

Fomenting the Bamboo Building Industry in Timor-Leste: Changing public perception, enhancing research and land governance with social partnerships

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Abstract: The Bamboo Industry worldwide is accelerating, with a global market of USD 68.8 billion in 2018 and expected growth of 5% between 2019-2025. China is the leader of this market with 22 tonnes of bamboo per hectare of production. Timor-Leste has the potential to produce over 20 tonnes of bamboo per hectare and the opportunity to drive development in a sustainable way. The experience from China over the last 20 years shows that under the right conditions, bamboo can be a lead sector for rural industrialization and large-scale poverty reduction. Although abundant in bamboo resources, it is clear the need for comprehensive change towards investments, research and development across the entire bamboo supply chain in Timor-Leste, and in particular, to foster the growth of a bamboo building industry. Nevertheless, bamboo is not yet recognized as a valuable material. Tourism, governmental or institutional structures do not use bamboo, and the public perception is negative or neutral. The paper reviews the resources and implementation strategies that have been established to date and discuss the barriers and opportunities to advance a local and export bamboo building industry in Timor-Leste in the foreseeable future. The authors argue for the role of demonstration projects that promote added-value design and acceptance, along with a review of government legislation and regulatory frameworks. These strategies can remove barriers and contribute towards an increase in local production, demand and consumption.

Most importantly, they foster the acceptance of bamboo as a contemporary building material while promoting sustainable development.

Keywords: Added-value Design, Bamboo Buildings, Rural-Urban Divide, Timor-Leste

Introduction

The Democratic Republic of Timor-Leste is located in the Lesser Sunda Islands (Nusa Tenggara) in South East Asia. It is a tropical island country of approximately 1.35 million inhabitants, with a total area of 14,919 km². Thirty-two languages are spoken in the 13 districts; four working languages are used with Portuguese and Tetun being the two official languages. In 1975, Timor-Leste declared itself independent from Portugal colonization, and later in 1999, the nation gain independence from Indonesia occupation. During the 24 years of Indonesia occupation (1975-1999), around 1/3rd of the population of Timor-Leste was decimated, and most of the infrastructure was demolished or burnt, plunging this resourceful country into famine and poverty. Since then, the nation has taken on the task to overcome challenges such as poverty alleviation, socio-economic development, environmental protection and land governance. Timor-Leste has one of the world's youngest population, with 20 percent of its citizens aged 15-24 years old and 40 percent aged 0-14 years old (Index Mundi, 2019). Widespread poverty and rampant unemployment are forcing its population, especially young males to migrate to more developed countries.

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For the last 20 years post-independence, support from International Aid Organizations and profit from the Oil and Gas Industry has been the life-line for the reconstruction of the country. Despite the rapid economic growth in recent years, with an economy highly dependent on oil revenues, Timor-Leste's urge is to diversify its economy and build sustainable industries to reduce its vulnerability (Carmona, 2014). Amongst major efforts towards achieving these goals, bamboo has appeared in policy documents (Timor-Leste Strategic Plan 2011-2030) due to its potential to income generation in communities and environmental protection (e.g., erosion control, reforestation). Bamboo is a raw material with the potential to significantly advance societies predominantly rural such as Timor-Leste, towards self-reliance and decentralized living in harmony with nature (Takeuchi *et al.*, 2019). It is an excellent source for carbon sequestration, and it is not a carbon-intensive material such as steel, aluminum, concrete or plastic.

According to Swain and Hartman (2009), there are five commonly found species of bamboo suitable for flooring, laminated boards, and construction in Timor-Leste (*Dendrocalamus asper*, *Gigantochloa atter*, *Schizostachyum brachycladum*, *Bambusa heterostachya* and *Guadua augustifolia*). Using bamboo for construction can create new connections and economic flows between urban and rural areas, simultaneously supporting local economies while transitioning to a more sustainable and built environment. The government aims at shifting towards sustainable practices as exemplified by the new National Strategy for Bamboo Supply Chain launched in 2019. However, there are many inter-linked activities in the forestry sector that need to be considered for a comprehensive "National Bamboo Strategy" and in particular, for the successful implementation of a comprehensive Bamboo Building Industry Strategy.

Little attention has been dedicated to developing a sustainable building industry in Timor-Leste. Previous research by Braz *et al.*, (2011) has explored Timor's traditional rural architecture to identify low-cost sustainable building solutions. The study emphasis is on the importance of valuing indigenous/local building material resources and cultural

aspects, and it proposes future bioclimatic design strategies. Although previous research has explored/identified the material and cultural aspects that comprise the traditional Timorese architecture, less attention has been devoted in studying the potential for the use of local resources such as bamboo to develop the modern building industry. As a result, there is little information available on the economic and environmental potential of a bamboo building industry. Therefore, it is of the utmost importance to gain a better understanding of ways of improving the contributions of bamboo to develop a local, sustainable building industry in Timor-Leste.

To address this issue, this paper details the contextual challenges to advance a Bamboo Building Industry in Timor-Leste in light of the National Bamboo Strategy and Action Plan (Yiping, 2018). In addition, it shows how the specific pilot initiatives developed by the authors in conjunction with the Bamboo Institute Tibar can be implemented and become a process catalyst for other projects to follow throughout Timor-Leste. The next section presents the research strategy adopted and describe the main studies. Next, we present an overview of the Bamboo Institute Tibar and an analysis of the National Strategy for Bamboo Supply Chain. Then, key opportunities for developing a Bamboo Building Industry are presented and discussed in light of the National Bamboo Supply Chain Strategy. Finally, we conclude with implications for future research.

Materials and Methods

In this section, we identify the research problem (1) with a justification of its selection and (2) describe the strategy of the overall research.

The research design in this paper adopts a participatory observation approach, qualitative in nature. It draws on a literature review, field observations, in-depth interviews and a design intervention in collaboration with local stakeholders. The research involves three main studies: 1) an analysis of the National Strategy for Bamboo Supply Chain (Yiping, 2018); 2) field research and interviews with key stakeholders, and finally, 3) a design intervention in partnership with the Bamboo Institute Tibar. In the first study, a literature review and the in-depth analysis was carried out to gain a better understanding

of the Timorese building industry and to identify relevant stakeholders. Based on this initial study, the authors selected key stakeholders and geographical areas to conduct the field research. The field research aimed at identifying relevant information about the local production, public perception and state of research of bamboo in Timor-Leste. Finally, in the third study, a design intervention was conducted to explore key areas for development.

Data collection and analysis

The empirical data reported in the paper comes from multiple field visits across provinces of Viqueque, Liquica, Aileu, Maubisse and Tibar (fig. 1). The field research was carried out between March 2019 and March 2020 (total of three visits, three months). Semi-structured interviews were conducted with local producers, residents and representatives from the Bamboo Institute Tibar. For example, an informal, semi-structured and open-ended interview was conducted with a representative of the Bamboo Institute Tibar (Interviewee A) to produce better insights regarding challenges of getting into export markets (e.g., compliance with international quality standards). Further interviews were conducted with an agronomist of a local NGO's in Baucau (Inter-

viewee B), an economist at the World Bank (Interviewee C), two employees at the Bamboo Institute (Interviewee D and E) and multiple short open-ended interviews were conducted with residents/villagers near the processing centers.

Secondary data derived from existing surveys, government reports and literature review were collected and analysed based on the archives of the Xanana Gusmão Library in Dili and the Timor-Leste archives at the National Library of Canberra in Australia. The secondary data were gathered in order to enrich the in-depth analysis of the National Strategy for Bamboo Supply Chain. Finally, during March 2019 and from January to March 2020, a research collaboration between the Bio-Based Materials Design Lab (University of Western Australia) and the Bamboo Institute Tibar have developed an architecturally designed bamboo pavilion and redesigned a bamboo chair. Triangulation of data was achieved by comparing pieces of information from the literature review and the analysis of the national strategy, with data collected from field observations and interviews. The cross-validation of data contributed to better inform the final design intervention.



Fig 1. Location map of the study area

Source: <https://freevectormaps.com/east-timor/TL-EPS-02-0002?ref=atr>

An overview of the Bamboo Institute Tibar

The establishment of the Bamboo Institute Tibar in 2008 by the Government of Timor-Leste and UNIDO has focused on applied research to advance “poverty reduction through employment and income generation in post-war scenario” (UNIDO, 2008). With the acquisition of machinery and equipment by UNIDO the Institute was placed in Tibar (approximately 20 km west from the capital Dili) with the construction of offices and open spaces for the establishment of the skills development center. Staff from the Institute has had access to continuous overseas training in particular in Asia, and exposure to overseas volunteers and experts that have contributed towards developing business strategies, labor training, and expanding its vision. The Bamboo Institute Tibar is paving the way to advance goals related to energy, economic growth, industry, infrastructure and sustainable production and consumption (SDGs 7,8,9 and 12) alongside goals related to poverty and food security (SDG 1 and 2).

However, the current capacity of bamboo production and consumption in Timor-Leste is reduced due to its small scale, with little interest and trust on bamboo as a sustainable material by the population. Bamboo is mostly used in rural housing, fencing and basic furniture. The marketing capacity of the Institute is low and is only comprised of foreign volunteers (Peace Corps USA). As we speak, due to the COVID-19 pandemic, the overseas-based capacity at the Institute have left Timor. The demand for products is also based on the local market (foreign contracted workforce, foreign aid workers, or some government contracts). The need to expand the design and diversity production with added-value products through training and research partnerships, along with effective marketing and branding, will potentially propel further demand locally as well as expanding towards the external market. In terms of production, there has been demand and interest from overseas buyers to establish regular export contracts with the Institute. However, the production capacity is still irregular and insufficient, as well as not reliable at the level of the supply chain for exports. Bamboo nurseries and bamboo seedlings are not widespread across the country, and bamboo plantation and harvesting with the necessary

training for farmers is not available at the scale that is needed. Even though the Bamboo Institute Tibar is working at almost all fronts, from nurseries to marketing of final products, the scale, scope and reach of implementing a national strategy need to evolve. This means to create a governmental task force that simultaneously can advance a vision and action plan in the next 10-20 years to work across the different ministries of forestry, agriculture, education and culture.

The National Strategy for Bamboo Supply Chain:

The National Strategy for Bamboo Supply Chain (Yiping, 2018) has analyzed the various sectors of the Timor-Leste bamboo supply chain in detail (e.g., resource and production, harvesting, processing, storage, transport, marketing) and such analysis was confirmed by the authors during the field observations conducted from March 2019-March 2020. In the next section, it is presented a summary of such fieldwork observations in light of the national strategy for the bamboo supply chain (Yiping, 2018).

Resource, production and harvesting: One of the major challenges for the bamboo sector in Timor-Leste is the degradation of its bamboo resources, through poor management. Despite being abundant in bamboo resources, it is challenging to establish the supply of high-quality poles throughout the year in Timor-Leste, which is exacerbated by the poor conditions of roads (in particular, during the rainy season). In some areas, the accessibility is difficult due to mountainous regions, lack of proximity from roads, and also due to land tenure issues. Plantations are small and scattered across the country, with low productivity. Moreover, the ability of farmers to invest in bamboo seedlings and plantation in lands that might be at the center of the customary conflict is a real issue across the nation. Without large scale bamboo plantation and the resolution of land tenure in Timor-Leste, it is almost impossible to develop a commercially viable sector in the country, with incentives to farmers and communities to plant bamboo. Such initiatives would allow not only for income generation for farmers but also protection from soil erosion, particularly in hilly areas, which is a significant problem across the country. Another aspect is the lack of training

for farmers to manage their bamboo resources and the low availability of seedlings. During several field visits across Viqueque, Liquica, Aileu, Maubisse and other areas the authors observed poor harvesting of clumps (e.g., harvesting larger and younger culms outside clump, leaving older and smaller ones inside, making the clump old and dense), which was confirmed by Yiping (2018) on his national report. Overall poor knowledge and inadequate capacity of technicians and farmers to manage plantations along with poor management of plantations (e.g., lack of soil preparation, lack of soil management of clumps) were also identified during field observations as key aspects on the low productivity of bamboo plantations (Yiping, 2018).

Processing and marketing: The Bamboo Institute Tibar have established pre-processing centers in 10 locations throughout the country. However, due to the issues mentioned above, only eight of the pre-processing centers were active as of February 2020, with some at very low production. The average capacity of each pre-processing facility is 53,396 bamboo strips per year. However, the low utilization rate during processing leads to a high volume of bamboo waste. At these facilities, farmers bring poles to the pre-processing station where they can sell these poles. The bamboo poles are split and collected by trucks from the Institute to be preserved and processed into laminate boards for furniture, handicrafts, daily utensils or charcoals. The low utilization rate of the bamboo poles at the Institute (approximately 50% of the raw bamboo poles) has been decreasing as they have started to diversify its line of products.

Nevertheless, there are still opportunities for improvement in terms of waste management. The Institute has been investing in design capacity (e.g., contract, volunteers) to develop multi-products that can use the different parts of the culm and therefore improve their overall production efficiency. As the Institute still lacks sophisticated design capability and manufacturing, the products are basic, heavy and unsuitable for export markets. The number of techniques used in its products, considering the variety of bamboo processing techniques available is fairly limited. It is noticeable, however, that being the only institution that deals with bamboo planta-

tion, preservation, processing and manufacturing in the country, and fully funded by the government it does not provide the best possible incentive to market expansion. For these reasons, there are recommendations from government representatives and locals to transform the Bamboo Institute Tibar into a private enterprise, which seems a reasonable approach. Private investments are paramount to ensure the stable provision of jobs, training and upskilling at all steps of the supply chain, so that there are competition and provision of best possible resources and products to the market. However, without regulatory frameworks or financial mechanisms from the government to provide incentives and motivate the private sector into the development of the bamboo industry (e.g., subsidies, credit lines), it will be difficult to change this context in the long term.

Moreover, there are little governmental or institutional arrangements in promoting and advocating for bamboo products (e.g., buying bamboo products, procuring policies for bamboo products), as well as building and construction with bamboo products within government offices or institutions. Indeed, demonstration projects are an essential part of promoting bamboo as a national material, while fully deploying more training, upskilling and demand in the market. To promote research and development and private sector investment, it is utmost for any bamboo industry to flourish, as per most Asian countries that have successfully deployed such industry at a large scale (e.g., Vietnam, China, Thailand) (INBAR, 2014). Finally, yet importantly, is the absence of research capacity in Timor-Leste with regard to all aspects of bamboo, from cultivation to preservation, processing, design, manufacturing and marketing. The need to engage local knowledge and cutting-edge international research is the need of the hour to promote sustainable practices that are suitable to Timor-Leste and its communities.

Results and Discussion

Bamboo as a resource in Timor-Leste for the building sector: vision and action plan

While considering the importance of all the aspects described in the previous sections, and in light of the National Bamboo Supply Chain Strategy (Yiping, 2018), this study identified three factors of utmost

importance for the foment of a Bamboo Building Industry in Timor-Leste. The three key facts are: 1) Improving land governance; 2) Creating awareness and acceptance about the industrial potential of bamboo as a modern and sustainable material resource; and 3) Building construction research capacity, skilled bamboo building professionals and design labor.

1. The land tenure issue limits the capacity of bamboo production and consumption considerably, and therefore processing and manufacturing. It affects the entire supply chain as land is claimed, through first possession, by specific communities or groups (Nixon, 2005), leaving much uncertainty and conflict over land and resources.
2. The majority of the population still perceives bamboo as the “poor man’s timber”. Bamboo is mainly used for local household purposes (e.g., fencing, simple utensils) or traditional housing. To change the public perception of bamboo as an inferior, non-permanent material entails the development of value-added products and building demonstration sites widely available throughout the country, as well as the accessibility to preservation courses and training. At the time of writing this paper, the capital Dili does not have a single contemporary building built out of bamboo.
3. A research collaboration between the Bio-Based Materials Design Lab (BBMLab) and the Bamboo Institute Tibar have developed an architecturally designed bamboo pavilion and redesigned new bamboo chair options for the furniture line of the Institute. The pavilion roof structure is based on current field documentation of traditional housing (Uma Luliks) in the country (Tenorio & Hirth, 2021), recovering identity symbols from traditional architecture using traditional joinery techniques and materials, such as bamboo. Phase two of the pavilion have been designed as a Café/housing prototype, with alternatives for efficient cooking stoves, waterless toilets and industrialized roofing shingles developed out of bamboo. The BBMLab has also worked with the Institute to develop new furniture, allowing for a lighter and higher-value design that can appeal to the export market.

Land governance and customary traditions: community development and prosperity

According to Srinivas and Bell (2015), close to 90 percent of Timor-Leste’s landmass is rural land. Most of which is administered through customary practices, claimed through first possession, by groups or communities. The exception to this is peri-urban and urban land, which is covered by “privately held rights”. Given to the Indonesia and Portuguese occupations, there has been “State Land” impositions coexisting with customary land rights, most of the time ignoring such traditional groups or communities access to land. The Portuguese, during their colonial times, issued almost 3,000 land titles, but it also issued numerous “ownership rights” (i.e., *propriedade perfeita*) and perpetual land use rights (i.e., *aforamento*).

Such titles were issued for specific use purposes, and prescribed yearly payment of fees, and issued for elite groups. The Catholic Church has also received numerous donations from communities (during Portuguese occupation and, in particular, during the Indonesian occupation). During the Indonesian occupation, there has been a significant aggressive policy on land grabbing, with forced displacement of Timorese from their land into small plots of land away from inland areas, and moving of Indonesians citizens into Timorese territory. The communities lost access to resources and their way of living, where farming, living and pastures used to happen at separate plots of land. Such poor recognition of customary rights in the name of economic development for ‘public good’ has undone community relationships, created conflict through much tenure disagreements and affected people’s ability to access and use of resources (Fitzpatrick, 2001).

As the Indonesians left Timor in 1999, almost 70 percent of public buildings were destroyed by Indonesia militia and military forces, displacing around 300,000 people (out of Dili, capital) and 250,000 people into the Indonesian border (Carmona, 2014; International Crisis Group, 2010). As these families returned to resettle after the crisis, significant claims on their abandoned land and properties were put forward. The subsequent political crisis that has occurred in the country has its foundation on the instability of land tenure that persists to date. As

stated by Srinivas and Bell (2015) it is not possible to have land registration rights in place, until there is a 'land law' that recognizes and settles conflicts between the different records of "Portuguese land rights, Indonesian land rights, customary tenures and just compensation arrangements for those who hold verifiable entitlements or long possession in favor of statutory rights" (p. 5).

During the fieldwork conducted in 2019 and 2020 in various provinces, land tenure has proved to be one of the most contentious topics while in discussions with communities and groups. Due to the displacement suffered by land conflict in the 20th century, knowledge and skills about resources have been lost considerably, including that on timber and bamboo forestry and preservation. For example, interviews with older builders evidenced the deforestation practices by Indonesians and the younger Timorese generation, who are unaware of correct forestry practices and long-term sustainability uses of different species of timber, bamboo and palm trees. Most traditional building knowledge is being lost, and in part, it is due to the displacement of the people and the loss of contact with their land and their cultural practices, passed from generation to generation orally (like their land titles). Various government and international development plans have bluntly ignored land tenure, and for this reason, have failed

comprehensively on delivering its main outcomes, as confirmed during discussions with government officials and aid organizations groups. This study suggests that to successfully implement a National Supply Chain for Building Industry Strategy in Timor-Leste is necessary to pursue transparency, participation and trust amongst all parties involved. Therefore, ensuring diligent administration and management of land and resources with equitable and inclusive deliverables for communal land.

Perception of bamboo as non-desirable material in the building sector in Timor-Leste

The fieldwork observations showed that the building construction industry in Timor-Leste is dominated by imported low-quality building materials, coming mainly from Indonesia or China. Cheap roof metal sheeting is used in housing across villages and cities in combination with concrete blocks and cement for walls. Such building practices in housing are perceived as 'modern', 'permanent', 'convenient' and of higher status for household owners across rural and urban areas despite reported low levels of thermal and acoustic comfort (Shastry *et al.*, 2016; Tenorio & De Paula, 2017) and high costs (e.g., transport, materials and energy). Local building materials such as timber, bamboo and earth are perceived as deficient, non-sustainable, inconvenient



Fig 2. Internal lining of a traditional housing (Uma Lulik) in timber and bamboo in Los Palos

as it requires considerable maintenance throughout its lifetime (Jackson and Tenorio, 2010) (Fig. 2).

Currently, the country's capital Dili does not have a single modern building constructed out of bamboo. For any given particular technology under development, institutional buildings have been able to demonstrate such technologies, and use it as a source of trust and marketing for local communities worldwide. Demonstration buildings allow for testing, researching, marketing and propelling specific technologies, as it has been the case for BIPV – (Building Integrated Photovoltaics), Green Roofs, Advanced glazing technologies and Rammed Earth. Ultimately, government infrastructure, in particular, when promoting entire new neighborhoods redevelopment and school buildings, have the appropriate scale for bamboo buildings to be tested. Government projects for social housing, such as the MDG Suco Program (initial goal was to have 55,000 pre-fabricated houses to be imported from Indonesia by 2015), has been widely criticized as a 'lost opportunity' for its lack of consultation, poor design and overall cultural, environmental and technical inadequacy (Wallis & Thu, 2013). Such a project was a suitable opportunity for demonstrating the potential of bamboo as an innovative, environmental, modern and pro-development material. Moreover, it had the potential to showcase the work that the Bamboo Institute Tibar is doing since its foundation in 2008, as well as generating jobs and income for the local population.

Other significant challenges are the absence of bamboo processing building companies throughout Timor-Leste, its lack of durability if left untreated or exposed to the elements, and the lack of skills on detailing (e.g., poor joinery work) from young local builders. These factors contributed significantly to the winning competition of cheap imported materials. As discussed above, however, the use of demonstration projects in urbanized areas and rural areas can promote bamboo as a sustainable, high tensile and resilient local and affordable building material. Training at vocational institutions on bamboo construction and preservation should be established as to allow for technical upskilling of carpenters and builders into the detailing, processing and manufacturing with bamboo.

Research capacity into urban and rural building technologies: the need for interdisciplinary research and development

Building up from the topic of acceptance and trust on bamboo as a building material by communities, the need for demonstration projects and the availability of reliable bamboo resources, require continuous development of interdisciplinary bamboo research. The fields of research like Agriculture, Architecture, Education, Engineering, Forestry, Law and Product Design are amongst those that have a direct impact on the development and establishment of a Bamboo Building Industry in Timor-Leste. Moreover, research must be conducted in alignment with the needs, and in consultation with rural and urban communities. Similarly, it must consider the Timor-Leste's rich cultural practices such as elaborate traditional housing designs and large proportion of farmers that are knowledgeable on their contextual resources.

The opportunities that exist today require a coordinated approach towards collaborative research and development building capacity within existing institutions (e.g., Universidade Nacional Timor Lorosae, Bamboo Institute and Foreign Aid organizations), and in partnership with international universities and research institutions. Besides, there is the need to be directed and coordinated by institutional and local powers, within a national framework and strategy that oversees the progress and implementation in consultation with local stakeholders.

Context and brief: Bamboo Institute Pavilion and "Café Uma"

A partnership between the Bio-Based Materials Design Lab (BBMLab), The University of Western Australia and the Bamboo Institute Tibar have developed the design of a demonstration pavilion to be built at the Institute. The Pavilion would fulfil the needs of the Institute to become an iconic symbol of bamboo construction, using traditional joinery techniques and representing the potential of modern bamboo construction in Timor-Leste. It is meant to serve as a demonstration building for bamboo construction, and to display Bamboo Products (e.g., furniture) for those visiting the Institute. Affordability of resources, sustainable use, and flexibility of uses were essential parts of the brief. The design

and construction were set in two phases: Phase 1 – Pavilion and Phase 2: Café Uma (Fig. 3).

Phase 2, “Café Uma”, used a combination of lightweight and heavyweight materials, giving the possibility of on-site materials sourcing and construction, and or off-site materials preparation. The design used pre-fabricated bamboo trusses, earth stabilized brick walls on a concrete foundation and bamboo roofing sheets, specifically developed and manufactured at the Bamboo Institute Tibar. The Café was designed to collect rainwater, with composting toilets, powered by BIPV (Building Integrated Photovoltaics) and SHWS (Solar Hot Water System). The modulated structure has been designed for testing and monitoring at the Institute, but to be also later adapted and redesigned to serve as housing typologies for different regions of Timor-Leste, according to climatic and social needs. An open-source manual, visually illustrated specifically for illiterate individuals is to be made available along with literature (books and flyers) over the internet. Householders would have instructions on how to harvest their materials, prepare, preserve, source machinery when necessary, buy specific parts of the modular construction unit (e.g., roof trusses, foundation kits, window frames) and also have

options on how to adapt spaces and structures on a modular basis.

Context and Brief: bamboo Institute Weaving Chair Design

The Bamboo Institute has been successful in producing basic furniture for the local market. However, concentrating from the beginning on producing furniture made out of laminated boards, have brought some additional problems into the design and manufacturing process. Despite being built out of bamboo, the amount of material used in the production of each chair is considerably higher due to the techniques used (lamination), producing much waste on its process of construction. Material recovery is difficult given the way it is layered, the use of glues, nails and bamboo pins on the joinery. Chairs are robust and difficult to disassembly (e.g., due to the use of nails and permanently glued joints) and heavy due to the consumption of larger amounts of materials.

Weaving has been a traditional technique widely available in communities where bamboo is present. Some of the handicrafts produced at the Institute used traditional weaving. The BBMLab, in collabo-



Fig 3. Integrated environmental design: Pavilion (left) and Café Uma (right) - Bamboo Institute



Fig 4. Maun Carlos, Master Bamboo Weaver Aileu (2020)

ration with the Bamboo Institute and local craftsman, developed the Uma Chair, based on a simple design to introduce weaving and disassembly as part of the final product. The new design intended to reduce the relative weight of the chairs and introduced a redesign for disassembly and reuse, with more complex joinery that could allow less waste of materials. Sessions with a Master Weaver who is already working with the Institute were scheduled to develop the prototype (fig. 4 and fig. 5). An initial design has been completed (fig. 6 and fig. 7).

One of the main outcomes of the development of this product is to allow for the production of furniture for export, which needs to be lightweight and easy to assemble and package (flat-pack furniture), consuming less space for transport and also allowing for less waste during the manufacturing process. The possibility of including traditional techniques, such



Fig 5. Women from Maubara weaving with palm leaves (2020).



Fig 6. Uma Chair by Bamboo Institute and Bio-based Materials Design Lab (UWA, 2020)

as weaving in the industrialized process adds value and contributes towards inclusive income generation within the communities. Weaving in Timor has been passed from male and female masters to the youth, and it is produced using a range of materials, such as bamboo and leaves from palm trees. The patterns and variety of designs are diverse, and the richness of its use can become an asset into contemporary furniture design.

Conclusion

The role of demonstration projects, documentation and preservation of traditional architecture and heritage (craftsmanship), development of added value design along with government legislation and policies can substantially contribute towards an increase in local production, demand and most importantly acceptance of bamboo as a contemporary building material while promoting development.

Research partnerships such as the one presented in this paper can help to change the public perception considerably faster, by channeling resources more efficiently and presenting results that can be tested and implemented, bringing trust from the governmental and private sector. The establishment of Bamboo Institute in 2008 by the Government of Timor-Leste and UNIDO has provided Timor-Leste with a good focus point for the development of a Bamboo Industry. However, much needs to be done to expand the work of the Bamboo Institute Tibar

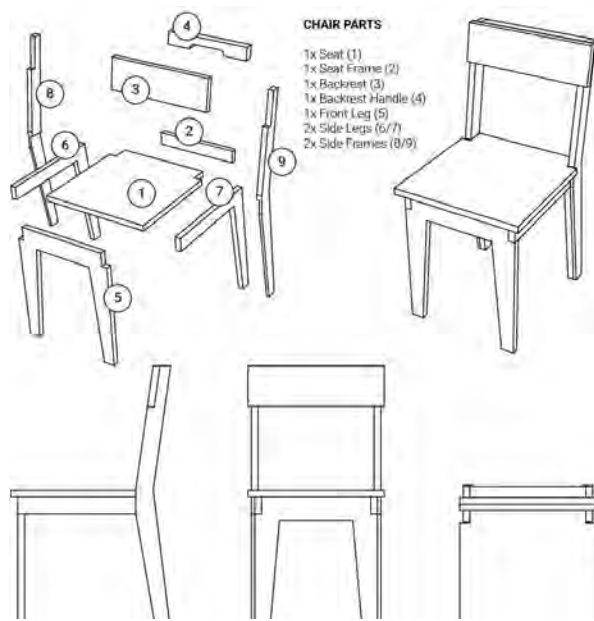


Fig 7. Construction plans, Uma Chair Design Bamboo Institute (2020).

through National Strategies that will embrace further the building sector. The scope and complexity in which the Institute operates are too large for their reduced staff and volunteers.

Acting upon land governance in Timor-Leste is of utmost importance before any national bamboo strategy or policies are to be implemented. Communication and transparency for future governmental and private sector plans needs to involve extensive consultation with communities and groups so that appropriate management of land and resources are truly inclusive.

Governmental institutions should take the opportunity to use public buildings in urbanized areas and social infrastructure projects, in particular school buildings and social housing that are built across rural areas, as demonstration projects using bamboo technology. This will enhance demand for the development of modern bamboo products for local and export markets and drive consumption of such materials as well as generate jobs and income. Such projects must be research led, leading local universities and research institutions to collaborate and to develop appropriate solutions that consider rural-urban living traditions, environmental and social needs as well as modern aesthetics.

A process of healing from the past is in motion in Timor-Leste. There exists the need for tools to

promote development that is accessible and affordable, and environmentally, culturally, economically and socially inclusive. Bamboo has the potential to deliver growth with development at the scale of individuals, communities and nationwide.

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