

Case Study: Community Value Supply Chain Impacts on Economic/Community Development

Shaun Rolph¹

Abstract:

The purpose of this paper is to identify a model of growth for a bamboo industry in a developing country that practices sustainability, environmentalism, and humanitarianism as fundamental corporate social responsibly within a business model. This case study gives a potential example of how a country can invest and create an industry to increase growth at micro and macro-economic levels with available natural and financial resources. This all while molding modern business and supply chain practices into the fabric of the industry, from agriculture to manufacturing to even services. The Bamboo Institute boasts a unified front across multiple organizations managed and applied by country nationals. At the core of this front lives a community value supply chain that holds all these organizations and nodes together to produce a potential output Timor-Leste needs for a sustainable, economic, and environmental conscience future.

JEL Classification:

Key words: Value Supply Chain, Timor-Leste, Business Model

¹ Bamboo Institute, Ermera Road, Tibar, Timor-Leste, Phone: 5087354206. Email: shaun.c.rolph@gmail.com

Introduction

In South East Asia (SEA) resides the island of Timor-Leste. This island recently gained independence and is using independence to push economic growth in innovative and sustainable ways. Being an oil dependent country, the government has actively worked to promote growth in many sectors including coffee, eco-tourism, and bamboo. By far, one of the most progressive investments from the government has been the creation of a social-enterprise, Bamboo Institute (BI). BI has operated in the last decade using a small budget from the government and the utilization of bamboo, one of the most sustainable resources Timor has. Bamboo is a grass with many benefits compared to timber forests, such as a higher oxygen output, reduced lead-time for harvest, regrowth once cut, soil erosion prevention, and branches can be cut and replanted making future bamboo.

Bamboo Institute has used this green and sustainable resource to develop a bamboo industry through investments into their community value supply chain, growing supply quality and quantity, and the development of a manufacturing facility to produce high quality modern and cultural bamboo products. BI has cultivated human capital and income through two focal points: 1) training for and investing into nurseries, farmers, and processing groups and 2) the purchase of raw supply material from these groups. Each supply node is autonomous from BI and produces income separately; giving empowerment through independence.

The second focal point feeds BI's manufacturing facility to produce and sell bamboo products. BI's manufacturing facility utilizes bamboo by creating a closed-loop supply chain and reusing waste to fuel production lines or create more products. Implementing important goals as a foundation for business and supply chain practices is what makes BI a good case study to evaluate. BI has produced economic and community growth through the utilization of modern supply chain practices fused with cultural beliefs, and though BI has not generated profit, its growth is impressive. Another impressive feat is BI's ability to work in communities and without impeding on other industries such as coffee and subsistence farming. All this effort harmoniously work in agriculture, manufacturing, and tourism services. But before BI can be fully analyzed, the importance of a country lens is needed to understand the landscape BI has worked in.

Timor-Leste: Country and Economy

Timor-Leste is a country the size of Connecticut that covers half of a tropical island with massive mountains just a hundred yards away from shore. The mountains act as mazes, difficult to navigate and pass through, but with ample natural resources such as gold, minerals, and wild coffee. Coffee is one of Timor's main exports which was planted hundreds of years ago when the Portuguese first colonized Timor in 1769, a hold that they did not relinquish until Timor-Leste's first independence in 1974. Timor did not gain independence until 2002 due to an Indonesian occupation soon after the Portuguese left. It took until 2017 to have Timor's first unassisted democratic election, but along the way, the Timorese forged a path of development from a country that desperately needed it.

GDP levels in 2001 were just above \$500 million USD, twelve years later GDP rose to a peak of \$6.671 billion USD in 2012 (World Bank). With a stable government, the country invested into infrastructure, coffee, petroleum, and improving living conditions. Most GDP of Timor is from oil reserves. Timor-Leste has been referred to as one of the world's most oil dependent countries. Timor-Leste has an oil reserve fund that saves profits intended for government expenditures, allowing the government to develop its country. Timor-Leste's dependency on government expenditures and aid have increased economic activity and living standards, but the question is for how long. Timor-Leste's political parties have been fighting for power and influence, so that a recent annual government budget was not passed until much later than projected, restricting most government expenditures.

By 2016, Timor-Leste's GDP had declined to \$2.5 billion USD, which is a significant decrease from GDP in 2012. The main contributors towards economic growth consisted of exports of mineral products (\$36.8M), vegetable products (\$17.4M), machines (\$1.24 M), and transportation (\$1.03M) (Atlas, 2016). The second source of dependency, aid, has acted as a cushion; organizations like USAID, the UN Development Programme, country embassies, and I/NGOs have invested over \$2.5 billion USD worth of grants and loans (Timor Government, 2016). Aid has been used to decrease poverty and malnutrition, and to increase economic activity, health, and education. Aid has seen success in education; Timorese primary school enrollment increased from 76 percent in 2008 to 95 percent in 2015 (WDI); and the poverty rate has decreased from 50.4 in 2007 to 41.8 in 2014 (World Bank).

A relatively new industry is bamboo. Aid organizations along with the Timorese government have invested in agro-business, manufacturing, and selling of semi-finished and finished modern bamboo products. Organizations see the benefit of a bamboo industry and have unified to ensure growth and sustainability.

Bamboo Institute (BI) Introduction

The Bamboo Institute, officially known as Instituto de Pesquisa, Desenvolvimento, Formação e Promoção do Bambu, is not only one of the largest manufacturing facilities within Timor-Leste, but holds a title of social-enterprise benefiting Timorese in rural areas expanding across 11 districts. Since its beginnings in 2009, BI has grown two sections of its social-enterprise to create an emerging market. The first, being a non-profit that trains farmers, processing groups, and nursery groups. The second, a manufacturing facility with a high production capacity that trains carpenters. When the two work together they create a community value supply chain from nurseries to customers.

With the assistance of the government and aid, BI has formed a model for other developing countries to foster industries that benefit people in a sustainable and eco-friendly way. Using Timor-Leste's ample resource of bamboo, BI has created a diverse range of products such as modern furniture, handicrafts, blinds, and briquettes. What makes BI truly unique lies within unbending goals that underlie its foundation.

Goal 1: Create an eco-friendly and sustainable bamboo industry in Timor-Leste.

Goal 2: Invest in and train bamboo farmers, groups, and carpenters to continually raise the level of opportunity for local Timorese.

Goal 3: Alleviate poverty and generate income, especially in the most rural areas of Timor-Leste, while maintaining an efficient community value supply chain.

Investing into these goals might not have a short-term return of complete financial sustainability, but Bamboo Institute believes that the industry needs a green hand before it can grow by itself. Nurturing this industry has created value added by the connection between BI and the community to meet these goals together. Goals that not only created a closed loop supply chain,

but skills and knowledge that increase the quality and quantity of product. Timor-Leste is not the only country utilizing bamboo, as it has many properties other countries have utilized to increase economic growth. By 2027 the global bamboo industry will have a net worth of over \$10 billion USD and is currently valued at \$3.9 billion USD (Future Markets Insights, 2017). The bamboo industry is projected to increase at a value CAGR of 10.6%. China and India are the main contributors and Asia-Pacific accounts for 50% of bamboo resources (Future Markets Insights, 2017). Timor-Leste has the opportunity to enter not just the SEA market, but the global market as well.

Think Green. Think Bamboo.

Bamboo has amazing properties; it can be harvested and continues to regrow sprouting new culms (poles) from a clump of bamboo. With a lead time of three to five years to harvest, bamboo puts other wood to shame, as most timber can take from 10 to 50 years to be harvested. Bamboo provides additional important benefits such as deep roots and clumps that prevent soil erosion, and it produces 35 percent more oxygen than timber forests. One of the most sustainable properties of bamboo is that its pruned branches can be planted in poly bags to create saplings for future growth. Farmers often increase future yields rapidly because one sapling can product a clump of 20 culms (poles) or more.

BI trains nursery groups and farmers to utilize every benefit bamboo has, as well as to reinforce respect for the forest. One issue that inspired BI to develop an innovation solution was the frequent practice by Timorese of farming coffee and fruit trees. Subsistence farming is prevalent in all areas in Timor, and farmers use their land to grow food instead of a cash crops like bamboo. BI works with farmers to find good mountain locations for plantations and uses road sides to plant bamboo, both usually being on includes planes This is an innovative solution to soil erosion on dangerous roads and making sure farmers don't have to sacrifice their livelihood to grow bamboo. Bamboo needs to benefit the entire island and the government and I/NGOs agree. Often organizations will make plantations in dangerous road areas to reduce soil erosion than destroys entire section of road. Soil erosion in Timor-Leste has not only swallowed miles of roads during the raining season, but can be a major cause of vehicular accidents. BI provides 13 different species of bamboo to not only grow an industry but help contribute to Timor-Leste's road development.

Currently BI sources the majority of its bamboo from the western half of the island, but BI is working with the multiple organizations to improve road conditions in the southern and western parts of the country by planting bamboo. Bamboo saplings turn into massive clumps of poles and roots can be as long as five feet. Clump roots absorb water efficiently while holding soil in place. Better roads will cut costs and increase supply of bamboo. With a good quality truck it can take up to 6 hours from the capital Dili to Baucau in the east, a journey of only 100 miles, and 12 hours from Dili to Viqueque in the south, which is only 111 miles. Driving along dangerous ocean cliff sides and high into the mountains roads with sections washed away. Rainy season is notorious for shutting down roads entirely for months at a time. With increased quality of road conditions, BI can expand access to more rural areas, decrease lead times, and decrease transportation costs.

One major benefit of developing a green industry within Timor-Leste is that it aligns with country efforts to create an adventure/eco-tourism industry. Timor-Leste is located close to Bali, just a couple hours away by plane. Bali is taking a high influx of tourists, more than its environment and industry want to handle. Timor-Leste is taking advantage of that and working with Bali to invite tourists to explore Timor-Leste's vast tropical destination mountains and beaches. The government has made impactful investments within infrastructure such as museums, hospitality, and roads, as well as protection of historical sites and the environment. Timor-Leste's ocean is one of the most diverse in terms of marine life, which has brought many tourists in.

BI is working with the government to establish tours of the manufacturing facility, which also include a plantations and nursery. Being only a half hour away from the international airport and capital city, BI can benefit from the tourist activity in the capital. BI is planning to build a central guesthouse in the capital, and another two in the mountain districts to show its entire supply chain and showcase products. These guesthouses will feed into current demand of tourism, giving tourist an adventure to the mountains and insight into a green industry of Timor. With a recent submitted grant to USAID, development of services to tourist can begin. Development such as the implementation of a marketing staff for outreach, networking, and tours. As well as an investment into handicraft production to increase diversity and capacity within the production line. Starting tours of BI's facility will give a service close to the capital where tourist stay as well as sell products they can go home with. BI knows it must find a target market for products and services before plunging into the investment of hospitality with guesthouses.

Bamboo Institute's Community Value Supply Chain

Due to being government funded, BI's business model is designed to generate income for a variety of Timorese throughout the supply chain instead of breaking even or producing profit like most businesses. The Institute's measurements of success and return on investment are income generation, growth of the bamboo industry, and sustainable/renewable practices. Though BI's long-term goal is to have a completely independent business and to create profit, growth takes time in a developing environment. The two focal points of investment to increase the value of BI's supply chain are 1) The purchase of seedlings to supply nurseries in turn feeding the supply chain and 2) The purchase of culms from our processing groups/farmers. Each provides an increase in the livelihood of the Timorese and the quantity and quality of BI's products. Investment coupled with the increase in capacity at the manufacturing level has given BI many opportunities as customers can clearly see the value of BI's product and its supply chain.

Nurseries, Farmers, and Processing Groups

Nurseries are vital to the distribution of saplings and access of supply to farmers in Timor. BI has created 20 nurseries in 10 districts, which in the last three years has produced an annual average of 26,000 saplings from the seedling input. Compared to the 1,600 saplings from just one nursery in 2009, BI's supply has grown as a direct result of the investment into the skills and knowledge of these nurseries. BI trains and mentors the nursery groups through their first batch of seedlings, taking about five months to grow into saplings to be transplanted into plantations. Through a 2018 UNDP grant, BI has created eight new nurseries to expand the supply base as well as access of saplings to farmers. By the end of December of 2018, these eight nurseries will transplant and additional 22,000 saplings from the annual 26,000. Material costs to implement and supply propagation materials and seeds will be \$26,400 USD. Often BI or NGOs will work with groups to subsidize or provide materials. Investments such as this are carefully conducted. If a nursery can show a healthy return of saplings, they are given significantly more seedlings the next year. BI has cultivated relationships with farmers by letting the nurseries network in their local areas with farmers they know and trust.

Farmers are essential to guaranteeing quality in BI's products; without proper plantation and bamboo clump management, volume/quality of bamboo yields would be very poor, especially in arid environments with red soil. With a 204 saplings per acre planting process, farmers need to

put time into caring for each sapling until it forms into a clump of around 20 culms. BI's farmers receive propagation and clump management training to increase the success rate of harvest size. BI estimates that 80% of culms are healthy enough to be harvested after the three to five year lead time.

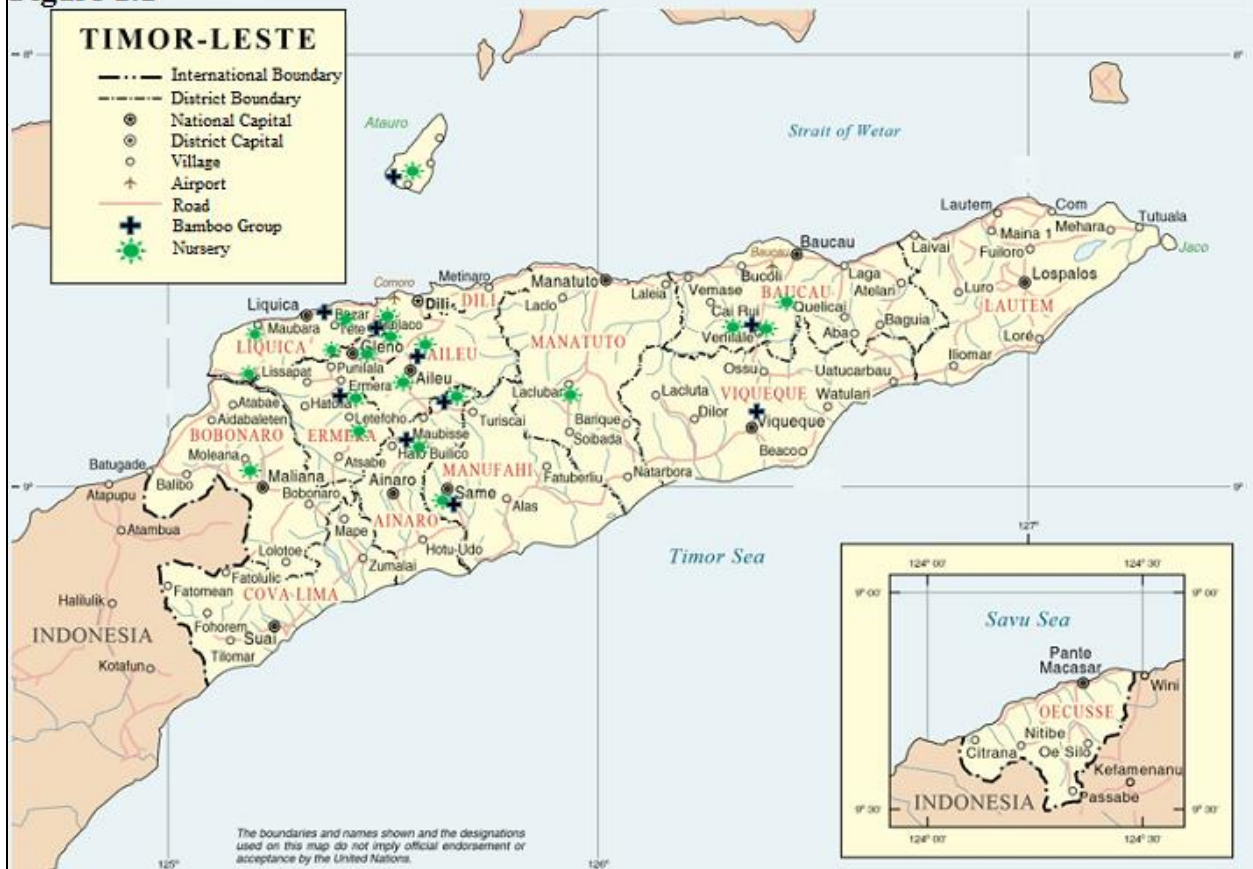
Timorese often subsistence farm, so nurturing the idea of farming for income is often a challenge for BI, but one they have been able to handle by working closely with the community and understanding the culture and lifestyle of Timor. When foreign I/NGOs work, there is often a barrier of culture and language; since BI is fully staffed by Timorese, they have the ability to communicate effectively, implementing new business and farming practices. One important technique BI ensures farmers use is pruning large branches and then replanting them in a poly bag to create more saplings. Often farmers will create small nurseries to replant bamboo adding more value to farming practices and the sustainability of BI's supply. In the last three years, farmers have sold an annual average of 34,000 culms to processing groups at \$0.80 USD per culm. BI invests into districts at differing times, so income is not split between all active farmers in a single year. Farmers often have several modes of income and for those who have sold to the processing groups have benefited in the long run when BI increases its supply input. The 22,000 sapling input into plantations will produce a potential yield of 352,000 culms and give potential income of over \$281,600 USD when being sold to processing groups.

Processing groups are hubs of communication and regulation, but are autonomous to BI. . Consisting of an average of four members trained by BI with donated machinery, these groups process bamboo into strips. Farmers travel to the 10 groups BI has with culms of a certain length, diameter, and wall width. Groups then cut and size bamboo into an average of eight strips per culm and sell each strip for \$0.15 USD. Hubs are located near central roads, allowing BI to efficiently gather an average of 18,500 strips monthly. Three reasons BI uses processing groups is that they provide accessibility to farmers in rural areas, they provide accessibility to BI, and they distribute income to local areas instead of a single isolated area. BI believes this supply model provides the opportunity to meet all three goals. Figure 1.1 below shows the geographic locations of BI's

nurseries and processing groups. It may look like these nodes are close together but the under-developed roads extend transportation lead time by hours.

Using the same UNDP grant for the implementation of the eight nurseries, BI is creating five new processing groups to expand its access to farmers. The potential 352,000 culms from the 2018 investment can be processed into 2,826,000 strips and create revenue of over \$422,000 USD once sold to BI's manufacturing facility. All of this growth comes through focal point one and two. In order to increase the input of supply, the manufacturing facility needs to have a high production capacity and navigate a domestic and international market to find demand. Focal point

Figure 1.1



two is highly dependent on demand and capacity. BI is currently at a crucial point in the development of the industry. Average annual investment input for the last three years has been 37,000 seedlings in turn giving a potential average annual supply of 605,000 culms for the next three years. BI needs to focus on the production capabilities to increase output, enabling an increase in purchase of raw supply material, strengthening BI's community value supply chain and meeting the three goals.

Capabilities of Bamboo Institute's Manufacturing Facility

Focal point two is dependent on the manufacturing facility's raw material expenditures. In order to give full value to the supply chain, BI needed to increase manufacturing capacity and product output. BI has had a fundamental shift in the last few years; supply is greater than demand, but BI is utilizing its physical, human, and technological capital to increase capacity in order to meet current and potential future demand. BI is funded by the government and other organizations; in order to allocate and get funding approved, BI has to present proposals explaining its average annual budget of \$300,000 USD with an allocation of 84 percent to the manufacturing facility and 16 percent to supply investments. This may slow down inputs but people in Timor-Leste have a saying, "Neneik neneik, maibe bebeik," meaning, "Slowly, slowly, but surely." BI is always moving forward with analysis from its own staff, the Timorese government, volunteers, and other organizations. Moving slowly but cautiously with every hour and dollar put into this manufacturing facility has given BI the resources to combat risk, problem solve, and grow. BI must continue do all three to instill practices that allow for efficiency and growth within the business and in the supply chain, including utilizing each capital investment to promote efficient growth.

Human Capital

Collaborating with bamboo Institutes in India and China under the China National Bamboo Research Center (CBRC) developed relationships to cultivate human capital beyond the country's ability during BI's creation in 2009. BI depended on organizations like CBRC and United Nations Industrial Development Organization for Training and Mentorship to increase knowledge and skills. But later down the line national institutions like SEFOPE, a technical college in Timor-Leste, provided training and resources to give a fundamental capacity of production through skills and knowledge transfer. BI often sends staff to train with groups in China and Indonesia spending an average of 4% of their budget to increase human capital. Two valued leaders have embodied the training since the beginning, the director of BI, Sabino Rua, and the design and production manager, Mario Ribeiro. Using advanced carpentry techniques such as joinery, rough cuts, and finishing coupled with design software such as AutoCAD and SketchUp, BI increased capabilities and staff from 21 in 2009 to 64 in 2017. Sabino and Mario also worked with local universities to find educated Timorese to help run administrative support. They look for people who possess skills

in product design, production management, finance, sales, and logistics. They also pushed for hiring a 17% female labor force and even hiring a few employees with physical disabilities. BI will often have interns and university students come and study the organizations as well.

BI invests heavily in building their human capital in-house, too. Carpenters cross-train and mentor in order to develop a better work force and BI even accepts foreign volunteers to work on business and supply chain analysis. Staff are very open to training with volunteers to improve on supply chain and business practices. Administrative staff have been trained in Excel, Access, and Publisher, and can utilize past and current data to create detailed financial reports, supply and demand forecasts, accurate pricing points for products, and much more. The most important aspect of the human capital is the quality of leadership. Mario and Sabino constantly improve the quality and capacity of production output through researched and thought-out implementations of new machines and processes, often with the advice from outside organizations.

Physical Capital

Over almost decade, BI has been able to purchase manufacturing machinery through a partnership with the Institute of Bamboo in China. This machinery includes planers, chemical baths, solar dryers, hydraulic presses, saws, and drill presses to increase production output. BI has used its budget to invest in a generator, as power outages are frequent in the area, and a weaving machine to create blinds which has stemmed growth through capital early on at BI. With support from the government, other bamboo institutes, and grants, BI has been able to increase its physical capital just short of \$800,000 worth of equipment, building development, and industrial machines. These physical capital inputs have increased the production output dramatically creating a robust furniture production line as well as blinds, BBQ skewers, handicraft and briquettes from sawdust waste. BI allocated a yearly average of 26% to physical capital investments to increase productivity and output at the manufacturing level. With annual product revenues of \$2,787 in 2009 increasing to \$130,000 in 2018, BI has kept an annual average 85% growth due to these capital investments; but growth has stagnated in the last three years. In the last five years average annual revenues has been \$100,000 USD, but with current orders and projections for 2019 that average will increase to \$126,000 due to revised marketing strategies to target bulk orders. Without the specific physical and human capital investment in the last decade, BI would not have the community value supply

chain or production capacity it has today. BI would also not be able to invest through the third and most important form of capital: to increase growth and opportunity, technological capital.

Technological capital

Technological advancements take the form of physical and human capital, but achieved with use of information technology or modern business and supply chain practices to increase capabilities. Since 2009, BI has developed their community value supply chain, though this term did not yet exist until recent times. Value added through the relationships and investment into supply was an outcome of Timorese culture. Community well-being is the most important facet of Timorese culture, and BI was using a combination of business practices to increase its supply while maintaining their natural culture. Once the understanding of the meaning of a community value supply chain was known, they utilized it as a brand and goal.

With the collaboration of other organizations and internal knowledge and research, BI has learned to utilize their physical and human capital more effectively. Data capturing systems have been put in place, such as a procurement database, fulfillment database, supply resource database, and even an activities based costing database. BI has even captured historic data such as supply investment and output, fulfillment data, budgeting data, and even mapping out production lines to better understand pricing points, lead times, and production capacity. They have used this information to increase understanding for future decisions. For example, they have created marketing strategies that build on analysis of demand, cost effective products, and production capabilities. When looking at past and real-time demand data, BI changes their product material, as well as what they present on their website. BI has yet to fully utilize marketing, as they primarily rely on word of mouth. In order to keep increasing production output BI has been working with a volunteer to find target markets, international and domestic. Currently BI is developing a marketing strategy to implement and with the USAID grant, a staff member can push the implementation through BI's website, social media, networking, and more.

Management has been able to track growth in all production lines and use data to make investments that increase value. An example of increased value in the supply chain is the current investment into BI's toothpick production line for 2019. Raw culm material for the blinds and BBQ skewers are supplied directly from farmers and are processed into stick material. All three product lines use the same sticking machine, but the machine quality has faded with age. BI

proposed a second grant from UNDP for a sticking machine and the toothpick line that has been accepted and will be implemented in 2019. BI did this knowing that demand for blinds is stagnant, but now BI can reallocate raw supply material and labor based on demand fluctuation to create a stronger revenue stream for the production section, giving it a chance to produce potential future profit. BI has even done similar analysis to make investment into the furniture line.

While mapping out the production process, the production manager saw a bottleneck in board production. The solar dryers used for reducing humidity in the wood to eight percent takes two to three weeks to dry 24,000 strips; with current monthly raw supply input being only 18,500 strips, the drying process has the ability to halt production, especially if the input of strips becomes greater than the capacity for the solar dryers. The solution was to use the UNDP grant to purchase a carbonizing machine, which not only chemically treats strips but reduced the humidity to the eight percent needed. Though the machine can only treat and dry 950 strips, the lead time is two days compared to the 20 to 25 days of the older process and when running the new machine for 25 days the output is over 11,975 strips, dried and treated. Through information technology and an understanding of supply chain practices the production manager has created a more agile supply chain with this input, giving BI the capacity it needs to effectively increase production output for short and long-term orders alike.

Production Output

Capacity is not solely the ability to meet demand but the ability for maximum production. All BI production lines start with the purchase of bamboo strips and culms. Culms are cut and used to make blinds or skewers, and the strips are used to make modern bamboo board. BI purchased 227,871 strips and 8,264 culms in 2017 with the ability to make 3,342 square meters of bamboo board and 3,833 square meters of blind material in 2017. Procurement of raw materials cost on average \$36,000 USD annually, but BI wants to increase procurement cost to \$55,000 in 2019 to meet projected output demand. BI has the ability to meet large bulk orders for a diverse set of products. Some high demand products are chairs, tables, desks, shelves, and window blinds. BI has shifted its focus on demand meeting the current supply of bamboo. But in order to maintain its goals, BI needs to increase target markets to be able to increase supply input.

Table 1.1 and Table 1.2 demonstrate the possible maximum capabilities of production using 2017 and projected 2019 raw material supply. Creating a model to test maximum profit and

minimum cost if BI increased its market for popular products domestically and internationally can show just how far BI can push capabilities in the future with raw material inputs. Linear Programming was used to make this model and gives an accurate optimization point for production as well accurate fulfillment information. Test output can be used to find cost effective products for target markets. BI's target markets include large domestic finished furniture products, as well as negotiations with international companies in SEA, and even a bamboo housing company based in California looking to purchase semi-finished bamboo culms. BI has used 2017 demand levels to

Table 1.1 Demand Capabilities Test Using 2017 Supply Input						
	Chair	Table	Desk	Shelf	Blinds*	Semi-Finished Pole*
Average Sq M Used	0.8	3.49	3.13	4.6	90	1
2017 Demand	300	197	35	41	7.83	N/A
Average Cost to Make	\$34.10	\$173.60	\$173.60	\$325.50	\$412.43	\$1.20
Average Price	\$55.00	\$280.00	\$280.00	\$525.00	\$570.00	\$3.00
Test 1: Max Profit						
Production Output	300	197	35	501	7.85	6733
Cost of Production	\$10,230	\$34,199	\$6,076	\$163,076	\$3,238	\$8,080
Revenues	\$16,500	\$55,160	\$9,800	\$263,025	\$4,475	\$20,199
Profit	\$6,270	\$20,961	\$3,724	\$99,950	\$1,237	\$12,119
Total Cost	\$224,898		Total Revenues \$369,159			
Total Profit	\$144,261					
Test 2: Min Cost						
Production Output	2945	197	35	41	7.83	6737
Cost of Production	\$100,425	\$34,199	\$6,076	\$13,346	\$3,229	\$8,084
Revenues	\$161,975	\$55,160	\$9,800	\$21,525	\$4,463	\$20,211
Profit	\$61,551	\$20,961	\$3,724	\$8,180	\$1,234	\$12,127
Total Cost	\$165,359		Total Revenues \$273,134			
Total Profit	\$107,775					
* Blinds and semi-finished poles are sourced directly from farmers; furniture is sorced from processing groups as strips. Blinds are produced at 90 sq m per unit, and are later cut to meet demand specifications.						

set the lower bounds of demand. As for upper bounds, the tests have been run without a natural upper bounds to find the most cost effective and revenue optimizing products.

With a maximum profit of \$144,261 USD for test one due to the production of shelves price model, and a minimum cost of \$165,359 USD for test two due to the cost effective production of chairs, revenues have the potential to generate profit at BI. Within BI's supply chain, the highest cost of production is the bamboo board production. This takes most of the physical capital costs and staff in order to treat, dry, cut, glue, and press strips into board; the average cost per square

meter is \$39 USD. Shelves with the highest selling price made profit of over \$99,950 USD in test one due to having the highest gross profit margin. However, chairs made a profit of \$61,551 USD while accruing 62% less costs, and demand for chairs is much stronger. Using this analysis with an understanding of the current demand market of chairs, BI can increase chair production with little cost risk. It has a potential domestic demand for 2019 of over 300 chairs, and in SEA a client in Bali wants BI to make 2000 lazy chairs. Increase in the production and exportation of chairs will increase sales using the least amount of wood, freeing BI up to pursue other finished product markets domestically.

As for blinds and semi-finished products, both test one and two have a high output for semi-finished culms. Culms do not go through a machine heavy process and therefore decrease cost of production significantly. Within the model made, semi-finished culms are not only cost effective but they are the greatest source of revenue when competing for resources with blinds material. The cost of production for the blinds leaves BI at a greater risk if production was to increase without demand to match; profit margins are just too small for blinds.

	Chair	Table	Desk	Shelf	Blinds*	Semi-Finished Pole*
Average Sq M Used	0.8	3.49	3.13	4.6	90	1
2017 Demand	300	197	35	41	7.83	N/A
Average Cost to Make	\$34.10	\$173.60	\$173.60	\$325.50	\$412.43	\$1.20
Average Price	\$55.00	\$280.00	\$280.00	\$525.00	\$570.00	\$3.00
Test 1: Max Profit						
Production Output	300	197	35	890	7.85	16594
Cost of Production	\$10,230	\$34,199	\$6,076	\$289,695	\$3,238	\$19,913
Revenues	\$16,500	\$55,160	\$9,800	\$467,250	\$4,475	\$49,782
Profit	\$6,270	\$20,961	\$3,724	\$177,555	\$1,237	\$29,869
Total Cost	\$363,351		Total Revenues	\$602,967		
Total Profit	\$239,616					
Test 2: Min Cost						
Production Output	5184.15	197	35	41	7.83	16598
Cost of Production	\$176,780	\$34,199	\$6,076	\$13,346	\$3,229	\$19,918
Revenues	\$285,128	\$55,160	\$9,800	\$21,525	\$4,463	\$49,794
Profit	\$108,349	\$20,961	\$3,724	\$8,180	\$1,234	\$29,876
Total Cost	\$253,547		Total Revenues	\$425,870		
Total Profit	\$172,323					

* Blinds and semi-finished poles are sourced directly from farmers; furniture is sorced from processing groups as strips. Blinds are produced at 90 sq m per unit, and are later cut to meet demand specifications.

Results for 2019 raw supply input tests have similar production output patterns for chairs, shelves, and semi-finished culms, but at a much greater output. With \$67,000 USD planned allocation for raw supply purchases, supply input levels in 2019 will increase to 350,000 strips, making 5,133 square meters of bamboo board, and 18,125 culms. Estimated 2019 raw supply purchases will only exhausts 36 percent of BI's potential 506,000 culm raw supply. Even if BI tripled its allocated cost for raw supply purchases through its potential profit, supply exhaust would only reach 25 percent and available bamboo board would increase to over 15,400 square meters. Increasing production output in the 2019 resulted in a cost increase of 61 percent and 66 percent for profit for test one. Test two had a 53 percent cost increase and 59 percent profit increase. Testing capacity output levels with current trends withstanding can increase potential profit margins as output increases, as well as demonstrate which price points and products are more competitive. BI currently is being trained on these analysis methods and as demand increases and opportunities arise, they will be better equipped to make future business decisions on pricing points of products for certain target market international and domestic.

For instance, test one and two of 2017 and 2019 semi-finished culms produced a greater revenue stream than blinds. BI made around 20 units of blinds material in 2017, but demand was only 7.83 units. Reallocating labor and raw supply material from the blinds production line to process culms or toothpicks for exportation may give greater returns than operating the blinds production line at full capacity. Another example is that BI has a large domestic order of over \$150,000 worth of domestic office/school furniture for 2019 and can use this opportunity to test pricing points and design. Designing products that can meet incoming demand while also being cost effective will increase value added as a manufacturing facility. Production manager/designer, Mario, is able use the activity based costing database to compare material, labor, and overhead costs of product designs to find one that works for BI and customers. Once trained in using production output optimization, he can implement change at a fundamental level. When BI uses the full potential of physical, human, and technological capital, it has a better chance in completing the fourth goal: having complete financial sustainability and independence while contributing to economic development in Timor-Leste.

Conclusion

Domestic orders alone for 2019, and demand forecasted, could increase revenues upwards of \$300,000 USD, and could increase exponentially with exportation. This might not be much to a global market net worth of \$3.9 billion USD (TMI, 2017), but projected revenues will set the bamboo industry as a major contributor towards Timor's exportation of products and economic growth. Entering the international market and expanding the range of the domestic market takes investment expenditures. Potential 2019 revenues could increase to levels above the government budget set for BI. In the last three years, revenues have only reached 23 percent of total cost, and 27 percent of all manufacturing costs. As of 2018 revenues have reached just over 42 percent of total cost. BI is close to achieving financial independence, but a small budget can stifle major investment. Since BI is a public institute, revenues go straight back to the government. However, if BI had the option to use those revenues for investment it can launch its community value supply chain to new heights and increase production tenfold.

The community value supply chain BI created has generated over \$657,500 USD of finished product revenues with an average growth rate of 85 percent from 2009 to 2018. Investment into the supply chain has generated income for staff, nursery groups, farming groups, and processing groups of over \$1.25 Million USD from 2009 to 2017 with an average growth rate of 15 percent. Without the relationship between BI and its suppliers, product would not have the quality it has now, and BI would not have reached the capacity it has now. A business model founded by progressive green and sustainable beliefs, with a community driven culture is the result of almost a decade of work on this unified front. Bamboo Institute has infused modern business and supply chain practices with those beliefs and culture. The challenge now is growing beyond the capacity BI has now. Domestic demand at the time is stagnant and there is little marketing presence for BI.

If BI wants to continue being a case study, limitations need to be dissolved and challenges need to be met. Government funding might not have been a limitation in the past but now has adverse effects, as BI's budget is small and revenues cannot be utilized. Large investments are needed to increase production and supply, and maintain sustainability for future growth. Even grants might not be enough, as BI's ambitious goals to create guesthouses from bamboo and export product in bulk would dramatically increase expenditures; two challenges that, if met, will increase

revenues and lead to actual profit. BI cannot grow without internal and external analysis; marketing presence needs to be stronger and an understanding of the bamboo market in SEA is needed. Without the two, BI will not be able to utilize the capacity developed from the community value supply chain it has grown.