang Province. In the same situation in Linan County located in the southern part of Anji, bamboo sector reform and other initiatives significantly increased the role of the bamboo sector in the local economy. Income derived from bamboo also plays an essential role in moving many households from the poor to the wealthier classes [17]. However, there has been no research on the utilization of community bamboo resources as a supply of industrial raw materials in Indonesia because not many industries process bamboo into modern products on a large scale [18].

The bamboo development program in Ngada Regency was initially carried out through the planting of a million bamboo under a collaboration program between the Environmental Bamboo Foundation (EBF) and the local government of Ngada Regency in 1995, which also corresponded as a recovery program of the 1992 Maumere earthquake. Subsequently, from 2006 to 2008, the central and local government carried out a bamboo nursery and planting program targeting 500 ha of land area [19]. In 2007, the local government, in collaboration with the Gadjah Mada University, undertook a feasibility study for the bamboo business development in various levels based on its utilization [20]. The feasibility study [20] revealed that Ngada has the potential of abundant bamboo product supply based on the existing raw bamboo resources in the area. Thus, the study in effect pointed to how bamboo utilization has not been optimized. Worth noting is how the study provided recommendations for modern bamboo having added value, such as laminated bamboo products, on medium and large industrial scales. In 2012, a bamboo processing factory was thereafter established, producing preserved bamboo strips and sticks as half-finished materials for engineered bamboo products. This factory processes community bamboo by applying selected harvesting because the raw material requirement for their bamboo product is limited to four-year-old bamboo poles.

From those baseline programs, Ngada has become a pilot model of community-based integrated bamboo development from upstream to downstream through the involvement of various stakeholders. The model refers to the utilization of bamboo and the direct interaction of the community on bamboo management. Later, in 2016, an initiative was

conducted by the EBF, in collaboration with the Ministry of Environment and Forestry through a movement called Thousand Bamboo Villages, as a platform for integrated community-based bamboo industry development in Indonesia. Following the initiative, the Ministry of Environment and Forestry, the Ministry of Industry, and the local government launched the center for community-based bamboo industry development as a running model of implementation in the country [18].

As a model of the community-based bamboo development center, Ngada has fulfilled the requirement of the upstream sector with its great potential of existing community bamboo resources, and the established preserved bamboo strip processing industry as existed in the area to support the downstream sector. However, the driving and the barriers factors in the implementation of the community-based bamboo supply for industrial purposes are yet to be identified. However, from the time the bamboo development center began operations in 2012 until today, many challenges still confront the development of processing preserved bamboo strips. In the same situation with the community, bamboo owners as bamboo suppliers should fulfill the requirements for bamboo age and sustainable management. Therefore, this study aims to provide strategic recommendations by determining and assessing drivers and barriers for the success of community-based bamboo supply for industrial-scale utilization in Ngada Regency in Indonesia.

## 2. Materials and Methods

### *2.1. Study Area and Condition*

Ngada Regency is located between 8°20′24.28″–8°57′28.39″ south latitude and 120°48′29.26″–121°11′8.57″ east longitude, in the center of Flores Island, East Nusa Tenggara Province, Indonesia (Figure 1). The regency is geographically bounded by Nagekeo regency in the east, East Manggarai regency in the west, the Flores Sea in the north, and the Savu Sea in the south. Ngada Regency has an area of 1776.72 km$^2$, total water area of 708.64 km$^2$, and a beach length of 102,318 km. Being an area with relatively young active volcanoes and volcanic remnants, mountainous and hilly contours or reliefs are found in Ngada. In terms of topography, it is a hilly area with a relatively high level of land slopes, majority of which are steep, usually between 26% to 40%, covering 21.5% of the total land area. Around 45.4% of the regency lies at an altitude between 500–1000 m above sea level (asl), while 39% is at 0–1000 asl, and about 15.6% is above 1000 asl. This hilly and mountainous topography makes many areas of Ngada prone to natural disasters such as landslides, especially in the southern part [21].

In general, it receives high rainfall at intervals of 1500–2000 mm/year due to the presence of surrounding oceans and the differences in air pressure and temperatures. The regency area is located also upstream of the Aesesa watershed, including Wulabhara and Wae Woki sub-watersheds. Several large rivers provide the community with drinking water, cooking, shower, agriculture, and other needs. Bajawa as its capital consists of 12 sub-districts (Figure 1), of which the sub-district Riung has the largest land area, reaching 327.94 km$^2$ or 20.23% of the total regency area. In contrast, the Jerebuu sub-district has the smallest land area of 64.90 km$^2$, or only 4% of the total area [20].

The total population is 165,254 with a growth rate of 1.25% per year and population density of 102 people/km$^2$. The largest population is in the Bajawa sub-district (25.31%), followed by the Golewa sub-district (12.90%). The least populated is the Wolomeze sub-district, accounting for only 4.08% of the total population of Ngada. Demographic-wise, it has slightly more females than males (51.22% versus 48.78%). In addition, its population is dominated by 15 to 65 years old age, which is considered as the productive age group [22].

Ngada's income mostly comes from the agricultural sector, especially fisheries and forestry. This sector accounts for 34.15% of the total Gross Regional Domestic Product (GDRP), followed by the public sector (19.88%) and the construction sector (13.27%). Other contributing economic sectors are wholesale and retail traders as well as car and motorcycle repair shops (7.91%), also financial services, and insurance (6.31%) [21].

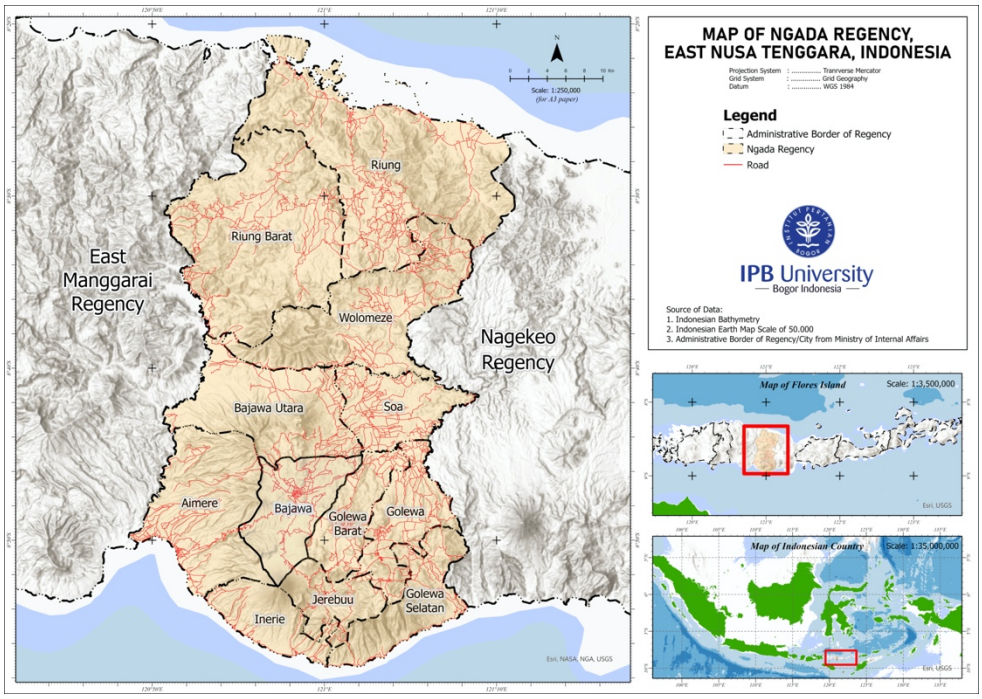


**Figure 1.** Study site and location.

### *2.2. Data Collection*

The research data were collected through literature reviews, questionnaires, interviews, focus group discussions, and direct field observations. Data collection took place from July 2019 to June 2021.

#### 2.2.1. Literature and Documents Review

A literature review was carried out by collecting data and information from activity reports, regional planning documents, the central and provincial government's plans, statistical data, reports, news, and publications related to the topic of study. However, it should be noted that there exist very few academic research journals articles on the development of community-based bamboo as an industrial raw material in Indonesia. The documents and literature collected are used as references to support this research.

#### 2.2.2. Questionnaires and Surveys

The targeted groups for questionnaires and surveys were from the local community whose main economic activity is directly connected to bamboo. The data was collected through questionnaires, using two types for different target groups of community respondents based on purposive sampling. The first groups were bamboo owners or bamboo farmers, and the second groups were bamboo products crafters, artisans, and entrepreneurs. The grouping of these respondents was carried out to obtain data and information about the condition of bamboo resources as the upstream sector and the various uses of bamboo currently available in the downstream sector. In filling out the questionnaire, the community respondents were assisted by local enumerators who helped write down the answers and translated some terms into the local language.

The bamboo farmers that possess a minimum of 50 bamboo clumps, either privately or communally owned, were selected for the community bamboo owners. A total of 119 participants served as respondents to the questionnaires. For the first group, questionnaire items included the following: general information describing the demographic characteristics of respondents and their perceptions toward existing bamboo resources. For the second group consisting of current active crafters, artisan, shops, workshops, entrepreneurs, and

industry workers, a total of 121 participants responded to the questionnaires. The items in the questionnaires cover the type of business, bamboo products, and company's scale.

#### 2.2.3. Interviews

The targeted group for the interviews was the expert group consisting of policymakers, researchers, practitioners, and civil society who are in charge of, and engaged in, facilitating bamboo development, management, utilization, and research. Semi-structured interviews were conducted with expert groups by asking several predetermined and other questions developed during the interview. The semi-structured interview technique has the advantage of by being able to obtain more in-depth information because it allows for the asking of additional questions from developing answers given by respondents.

A total of 20 respondents from different institutions of the expert group were interviewed, consisting of the following: 8 respondents from the local and central government, 6 respondents of researchers, 4 from civil society, and 2 bamboo practitioners. The educational level of all respondents in the expert group was either university or higher. The predetermined questions asked to all respondents in the interview were: (i) the main task and roles of the institution, including their authority; (ii) the direction of bamboo development and its strengths, weaknesses, opportunities, and threats; and (iii) the policies and governance to support the bamboo development.

#### 2.2.4. FGDs

The focus group discussions (FGDs) were conducted following the questionnaire survey of community groups and the interviews of expert group data collection in order to discuss the identified drivers and barriers factors obtained from the resulting collected data. Two FGDs activities were carried out involving key actors in bamboo development. The first FGD was held at the level of sub-tribal groups (called *sa'o*) in Golewa sub-district, where the center of the bamboo development program started. There were 25 participants in the first FGD, of whom some also participated in the questionnaire survey. The discussion with a sub-tribal group of bamboo owners was conducted to confirm all the drivers and barriers that were compiled from questionnaires results.

The second FGD, held in the local government office of the Ngada Regency, was conducted to discuss the rating and weighting of each factor of the internal–external drivers and enablers identified for the industrial-scale community-based bamboo. The discussion involved 40 participants that included heads of villages and sub-districts and representatives from the local government, central government, civil society, and private sectors.

#### 2.2.5. Observations

Other information and data were also collected from direct observations in the field during this author's several visits to the research area. This observational data collection was also conducted to directly examine the existing of potential community bamboo resources. Several field visits allowed the authors to interact directly with communities whose livelihoods are closely related to bamboo. The observation was also conducted on the associated stakeholders in their support to developing the supply of community-based bamboo as industrial-scale raw materials, in this case, the local government and the local non-governmental organizations (NGOs) that assist the community in developing bamboo resources.

### *2.3. Data Analysis*

This study used mixed methods in the descriptive analysis of data collected from questionnaires, interviews, FGDs, and observations that were conducted. An integrated analysis was carried out to determine the drivers and barriers in providing community bamboo supplies for industrial-scale bamboo utilization. Descriptive quantitative and qualitative studies were applied on bamboo resource management, community perceptions,

and current forms of utilization. The analysis was conducted to assess internal and external drivers and constraints and generate alternative strategies to overcome them.

#### 2.3.1. Validation and Reliability Analysis

Analysis of quantitative data was conducted by cross-checking, summarizing, synthesizing, and making narrative, descriptive, and evaluative analyses. The quantitative data from questionnaires were analyzed using the SPSS Statistics 25 software (IBM, Armonk, NY, USA) in order to test the validity of the survey questionnaire and the consistency between the questions and the answers given by the respondents. This analysis was applied to the questionnaire for the bamboo owners and farmers group before the descriptive study was conducted.

#### 2.3.2. Descriptive Analysis

Descriptive analysis was implied for quantitative and qualitative data collected. The quantitative descriptions were carried out for statistical data relating to the number and figures obtained from processing closed questionnaire data. In contrast, qualitative descriptions were conducted on what, why, and how questions were obtained from the effects of interviews and open questionnaires.

#### 2.3.3. Drivers and Barriers Analysis

Drivers and barriers analysis was implied from the modification of strength, weakness, opportunity, threat (SWOT) analysis. Dyson [22] argues that the relationship between SWOT analysis and various methods suggests that SWOT is a flexible model that can be incorporated into new approaches and methods. The modified SWOT approach implied cluster drivers and barriers factors identified from the questionnaires and interview results. The term SWOT was more familiar to respondents than drivers and barriers. Therefore, in this analysis, (internal drivers—ID) and opportunities (external drivers—ED) were grouped as drivers. In contrast, weaknesses (internal barriers—IB) and threats (external barriers—EB) were grouped into barriers. Internal factors were defined as the characteristics and conditions of the Ngada Regency originating from the local community as bamboo resources owners and business entrepreneurs, local governments, and the civil society groups engaged in bamboo empowerment. In contrast, external factors were defined to mean the characteristics and conditions from outside Ngada Regency, i.e., investors, provincial and central governments, and other institutions outside Ngada that support the development of community bamboo resources.

The classified drivers and barriers, both internal–external factors, were brought to the second stakeholders FGD in the local government office of Ngada Regency for further focus discussion and determined rating and weighting for each element's evaluations. The results of FGD were evaluated through internal factor evaluation (IFE) and external factor evaluation (EFE) matrix to assess the internal and external factors of drivers and barriers. The IFE Matrix is a strategy tool used to evaluate the condition of internal drivers and barriers while the EFE matrix shows how effectively the current situation and condition respond to external drivers and barriers.

In the second FGD, the IFE and EFE were implied with weight and rating for the key factors. Each key element was assigned with a weight ranging from 0.0 (low importance) to 1.0 (high importance), a number being indicative of how important the factor is if the program needs to succeed as the sum of all weights must equal to 1.0. The ratings in the internal matrix refer to the driver's factors influencing the situation or existing condition. The ratings range from 5 to 1, where 5 = very strong influence, 4 = strong, 3 = moderate, 2 = low, and 1 = very low influence on the situation and existing condition. The total scores of EFE and IFE were evaluated and put in nine matching stages of position and status for its development from the scale of 1 to 4, starting from weak, average, and strong for internal factors, and weak, medium, and high for the external factors.

The last step of the analysis involved the formulation of a comprehensive strategic development of the community-based bamboo for the supply of the industrial-scale use through evaluation and combining both identified internal and external factors of drivers and barriers. The four sets of alternative strategic development are: (1) ID–ED strategy, to create strategies that use internal drivers to take advantage of external drivers; (2) ID–EB strategy, to create strategies that use internal drivers to overcome external barriers; (3) IB–ED strategy, to create strategies that minimize internal barriers to take advantage of external drivers; and (4) IB–EB (weaknesses-threats) strategy, to create strategies that minimize internal barriers and avoid external barriers.

## 3. Results

### *3.1. The Bamboo Resources*

In general, Ngada Regency's climate condition and topography are suitable for bamboo's optimal natural growth and its cultivation. However, the existing bamboo resources consist mainly of traditional species, and bamboo has not been cultivated like other superior commodities produced from this area, such as coffee, candlenut, and cashew nuts. Nonetheless, bamboo grows well in Ngada Regency, and there are currently 15 bamboo species have been recorded, as shown in Table 1. There are three important bamboo species that are commonly found and widely used by communities in their daily life: *Dendrocalamus asper* (*betung/bheto*), *Gigantochloa atter* (atter/peri), and *Bambusa vulgaris* (*aur/guru*) [19]. A study by Sada and Jumari [23] reported that Ngadha ethnic, the most enormous ethic in Ngada Regency, has a long history dating back to their ancestral heritage relating to the use of plants as part of their traditional ceremonies. In addition to paddy *padi* or *pare* (*Oryza sativa* L.) and corn *jagung* or *sae* (*Zea mays* L.), bamboo is regarded as a crucial plant. Several bamboo species are used in daily life in the form of various products and also as artifact for ceremonial activities are *aur/guru* bamboo (*Bambusa vulgaris*), *peri* bamboo (*Gigantochloa atter*), *betung* bamboo (*Dendrocalamus asper*), and *wuluh* bamboo (*Schizostachyum latifolium*).

**Table 1.** Bamboo species found in Ngada Regency.

| No. | Scientific Names | Commercial Names | Local Names |
|---|---|---|---|
| 1. | *Dendrocalamus asper* | asper bamboo | *bheto* |
| 2. | *Dendrocalamus* sp. | brown or black bamboo | *bheto laka* |
| 3. | *Dendrocalamus* sp. | dwarf *betung* bamboo | *betho nitu* |
| 4. | *Gigantochloa atter* | *atter* or *legi* or *pering* bamboo | *peri* |
| 5. | *Dendrocalamus* sp. | *wulung* or black bamboo | *pering coklat* |
| 6. | *Bambusa vulgaris* | yellow bamboo | *guru (ngura dan sese)* |
| 7. | *Bambusa* sp. | *aur kerdil* or dwarf bamboo | *ezo* |
| 8. | *Gigantocholoa atroviolacea* | black bamboo | *peri laka* |
| 9. | *Bambusa blumeana* | thorny bamboo | *to'e, ga'a* |
| 10. | *Dinochloa* sp. | dwarf/small bamboo | *ejo* |
| 11. | *Bambusa* sp. | - | *bela* |
| 12. | *Schizotachyum latifolium* | flute/pipe bamboo | *wulu, yea* |
| 13. | *Schizostachyum brachyladum* | *bulu or talang* bamboo | *peri kedhi* |
| 14. | *Arundinaria japonica* | decoration bamboo | - |
| 15. | *Racemobambus* sp. | small dwarf bamboo | *guru* |

The Ngada Regency of Statistic Bureau [24] reported an estimated 90,000 bamboo clumps owned by the Ngada Regency community in 2017 and 2018 (Table 2). Bajawa, Golewa Barat, and the Golewa sub-districts, which together contribute 38% of the regency's population, are the largest bamboo ownership contributors, accounting for 80% of the total. The use of bamboo resources in these areas is more intensive than in the rest of Ngada Regency. This is also supported by good accessibility between the three neighboring sub-districts. Moreover, because Bajawa is the capital of Ngada Regency, the cluster is inclined to become the center of economic activities.

**Table 2.** The estimated numbers of bamboo clumps in Ngada Regency.

| No | Sub-Districts | Estimation Number of Bamboo Clumps | |
|---|---|---|---|
| | | 2017 | 2018 |
| 1 | Aimere | 832 | 1026 |
| 2 | Bajawa | 28,765 | 32,949 |
| 3 | Bajawa Utara | 1485 | 1837 |
| 4 | Golewa | 16,405 | 18,847 |
| 5 | Golewa Barat | 21,965 | 26,027 |
| 6 | Golewa Selatan | 1081 | 1403 |
| 7 | Inerie | 714 | 897 |
| 8 | Jerebu'u | 1301 | 1608 |
| 9 | Riung | 2194 | 3028 |
| 10 | Riung Barat | 3222 | 4393 |
| 11 | Soa | 129 | 159 |
| 12 | Wolomeze | 3271 | 4498 |
| Total number of clumps | | 81,364 | 96,672 |

Community-owned bamboo can be likened to traditional villages in Ngada. The current condition of bamboo resources can be seen based on satellite imagery/aerial photo showing the land, with doughnut-like pattern, covered with what has been validated as bamboo covers. The village, known as *kampung adat* is clearly surrounded by bamboos (Figure 2). This area is captured in Ratogesa village, Golewa sub-district, which explains that bamboo become an integrated part of community life. Interestingly, there exists a customary law (*waja* or *ri'i*), which is a part of local wisdom in Ngada, obligating the community to recover bamboo resources whenever the land undergoes any damage due to over-harvesting. This rule that is very strict, even accompanied by sanctions, ensures the recovery of bamboo in several years (about 5–10 years) with no harvesting.


**Figure 2.** Google map satellite image of community bamboo area (the compact green color of doughnuts and line block shapes) at Golewa sub-district, Ngada, East Nusa Tenggara (Google Map Satellite Image 2021).

### *3.2. Bamboo Management*

Section 3.2. Bamboo Management and Section 3.3. Community's Perception of Bamboo was presented from the result of 119 bamboo owners and farmer questionnaires. The community-owned bamboo resources in Ngada Regency were divided into two types: (1) owned by individuals (67%), and (2) owned by communal (33%), as seen in Figure 3. The communal bamboo resources are usually managed collectively in the community's tribe or sub-tribe groups. The management and utilization of the communal bamboo

resources must be carried out based on the approval and agreement of the sub-tribe groups, which is facilitated by the group's leader. On the other hand, individual bamboo owners have more freedom to use and sell their bamboo at any time.

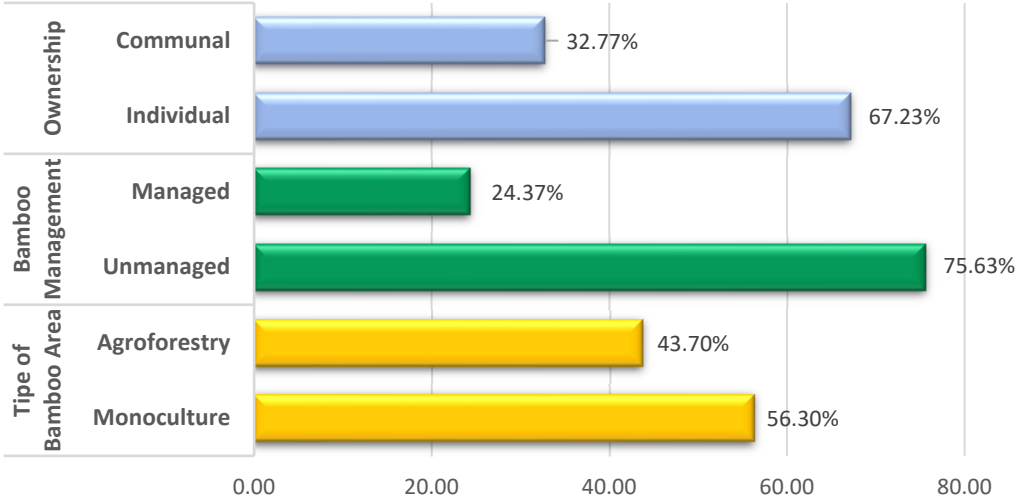


**Figure 3.** The existing bamboo resources of community bamboo resources in Ngada Regency.

The use of bamboo in the community continues to increase, particularly those relating to economic activities. Many bamboo resources have encouraged variations in utilization to provide the added economic value, orienting to be a bamboo industry. In 2015, a bamboo management system called sustainable bamboo forestry (SBF), in collaboration activities with the EBF and the Ministry of Environment and Forestry (MoEF), was introduced to ensure sustainability in the use of community bamboos [18]. This bamboo management system was applied as a requirement for the supply of raw materials to the industry. The Golewa sub-district became the first area to implement the SBF system on community-owned bamboo for the supply of the existing bamboo factory.

Regarding bamboo management, six of twelve sub-districts (Bajawa, Golewa, Golewa Barat, Golewa Selatan, Jarebuu, and Soa) have been socialized and introduced to the SBF system. However, currently, only three sub-districts (Bajawa, Golewa, and Golewa Barat) are actively implementing the system to fulfill the supply of bamboo raw materials to a local factory manufacturing preserved strips products [24]. However, this bamboo management system is only carried out for the industrial supply of preserved bamboo strips as the utilization of other bamboo products does not implement a bamboo clump maintenance system.

Results of questionnaires from the first group of respondents (bamboo owners or bamboo farmers) as representative of upstream sectors were collected from the targeted five sub-districts having a high potency of bamboo resources (Table 2), namely sub-districts; Bajawa, Golewa, Golewa Barat, Riung Barat, and Wolomeze. The respondents mostly come from the Riung Barat sub-district (27.73%), followed by the Bajawa sub-district (24.37%), and the Golewa sub-district (21.85%). The result showed that 78% of respondents leave their bamboo resources unmanaged and only 22% of respondents managed their bamboo using the SBF system, as shown in Figure 3. The respondents who applied the SBF system were found to come from the Bajawa, Golewa, and Golewa Barat sub-districts. These three areas are known suppliers for the preserved bamboo strips or sticks industry.

Since bamboo can be grown with other types of plants, the questionnaire also collected data on bamboo planting patterns owned by the community. The bamboo resources in the agroforestry system have become an important element of the community livelihoods [25–27], especially in traditional villages and rural area in Indonesia [6,8,9], and in other countries such as in a number of African countries [27–29], in India [30–32], in China [33,34]. In Ngada, there are two types of community bamboo resource utilization,

namely monoculture and mixed or agroforestry bamboo. The monoculture system is used by 56% of the respondents (67 bamboo owners), while the mixed or agroforestry plantation management is used by 44% of the respondents (52 bamboo owners), as shown in Figure 3. The monoculture bamboo resource management is commonly practiced in Bajawa, Golewa, and Golewa Barat sub-districts, while the agroforestry system management is mainly found in the Riung Barat and Wolomeze sub-districts. The agroforestry system includes a multi-strata canopy, combining bamboo with different heights of plants such as trees and understory plants. In general, this plantation system is practical for people's daily needs because it combines seasonal and yearly crops. In addition, as an agroforestry system management, community bamboos are usually combined with understory plants, such as *Zingeberaceae* spp. and cassava, and also with other seasonal crops for daily use.

### *3.3. Community's Perception on Bamboo*

The results of this study were gathered from 119 questionnaires collected from respondent bamboo owners and bamboo farmers group. Twenty (20) of the questions in the questionnaires asked bamboo owners and farmers about their perception and opinion on statements concerning the role, resources, and utilization of bamboo. The collected data were analyzed using the SPSS Statistics 25 software to test for validity and reliability. Seventeen (17) out of 20 questions were valid and reliable, as presented in Figure 4. The results of public opinions and perceptions show that more than 90% of respondents agree that bamboo plays an important role in socio-cultural life and serves the function of maintaining water sources and improving environmental quality, such as fresh air. More than 90% of the respondents support bamboo as a potential local commodity and agree that bamboo should be developed with more added value. The majority of respondents are in favor of the existence of a bamboo processing industry in Ngada. The community perception on the economic benefits of bamboo was diverse: 37.82% agree that bamboo provides economic benefits, 28.57% are neutral or do not know, and 33% of respondents disagree that bamboo is beneficial economically. These results suggest that 33% of respondents have not received direct economic benefits from bamboo; in other words, existing bamboo resources have not been utilized as household income. Another interesting finding is that people nowadays prefer to instead use bricks and cement to build their homes, especially in city areas. This is causing the current need for bamboo for general housing to decrease. While the bamboo houses still exist but it is only in traditional villages that they are properly maintained like the original houses.

In general, the condition of upstream sector as gathered from the results of the survey reveal the following: (1) from the ecological aspect and environmental benefit, Ngada community has the perception that bamboo plays an important role in maintaining environmental quality and water resources; (2) from the socio-cultural aspect, bamboo had become part of culture and tradition, also found in the local wisdom on bamboo preservation; (3) however, from the economic side, the benefits of bamboo have not significantly impacted on the community. For the above reasons, members of the upstream sector support the processing of bamboo with added value into modern products at industrial-scale for optimal utilization of the existing bamboo resources. Furthermore, the community is in agreement as to the need to maintain their bamboo clumps under conditions of good market and bamboo being able to augment household income. They are willing to plant bamboo whenever more of this plant resources needed. The community believes that if the use of bamboo can provide high economic benefits, bamboo can compete with other commodities in Ngada.

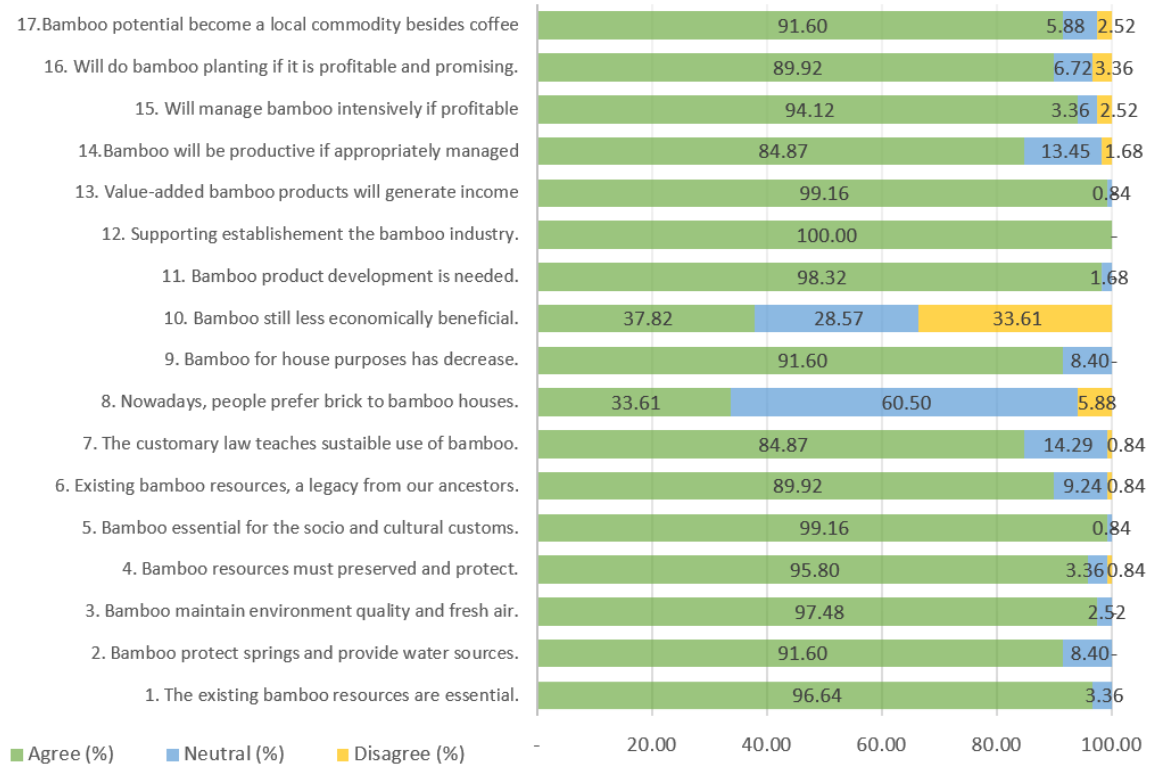


**Figure 4.** Community perception on bamboo resources, management, and utilization (N = 119).

### *3.4. Bamboo Utilization*

This section presented the results from the questionnaires responded to by 121 participants of the second group, consisting of bamboo crafters, artisans, and entrepreneurs. The data collection was aimed at identifying existing conditions of the downstream sector related to bamboo utilization and products, including the distribution of crafters, entrepreneurs, and industry. The use of bamboo in Ngada had been mainly for subsistence and daily life purposes and bamboo processing chiefly for woven and handicrafts products at micro and small enterprises level. Clearly, bamboo had not been a commodity for business or industrial-scale purposes.

The feasibility study of potential bamboo business in Ngada Regency provided recommendations showing that available bamboo has an excellent opportunity to be utilized in modern products such as the laminated and construction bamboo industry [19]. In line with said recommendation, the development of bamboo industry in Ngada began in 2012. The bamboo processing factory that was subsequently built processes community bamboo into preserved bamboo strips and sticks products, as half-finished materials for laminated bamboo as end products. The existence of this factory has increased the use of community bamboo and introduced modern bamboo processing to the community. In addition, the development also introduced the community to the sustainable bamboo clump management system and the selected harvesting system of 4-year-old bamboo poles as required by the industry.

The bamboo utilization data were collected from 121 respondents of the following nine sub-districts: Bajawa, Bajawa Utara, Golewa, Golewa Barat, Golewa Selatan, Inerie, Jerebuu, Riung Barat, and Wolomeze. The study discovered that the actors who process bamboo products are dominated by individual crafters, mainly women on a household scale (114 respondents, or 93% of total), followed by groups or small and medium enterprises and cooperatives (7 respondents or 6%), and only one bamboo processing factory (1%) (Figure 5).

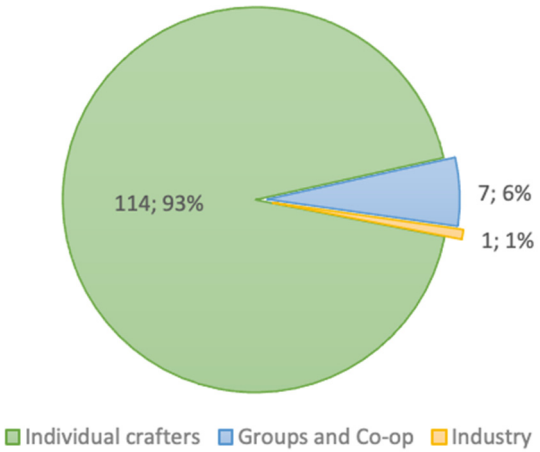


**Figure 5.** The bamboo actors in the use of bamboo products in Ngada Regency.

The study showed that in the downstream sectors, bamboo has been utilized in commercial products but mainly only for local and still limited markets. The main bamboo products in Ngada Regency are bamboo woven (72%), which includes handicrafts, baskets, kitchen utensils, and bamboo souvenirs. These are bamboo woven products produced by individual bamboo crafters, who are mostly women. The other products include bamboo cages (8%), bamboo furniture (7%), and bamboo component for structural purposes (3%), as shown in Figure 6. The majority of the survey respondents said that one of the challenges in the use of bamboo is lack of skills in product development and innovation. Therefore, training and capacity building in the processing and development of bamboo products are crucial. Another challenge is the uncertain market demand for bamboo products. Presently, production is dictated by the quantity of demand from consumers. Although there are already various kinds of bamboo utilization, this study focuses on the use of community-owned bamboo as a raw material for the existing modern bamboo industry in Ngada.

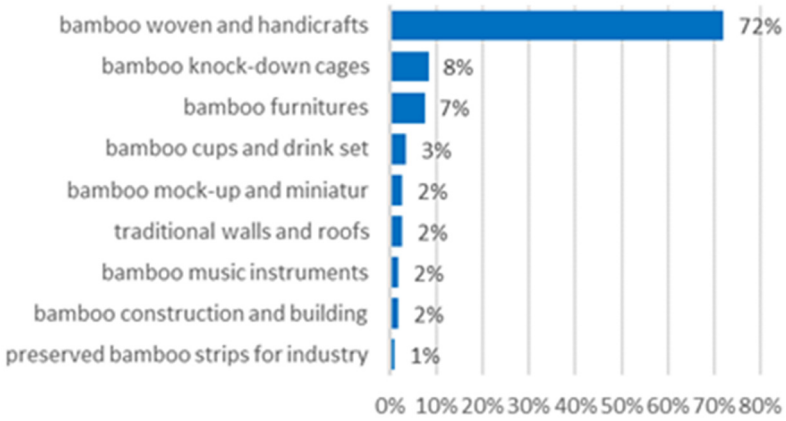


**Figure 6.** The variety of bamboo products in Ngada Regency.

In Ngada, the preserved bamboo strip and stick factory has existed since 2012 and have experienced many ups and downs in their bamboo processing. The problems faced include ensuring the supply of required raw materials from community-owned bamboo resources, specifically 4-year-old bamboo poles [35]. Therefore, the system of sustainable bamboo management was introduced to the community to fulfill this industry requirement. At the beginning of its operation, the factory received raw materials from Golewa sub-district, which was the first introduced to the SBF system. Currently, the supply has expanded to other sub-districts, such as West Golewa and Bajawa. The factory process bamboo culms into preserved bamboo sticks and strips as half-finished products. The products are then

sent to another factory equipped with more advanced technology and machinery in a different area to be processed into engineered bamboo products (i.e., strand-woven bamboo and laminated bamboo).

### *3.5. Identified Drivers and Barriers*

Drivers and barriers in developing community-based bamboo as an industrial-scale raw material supplier were identified from the questionnaires for the bamboo owner group and the artisan-entrepreneur group at the community level, in addition to the semi-structured interviews with expert groups. To obtain the identified driving and inhibiting factors from upstream and downstream sectors and the stakeholders involved, the determination of drivers and barriers factors was conducted by modifying the SWOT approach. The terms strengths, weaknesses, opportunities, and threats are more commonly used and are actually easier for respondents to understand.

The identified factors were classified into the internal drivers (strength), the external drivers (opportunity), the internal barriers (weakness) and the external barriers (threats), as shown in Table 3.

**Table 3.** Identified Drivers and Barriers.

| The Drivers | The Barriers |
| --- | --- |
| **Internal Drivers** | **Internal Barriers** |
| 1. High potential of bamboo resources<br>2. Biophysical conditions are suitable for bamboo cultivation<br>3. Existing strong bamboo culture<br>4. Community-owned social capitals<br>5. Community awareness on roles of bamboo<br>6. Existing local NGOs for bamboo development<br>7. Local needs of bamboo for housing decreased<br>8. Supports from provincial and central government<br>9. Local government support programs and events on bamboo | 1. Bamboo is still considered less valuable<br>2. Bamboo has not become a cultivation commodity<br>3. The use of bamboo is still traditional (low added value)<br>4. The bamboo product value chain has not yet been established<br>5. Lack of technology and innovation support<br>6. Low capacity of stakeholders<br>7. Low industrial culture<br>8. Low level of sustainable bamboo management<br>9. Lack of integrated regulatory support |
| **External Drivers** | **External Barriers** |
| 1. Ngada was designated as a center of excellence the for community-based bamboo industry from central and provincial government<br>2. Central and provincial government support in bamboo development program<br>3. Existing bamboo strips processing industry<br>4. Investors plan to build a bamboo industry<br>5. Market opportunities for wood substitute bamboo products<br>6. Market opportunities bamboo for green materials and life style<br>7. Regulatory support on bamboo planting and rehabilitation from central government | 1. Changes in land use and bamboo plants to other uses<br>2. Unsustainable utilization bamboo<br>3. Competitors of engineered bamboo products<br>4. Natural disasters |

The results identified that several drivers, both internal and external, have been existing for the development of community-based bamboo resources reserved the following:

for industrial purposes in Ngada Regency. These drivers are the following: strong bamboo culture, social capital, local government's program support, market-driven, transparent system and mechanism on bamboo utilization, and stakeholders' support. On the other hand, the identified constraints serving as barriers to be overcome include the following: lack of capacity building on modern utilization of bamboo with value-added, shifting from traditional to industrial culture, and some un-support regulation. The identified drivers and barriers on bamboo development were assessed and evaluated by driver and barrier analysis using modified IFE and EFE of SWOT analysis.

### *3.6. Driver and Barriers Analysis*

The drivers and barriers analysis was developed to formulate the strategic recommendation in terms of community-based bamboo resources for industrial-scale supply in Ngada Regency. Several internal–external drivers and barriers factors were recorded based on the results from questionnaires and interviews with expert groups. The internal and external factors as well as the key factors that refer to performance and priority index were identified and classified from FGDs. Based on the results, 18 internal factors are listed, consisting of 9 factors as internal drivers and 9 factors as internal barriers for IFE.

The three highest scores in the internal driver's factors are: potential bamboo resources, suitable biophysics conditions for growing bamboo, and the existence of a local NGO that facilitates bamboo development. Meanwhile, factors determining the bamboo products value chain have not yet been established. The lack of stakeholders' capacity in bamboo management and the lack of integrated regulation support on bamboo are found to be equally important internal barriers factors based on the evaluation of total values. The total score of internal driver factors is 1.814, which is lower than the total score of internal barriers, 2.041, suggesting that the weakness factors could be minimized by the internal drivers factors as shown in Table 4.

**Table 4.** Internal factor evaluation (IFE).

| No | Description Factors | Weight (a) | Rating (b) | Scores (c = a × b) |
|---|---|---|---|---|
| **ID** | **Internal Drivers** | | | |
| ID1 | High potential bamboo resources | 0.08 | 4.5 | 0.365 * |
| ID2 | Suitable biophysical conditions for growing bamboo | 0.08 | 4.2 | 0.341 * |
| ID3 | Strong bamboo culture | 0.03 | 3.0 | 0.081 |
| ID4 | Community social capital already exists | 0.03 | 4.0 | 0.108 |
| ID5 | Community awareness on the role of bamboo | 0.05 | 3.0 | 0.162 |
| ID6 | Local wisdom on bamboo management | 0.03 | 4.0 | 0.108 |
| ID7 | Local needs of bamboo for housing decreased | 0.05 | 2.0 | 0.108 |
| ID8 | Existing local NGO for bamboo development | 0.08 | 4.0 | 0.324 * |
| ID9 | Local government programs on bamboo | 0.05 | 4.0 | 0.216 |
| | Total | 0.49 | | 1.814 |
| **IB** | **Internal Barriers** | | | |
| IB1 | Bamboo is still considered less value | 0.05 | 3.5 | 0.189 |
| IB2 | Bamboo has not become a cultivation commodity | 0.05 | 3.0 | 0.162 |
| IB3 | Bamboo utilization is still traditional (low added value) | 0.08 | 3.5 | 0.284 |
| IB4 | Bamboo products value chain has not yet been established | 0.08 | 4.5 | 0.365 * |
| IB5 | Lack of stakeholders' capacity in bamboo management | 0.08 | 4.5 | 0.365 * |
| IB6 | Lack of technology support on processing and innovation | 0.03 | 4.0 | 0.108 |
| IB7 | Lack of industrial culture | 0.03 | 3.0 | 0.081 |
| IB8 | Lack of bamboo management to ensure sustainability | 0.03 | 4.5 | 0.122 |
| IB9 | Lack of integrated regulation support on bamboo development | 0.08 | 4.5 | 0.365 * |
| | Total | 0.51 | | 2.041 |
| | Grand Total | 1.00 | | 3.951 |

Remarks: * = the highest scores for each internal drivers and barriers factors.

We identify seven external drivers and four external barriers (Table 5) as the external factors. The three highest scores of the external drivers are as follows: central and provincial government support, the existing bamboo strips industry, and market opportunities for

laminated bamboo products. While the two highest external barrier factors are changes in land use of bamboo plants for other uses, also the utilization of bamboo without regard to sustainability aspects. The scores of external drivers factors total 2.602, whereas the total scores of external barrier is 1.023, indicating that the drivers are more important than the barriers.

**Table 5.** External Factor Evaluation (EFE).

| No | Description Factors | Weight (a) | Rating (b) | Scores (c = a × b) |
|---|---|---|---|---|
| **ED** | **External Drivers** | | | |
| ED1 | Ngada designated as a center of excellence | 0.08 | 3.0 | 0.234 |
| ED2 | Central and provincial government support | 0.12 | 4.0 | 0.469 * |
| ED3 | Existing bamboo strips processing industry | 0.12 | 4.5 | 0.527 * |
| ED4 | Investors plan to build a laminated bamboo industry | 0.08 | 3.5 | 0.273 |
| ED5 | Market for wood substitute bamboo products | 0.11 | 4.5 | 0.492 * |
| ED6 | Market opportunity as a green lifestyle | 0.08 | 3.0 | 0.234 |
| ED7 | Regulatory support for bamboo planting in forest areas | 0.10 | 3.8 | 0.371 |
| | Total | 0.18 | | 2.602 |
| **EB** | **External Barriers** | | | |
| EB1 | Changes in land use and bamboo plants to other uses | 0.11 | 4.0 | 0.438 * |
| EB2 | Unsustainable utilization of bamboo | 0.10 | 4.0 | 0.391 * |
| EB3 | Competitors of engineered bamboo products | 0.08 | 2.0 | 0.156 |
| EB4 | Natural disasters | 0.04 | 1.0 | 0.039 |
| | Total | 0.32 | | 1.023 |
| | Grand Total | 0.50 | | 3.625 |

Remarks: * = the highest scores for each opportunity and threat factors.

The next step of the analysis involves constructing a matching stage by evaluating and scoring the total of both IFE and EFE to determine the current position and situation (Figure 7). The scores indicate that the community bamboo resources management in Ngada Regency is growing and improving. This means that the community-based bamboo activities can be geared toward sustainability management, through support from stakeholders involved. Therefore, recommendations on strategies are required for further development.

The final stage of driver barriers analysis found the need to develop strategies in terms of evaluating the drivers and barriers of community-based bamboo resources for industrial-scale's supply in Ngada Regency. Based on the four sets of alternative strategies, derived from the combination of internal and external factors, ten developing recommendation strategies for the effective implementation of strategies can be formulated, as listed in Table 6.

The drivers and barriers matrix of Table 6 above can be summarized as follows: ID–ED strategies, namely, taking maximum advantage from internal and external driver; ID–EB strategies, which is essentially avoiding threats by internal drivers; IB–ED strategies, which are geared toward introducing new opportunities by reduction in internal barriers; and IB-EB strategies which essentially involves avoiding external barriers by minimizing internal barriers. The analysis adopted from the SWOT matrix provided a realistic interpretation of the drivers and barriers of a business and helped in providing an overview of the differences between actual and future plans, as well as in analyzing the current situation [36].

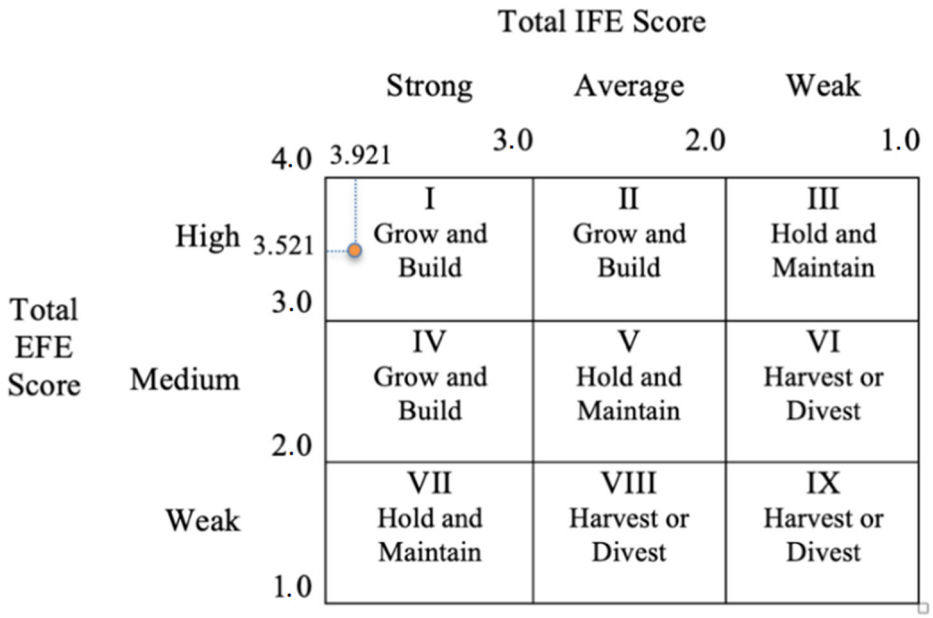


**Figure 7.** The current position and situation based on the analysis.

**Table 6.** Drivers–Barriers Matrix and Developed Strategies.

| IFAS<br>EFAS | Internal Driver (ID) | Internal Barriers (IB) |
|---|---|---|
| **External Drivers (ED)** | **ID–ED Strategy**<br>1. Increasing the sustainable utilization of bamboo resources for industry<br>2. Planting bamboo through rehabilitation programs supported by government.<br>3. Strengthened social capital to support community bamboo industry.<br>4. Synergized and strengthened stakeholders support to supply bamboo products for global markets. | **IB–ED Strategy**<br>6. Increasing the bamboo value-added to meet the market.<br>7. Strengthened value chain on community bamboo industry products.<br>8. Increasing the capacity building of stakeholders involved on sustainable bamboo management.<br>9. Develop regulation and policy on integrated community bamboo industry |
| **External Barriers (EB)** | **ID–EB Strategy**<br>5. Ensure the implementation of sustainable bamboo harvesting system, through a sustainable bamboo forestry (SBF) mechanism. | **IB–EB Strategy**<br>10. Increasing bamboo values to compete with other commodity plants. |

The community-based bamboo resources to support bamboo development in Ngada Regency are integrated between upstream, middle stream, and downstream sectors, with each sector involving different stakeholders. The formulated ten strategies are thus grouped into different aspects related to (1) resources, (2) people, (3) markets, and (4) policies, which are all connected and mutually supportive.

The resource aspects (upstream) consist of three strategies, namely, (i) planting bamboo through rehabilitation program supported by government, (ii) increasing the sustainable utilization of bamboo resources for wood substitute, bamboo products, and (iii) ensuring the implementation of sustainable bamboo harvesting system, through the SBF system.

The people aspects (middle stream) also relate to three strategies, which are: (i) increasing the capacity building of community and involved stakeholders, (ii) strengthening social capital to support community bamboo industry, and (iii) strengthening the stakeholder's supports.

The market aspects (downstream) relate to the following: (i) increasing the bamboo value-added to meet the market, (ii) strengthening the value chain of community bamboo industry products, and (iii) increasing bamboo values to compete with other commodity plants. In order to achieve appropriate and synergized implementation of these three aspects, it is beneficial to focus on the policy and regulation on integrated community bamboo industry, as the most important supporting aspect of policy.

In the community-based bamboo resources development, more attention is needed in strengthening the upstream sector (resources) and how it is connected to the downstream sector (markets). Nevertheless, other aspects such as human resources (people) and regulatory support (policy) are also important.

Therefore, it can be seen from the ten formulated strategies in community-based bamboo resources for restoring ecosystems, that there are three priority strategies to support the community-based bamboo resources for industrial-scale supply in Ngada Regency: (1) increasing the capacity building of stakeholders involved in sustainable bamboo management, (2) planting bamboo through a rehabilitation program supported by government, and (3) developing regulation and policy on integrated community bamboo industry. Furthermore, this study provides recommendations for policymakers to develop programs and regulations supporting the community-based bamboo resources to restore the ecosystem, improve livelihood, and contribute to the village's inclusive economic growth.

## 4. Discussion

The results of the study reveal that local communities in Ngada Regency, East Nusa Tenggara Province, perceive bamboo as part of their daily lives and livelihoods. The strong bamboo culture in the Ngada community has encouraged the people to value the existence of bamboo in their area. The community believes that bamboo has environmental roles and functions such as serving as a water catchment area, providing fresh air, and balancing microclimate. Several studies have shown that bamboo has significant ecological functions, such as the following: protecting the areas of watersheds and water catchment; maintaining the hydrological systems, springs, microclimate, and fresh air; preventing soil erosion; sequestering carbon; providing many other ecosystem benefits [37–40]. Bamboo has attracted new opportunities as a source of cultural, aesthetic, and recreational activities as well as several potential climate, watershed, and biodiversity functions [38]. Based on its ecological function, bamboo is ideal for restoring critical land, especially on necessary land where many plants cannot grow, while planting bamboo can provide economic value benefits for the community [41–43]. Many studies have documented that bamboo can make an essential contribution to household income and rural development. China is frequently considered a model or reference due to its long history of community-based bamboo management. It has played an important role in rural development, and its steady expansion proves that bamboo will continue to thrive for a long time [14,44–48]. They continue to serve as a model for other regions of the world facing rural poverty by developing their bamboo sector, what with the impact of its fast-developing bamboo industry on rural livelihoods.

Several studies reported that bamboo provides economic benefits and generates family income, which significantly impact on rural developments. In the northern part of China, the cultivation of dried bamboo shoots at the small-scale household level has crucially impacted on household income and livelihood. The high-income households have their highest total bamboo income from bamboo shoots, but low-income families depend on bamboo income [43]. In India's South Meghalaya area, bamboo mat making also contributes to community livelihoods, especially to women. Making bamboo mats is considered one of the most important jobs and adds to people's income, especially during the period

of the year when jobs are scarce [49]. Dwivedi et al. [50] reported that farmers can earn up to USD 800 per hectare annually by selling raw bamboo from their degraded land. Bamboo cultivation can generate around 10 CERs (certified emission reductions) per hectare annually, which can be traded as carbon credits. Additionally, under-employed farmers can work as skilled workers in the bamboo handicraft industry and can earn up to USD 2700 annually (at current exchange rates), which is significantly higher than the present average income (1750 USD/annum) of farmers. In Ethiopia, bamboo has great benefits for income diversification and other socio-economic values related to cultural and medicinal uses for the local community [51]. In Indonesia, there were several studies regarding bamboo and rural area development. Until now there has been no research that conducts the development of community's bamboo that purposes as an industrial supply. The use of bamboo that generally exists is mainly for handicrafts, woven bamboo, and other traditional bamboo products in micro and small businesses [52–57]. However, the potential of community bamboo development as a supply of bamboo utilization on an industrial-scale in Indonesia has not yet been explored.

The success of developing bamboo to improve the rural economy cannot be separated from the social capital owned by the community. The existence of social capital owned can be a strength to further sustainable bamboo development in the community [58]. Prasetyo [58] reported that in Ngada Regency, the current existence of bamboo resources is a legacy from their predecessors and parents. This is true not only in Ngada but also in some other areas in Indonesia that have a strong bamboo culture, given that bamboo has existed since time immemorial and is passed down from generation to generation, such as in West Java and Bali [42–44]. Because the existing bamboo is a heritage, the community has almost no experience in bamboo cultivation because people simply harvest bamboo that has been growing since they were born. Nowadays, the government put bamboo in the species lists used for rehabilitation and restoration of degraded lands, which basically means they will be planted in activities involving the community. The people who have experience in planting bamboo are those often who are involved in the rehabilitation program carried out by the government. The current existence of ample bamboo in Ngada is in part also partly from the result of the planting program carried out by the local government, civil society, and community after the Maumere earthquake, in 1992 [59]. A study conducted by Noywuli et al. [60] gave a recommendation for planting bamboo at the Aesesa Flores watershed, Ngada for the purposes of sustainable watershed management. Moreover, bamboo is a prospective commodity for the community culture, climate, land availability, and markets for industrial supply material. The development of bamboo as an industrial raw material must be supported by the adequacy and availability of sustainable raw materials; therefore, it is necessary to consider increasing the stock of bamboo raw materials for the industry by widespread bamboo planting.

In recent years, the development of technology and innovation has changed the use and utilization of bamboo. Bamboo has become a noble material that can be processed into multiple products with various use. The utilization of advanced technology in construction will contribute to the development and expansion of bamboo applications (buildings, structures, bridges, etc.) [61]. Endalamaw [62] reveals that in Ethiopia, the proportion of commercial use of bamboo is roughly a third of total consumption. Understanding local differences in small-scale bamboo commercialization and the factors contributing to it can be used as a basis for further investigation of the pathways for the broader development of the bamboo value chain. Furthermore, the study showed that industry and companies applying knowledge and technology play an essential role in bamboo innovation. The local company assisted by China companies through native sources interactive learning in inter- and intra-company networks. By applying such knowledge, bamboo farmers and companies are able to produce new products and new ways of using bamboo, substantially increasing its durability, quality, and competitiveness [62].

The existing preserved bamboo strip processing industry in Ngada can be an opportunity for enhancing the community's bamboo market. Currently, the use of bamboo by

the community is still not optimal and is still on a micro-industrial or household scale. Thus, the existence of industrial-scale can absorb the community's bamboo as raw material. Other important approaches needed for the commercialization process of community-based bamboo development are management intensification of bamboo resources, sustainable rural livelihood, and a strong and robust value chain [63]. Partiwi et al. [64] discovered that appropriate strategies to develop bamboo business in the district or regency level involve cluster approach supported by the government.

Policy support in the development of bamboo and its processing industry requires integrated regulation between the upstream sector, the middle sector and the downstream sector. The support from a successful national policy and political framework just as China has done in developing bamboo as a non-timber forest product [65] commodity is needed. For four decades now, China has been reforming its policies in support of the community economy, especially in rural areas, by building village industries that drive the people's economy [66,67]. Policy support at the regional level also plays an important role. Anji County and Linan County, in Western China, are two areas that are famous as centers of various bamboo products [15,16]. These two regions reformed the bamboo sector and made policy changes to support the community-based bamboo development, bamboo industries development, and rural social economy.

Therefore, in this study, the identified factors of drivers and barriers were assessed and analyzed to find out the real situations and conditions for the development of community bamboo as industrial-scale supply. The identified drivers and barriers are used as the basis for the formulation of strategic steps to solve problems; these steps can provide policymakers, decision makers, and related stakeholders with strategies and recommendations to support other policymakers. The regulations and programs that are prepared can answer the needs and problems faced.

## 5. Conclusions

Bamboo is part of Ngada community in their culture, daily life, and livelihood. The community still shares a traditional paradigm and mindset on bamboo resources and its utilization. The huge potential of bamboo has not been utilized optimally, while the need for local use is decreasing and people have not received significant economic benefits from their bamboo resources. The driving factors for the use of modern bamboo on an industrial scale have been identified. The three highest points of the internal drivers factors are as follows: the potential bamboo resources, suitable biophysics conditions for growing bamboo, and the existence of a local NGO that facilitates bamboo development and sustainable management. The three highest points of the external drivers factors are central and provincial government support, the existing bamboo strips industry, and market opportunities for laminated bamboo products.

However, there are barriers factors that must be overcome to enable the smooth development of modern bamboo utilization with the support of related stakeholders. The three strongest internal barriers are as follows: the yet-to-be-established bamboo products value chain; the lack of stakeholders' capacity in bamboo management; the lack of integrated regulation support on bamboo. The strongest external barrier factors are the changes in land use and bamboo plants for other uses and also the utilization of bamboo without regard to the sustainability aspects.

Based on the evaluation and assessment carried out by analyzing the situation and development conditions, it was found that the use of modern bamboo on an industrial-scale is growing and improving. Based on the existing drivers and barriers, it is necessary to formulate strategic steps to encourage the current growth and generate favorable conditions. The strategic steps made must be integrated across sectors, upstream, middle and downstream, and involve the role of the various parties. There are ten strategic steps for success that have been formulated based on the identified drivers and barriers, of which three have become priorities, namely, (1) increasing the capacity building of stakeholders involved in sustainable bamboo management, (2) planting bamboo through rehabilitation

program supported by government, and (3) developing regulation and policy on integrated community bamboo industry. Therefore, investing in targeted community capacity building enhancements with the application of effective training and transfer knowledge, sustainable bamboo management, and processing skills of industrial culture are needed, as well as appropriate recommendations for policymakers to develop programs and regulations supporting community-based bamboo resources to restore the ecosystem, improve livelihood, and contribute to the inclusive economic growth of the village.

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**Data Availability Statement:** The authors confirm that the data supporting the findings of this study are available within the article. The raw data that support the findings of this study are available from the corresponding author, upon reasonable request.

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