Supply Chain Innovation Effects on Supply Chain Efficiency in Teak Furniture Industry at Phrae Province

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Abstract

The purpose of the research was to study the innovation affects the supply chain efficiency and developed the highest efficiency of supply chain innovation in the teak furniture industry. As a result, chain 1 timber processing used operation innovation about wood defect classification of wood processing. Efficiency was benefiting 1,637.19 THB/m^3 and ROI 63.90%. Chain 2 making products used operation innovation about wood drying, increasing fire retardant of wood and designing innovation then efficiency was benefiting 3,293.43 THB/m^3 and ROI 18.81%. Chain 3 repairing used operation innovation about changing step of polish and painting. Efficiency was benefiting 2,009.95 THB/m^3 and ROI 45.78%. Chain 4 marketing used operation innovation about transportation service with a painter that efficiency was the reliability of entrepreneurs who can advantage of competitors. Chain 5 consumers got designing innovation that efficiency was consumers' purchase decision of teak products. Therefore, the development of supply chain innovation can improve the teak industry. As the model consists in quality control development, research, and development, value added product and marketing development that important for entrepreneurs who can advantage of competitors of business.

Keywords: 1) teak 2) furniture industry 3) supply chain 4) innovation 5) efficiency

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Background and importance of the problem

The teak furniture manufacturing industry in Phrae creates economic value in the province over 1,800 million baht per year and the teak industry is the main industry that has been packaged in the strategy for Economic and Infrastructure Development to create value-added in Phrae Province during the years 2015-2018 towards a furniture city and still in the strategic plan for the years 2018-2022 (Review Edition in 2022). Since this kind of industry needs a lot of investment, for example, the wood and wood products industry (doors, windows, construction planks, frames) costs an investment of 928.47 million baht and needs 2,729 workers. As for the wood furniture and furniture industry (cabinets, beds, sofa sets), its investment costs 585.48 million baht and needs 1,905 workers (Phrae Provincial Office, 2018). It needs skilled laborers for its main production and focuses on marketing at a discount rather than making a difference from the designs that emphasize the value of teak. This causes the industry to face market competition both within Phrae and from the outside using product designs that are consistent with the lifestyle and society of the new generation both from other materials to meet consumer demand. In the situation of the furniture industry in the first half of 2020, its output stood at 94.14 percent, contracting -5.57 percent. The risk factors for the furniture industry in 2020 (Tangon, 2020) include the spread of the COVID-19 virus, the contraction in the real estate sector, and more and more new importers and distributors of furniture coming in continuously. It causes high competition with the older operators in the market from cheap furniture from China and Vietnam.

In addition, due to the epidemic situation of the COVID-19 virus, the affected business in 2020 was the traditional wooden furniture manufacturing business. that lacks design and was labor-intensive (Matichonweekly, 2020). It made the older operators adjust their production to suit the best new consumers' behavior after quarantining and working from home resulting in a change in the behavior of purchasing products through more online channels. As a result, furniture entrepreneurs have to speed up their adaptation and turn to online marketing more including offering quality furniture with new innovations to meet the changing lifestyles of consumers.

The market outlook for furniture, home appliances, and home decorations in 2021 began to recover after Thailand eased its urban lockdown (Money and Banking Thailand, 2021). There are contributing factors during the Covid-19 period when people live at home to reduce the spread and more work-from-home style, increasing the volume of orders from foreign customers, especially for customers from India, China, America, and Japan. They get more furniture orders (BlueChip, 2021).

As for the European market in 2020, the volume of imported furniture by Hungary was increased by 2 percent, valued at 337.15 million USD. The designs or styles of home decoration that were popular and took the highest market share in Hungary were Scandinavian styles that emphasize the use of natural furniture and Minimalism style, which is a simple style that uses few pieces of furniture

(Department of International Trade Promotion at Budapest, 2021). It can be seen that, unlike other businesses, the furniture and home decoration business is still growing. Furniture sales online channels in IKEA, Thailand increased by 320% during May-June 2020 (Bangkokbiznews, 2020). This caused small furniture entrepreneurs to adjust their production, for example, the functions that served the needs of the customers. A piece of furniture should not be just a household item but must be an item that helps decorate the house to be beautiful and can be used at the same time. There should have a wide variety of product options, many convenient purchasing channels, value-for-money prices, and trustworthiness of operators including reliable delivery and customer service Besides, the furniture should have functionality that meets health needs (Money and Banking Thailand, 2021).

Although Teak products from Phrae are made from real wood, the production uses incomplete technology, such as not drying the wood, not decorating to hide the disadvantages of wood quality, lacking a variety of styles to choose from, etc., which affect the long-term use of the product and causing problems with wood shrinking, cracking, warping, etc. Therefore, upgrading and strengthening the Phrae teak industry can add value as well as reduce production costs by developing technology including the development of innovation as well the supply chain innovation factor. This is considered a very important factor to be taken into consideration in the industry. For example, the use of technology equipment and automation (IT solution) can result in accuracy, convenience, and speed. The database in the system can be analyzed for decision-making. Creating a new form of networking can create communication and exchange information between each other for business development. This is because supply chain innovation factors affect supply chain efficiency (Kongmanee, 2017, pp. 118-119), and supply chain innovation helps in product and service development, production cost reduction, and efficient use of raw materials in production (Seidiaghilabadi, et al., 2019, p. 321). This is due to consumer behavior that affects the decision to buy furniture and home decorations. Most consumers choose to buy the main material, which is real wood (Sriratana and Fusiri, 2020, p. 724), creating a channel to expand market opportunities (Pasesawas, 2017, pp. 58-59). Original products and new designs for every year are emphasized to keep the costs of production low to make the price of the products cheaper (Kusirivanitkorn, 2017, p. 109). Consumers focus on quality, practicality, and usability factors. followed by marketing promotion factors, distribution channels, and designs at the least. This research study is to design the knowledge management and to support appropriate knowledge, technology or innovation throughout the planning of market development to those involved in the industrial supply chain. It begins from the initial stage (wood handling/wood drying, chemical treatment) intermediate stage (furniture designs, furniture processing), increasing the production potential of the entrepreneurs, and teak processing to create a body of knowledge in the manufacturing process of teak products.

These are to make the teak have valuable use, and produce beautiful, high price, and high-quality production by selling more craftsmanship than selling teak. It also helps reduce the problem of using wood extravagantly but effectively which can lead to the success factor of the ultimate stage of the supply chain management. Therefore, the teak furniture industry in Phrae Province tries to adapt and develop on the technology and innovation, the burden of high management costs, and the inefficient demand management and delivery. Therefore, strategies and operating methods need to be adjusted. to create opportunities and a higher competitive advantage to upgrading the teak furniture industry of Phrae Province to have more quality in use.

Objectives of the Research Study

1. To study the innovations resulting in supply chain efficiency in the teak furniture industry in Phrae Province.

2. To investigate ways to develop innovations in the supply chain for maximizing efficiency in the teak furniture industry in Phrae Province.

Scopes of the Research Study

Study area: The target area for conducting the study was Sung Men District. because it was a district where most of the teak furniture industry was made and entrepreneurs were ready to participate in the project.

Data Collection

Population and samples: The population was the ones involved in the production supply chain, the entrepreneurs in the teak furniture industry in Phrae (manufacturing chains) from both community enterprises, and single entrepreneurs registered with the Phrae Provincial Office of Industry in 2018. There were altogether 1,510 factories and the samples were selected by a purposive sampling technique under a set of qualifications as criteria. The participants must be entrepreneurs grouped into a registered community enterprise with a strong association. The group of entrepreneurs has a network of operations at the sub-district level. It consists of four sub-district enterprises, namely Nam Cham Sub-district, Phra Luang Sub-district, Don Mun Sub-district, and Wiang Thong Sub-district. A total of 503 entrepreneurs participated in the project, comprising 76 community enterprises and 427 cooperative entrepreneurs.

The community enterprises consist of 19 Hua Dong furniture traders' community enterprises, 36 teak furniture community enterprises, and 21 SME Wiangthong community enterprises. The wood product service cooperatives were divided into 170 Hua Fai sapwood product service cooperatives and 257 Donmool wood product service cooperatives. There were 1,510 teak industry entrepreneurs in Phrae; therefore, the entrepreneurs who were network operators in the study account for 33.31% of the whole entrepreneurs in the province.

Consumers: The consumer population was unknown or indefinite. The sample size was calculated using a formula for an unknown population size formula with a 95 % confidence level and a 5% error ratio (Vanichbuncha, 2011,

p. 24). The formula used in the study was:

$$n = \frac{P(1-P)Z^2}{E^2}$$

where:

n= sample siz

P = the proportion of the population randomly selected (using a 50% proportion).

Z = the researcher-defined confidence level or statistical significance level. Z is equal to 1.96 at the 95% confidence level (0.05 level).

E = the maximum error that occurs. (corresponding to the Z value at that confidence level)

When the confidence level is 95% and the error ratio is 0.05, the sample size can be found as follows:

$$n = \frac{(0.5)(1-05)(1.96)^2}{(0.05)^2} = 384.16$$

Therefore, the optimum sample size for consumers under the mentioned criteria was 385. However, to facilitate the evaluation and analysis of the data, the researchers decided to use a total sample size of 400 customers which was regarded as meeting the criteria of not less than 385 samples.

Tools Used for Data Collection

Two sets of questionnaires were used, namely an Interview Form for Entrepreneurs and Consumer Questionnaires. The former tool consists of general information, production cost data, production yield data, marketing, and market development guidelines, etc. and the latter includes social data, purchasing information (type of teak products, designs, purchase goals), satisfaction with the products, problems, and suggestions for development that meet consumers' needs.

Data collection period: January 2019-June 2020

The data used in the study consisted of

Secondary data were pieces of information obtained from literature reviews and related research studies collected from various related journals and textbooks.

Primary data were pieces of information obtained from a survey using questionnaires with entrepreneurs in Sung Men District about production and consumers in Thailand about consumers' behavior.

Focus Group Meeting data were pieces of information gathered from concerned parties including entrepreneurs in the supply chains 1-3, experts in teak product development marketing specialists and researchers /academics to analyze the situations, problems, and obstacles in the whole industry, and brainstorming opinions from concerned entrepreneurs. The discussion topics were on how to develop product designs to enhance the competitiveness of the industry (product design guidelines, reducing production costs, rebranding, expanding marketing opportunities, etc.)

Research Hypothesis

Premise 1 (H1): Supply chain innovation in the teak furniture industry has a positive impact on supply chain efficiency in the teak furniture industry (supply chain efficiency).

Data Analysis

Quantitative data analyses were to investigate the cost-benefit and cost structure

of the products using CBA and ROI.

To conduct the Cost-Benefit Analysis (CBA), the formula below was applied (Mingmaninakin, 2007, p. 140):

TC = TFC + TVC.

Where:

TC = the total cost incurred by using different types of inputs in the production of many goods and services. It consists of total fixed costs (TFC) and total variable costs (TVC).

To conduct the Return on Investment (ROI), the formula below was applied (Kotler, et al., 2013, p. 59):

$$ROI = \frac{FCI - ICI}{ICI} * 100$$

Where:

ROI = Return on Investment

FCI = Final Cost of Investment

ICI = Initial Cost of Investment

The higher the rate of return on investment, the more effective an entity can manage its assets to benefit or generate income.

To analyze the supply chain innovation, the following aspects were taken into consideration, namely:

1) Design innovation is the designing of products for consumers by using the data from a survey of current consumer needs and design trends of furniture products that are popular at the present and in the future to make the products meet the market demand as much as possible. It aims to product design and to provide more choices for the consumers to have satisfaction and decide to purchase the products to support their business and increase income such as modern designs, internal restructuring to make the product lighter, and the designs to show the feeling of golden teak, etc.

2) Operation innovation is the steps and operational procedures by using the right technology and tools to make the production process highly efficient. This contributes to the creation of better product values such as the use of standardized wood drying methods, suitable equipment, and hidden-tool techniques to show the golden teak wood clearly.

Supply chain efficiency was determined from:

1) Supply chain profitability is the total profit shared by all the stages and intermediaries and depends on the supply chain management model to create cost and process management, create business opportunities, and create value, income, and profits for the business as much as possible.

2) Supply chain reliability is the qualifications of the operation of the supply chain with an efficient operating system until building credibility and trust in business

Research Findings

Based on the Supply Chain Analysis in the Community Market of Phrae Teak Furniture Industry, it was found that the supply chain consisted of 5 chains, namely: Chain 1: Teak Logs Processing, Chain 2: Product Forming, Chain 3: Defects, Sanding, and Painting, Chain 4: Market, and Chain 5: Consumers. A traditional door (Figure 1) and a prototype door (Figure 2) are used for comparison to provide details in each supply chain innovation as follows:

Chain 1: Teak Logs Processing is a process to turn a teak log or lumber into

planks. The raw materials are teak wood planted in private/public areas and have a medium quality. Most of them have a circumference of 70 centimeters, a length of 6 meters, and a cutting life of 10-15 years or more. On average, the lumberjacks had 13.7 years of working experience, and most of them learned how to do the job taught from generation to generation. Sawing tools and accessories include a 36-inch saw blade. Since their sawing technology was folk wisdom, it had to use accessories such as nails, jigs, or an angle ruler. They were devices for making wood to have the right angles and wood planks of the desired sizes.

Innovations that help to upgrade products in the community market include innovations in the pre-processing assessment of the plank sizes. There is a procedure to measure the circumference of all 3 positions, namely base, middle, and tip. The lumberjacks must learn how to choose the area with the smallest circumference, the area where the log is mostly straight, and the wood with the least defects such as eyes, cracks, holes, etc. They must learn also how to estimate the size of the wood planks before sawing, the size of the saw kerfs, and the bark section into consideration to reduce the loss of wood and use a jig to hold the wood while sawing to help determine the size of the wood accurately.

The use of technology to develop the supply chain for the processing of teak logs into planks. Sawmills should have regular maintenance on their saw blades. Saw blades should be sharpened every 6 m3 in wood sawing, resulting in sharp and precise sawing, saving time, increasing workplace safety, and reducing the loss of wood.

The efficiency resulting from the cost of transforming logs into planks consists of the main costs as follows: Log costs 1,500 baht/cu.m., sawing labor costs 420 baht/cu.m. and other costs 642.11 baht/cu.m., so the total cost of sawing is 2,562.11 baht/cu.m. Total income is 4,199.30 baht/cu.m., accounted for revenue over cash cost 1,803.21 baht/cu.m. and revenue above total cost is 1,637.19 baht/cu.m. The return on investment (ROI) is 63.90% This is because the processing of turning teak logs into planks in the community market uses wood sawing technology as folk wisdom. The transformation of the innovative use of prefabricated wood size assessment requires the skill and experience of the carpenter. This takes some time to adjust. The change in the rate of return on investment is therefore the same.

Chain 2: Forming products Most of the entrepreneurs in the community markets dry their wood planks in the sun to reduce humidity and reduce the cost of drying the wood. Sun exposure takes about 30 days. Problems arising from sun exposure are warping of wood used to make products because the wood still has moisture. Forming products is the use of craftsmen to assemble various parts with air gun firing technology and hot glue application. They use an assembly technique by avoiding sapwood and trying to show off the best part of the wood. It is a work that does not emphasize refinement but focuses on making large quantities. The moisture content of the wood from which the door is made is more

than 18 percent.

The innovation that helps in upgrading products in the community market is the innovation of wood drying before being molded, and it helps to make the product have more quality. Making use of a wood pressing machine makes the carpenters get the correct and consistent wood sizes. Innovation in the design of Scandinavian Minimalism prototype pro-ducts takes into consideration of the practical use of furniture and the reduction of wood. In addition, the innovative implementation to add fire retardant properties into the production of doors was introduced. The wood was treated by a full-cell process and a steeping treatment with ammonium compound concentrations of 1% and 5%. The products were later tested at the Analytical Testing and Standardization Center at the Institute of Textile Industry Development. It was found that such products were fire retardant and passed the ISO 3795 standard.

Using technology to develop a product forming supply chain Using the cutter heads makes the tongue groove fast and accurate. When measuring with a Vernier Caliper, the part is cut to size according to the design resulting in easier assembly. With 45-degree chamfering and the remaining space of the upper and lower sash parts, this gives the wood a space to stretch and shrink to prevent warping and cracking. Changing the use of hot glue to PVAC glue reduces the use of maceration that may cause defects on the surface of the workpiece. Instead, the carpenters were trained to use inserting methods for joining wood, such as using glue, screws, dowels, and angular shooting. or making a door frame with interlocking plywood.

The efficiency of the traditional door molding has a total cost of 17,620.51 baht/cu.m., total revenue is 19,800 baht/cu.m., accounted for revenue over cash costs of 2,443.95 baht/cu.m., revenue over the total cost of 2,179.49 baht/cu.m. The return on investment (ROI) is 12.37%. The prototype door has a total cost of 17,506.57 baht/cu.m., total revenue is 20,800 baht/cu.m., with revenue above the cash cost of 3,537.68 baht/cu.m. and the revenue above total cost is 3,293.43 baht/cu.m. The Return on Investment (ROI) is 18.81% and it was found a positive impact on efficiency. The change in the Return on Investment (ROI) was increased by 6.44%.

Chain 3: Defect hiding, sanding, and painting. Traditionally, sanding and painting are the corrections of defects in the wood. Using glue, sawdust, and wood chips in filling the defects of the wood and followed by polishing and coloring the products rapidly about 1-2 times using a paintbrush. The problem is that the color is not smooth and neat. The color is not consistent throughout the piece. Painters have mostly been taught from generation to generation. The process of covering defects is sanding with a coarse sandpaper 1 round, painted by paint with shellac 1 round. To cover all defects, all products are using glue, sawdust, wood chips, and paint powder. It takes 5 minutes to finish 1 door and 1 worker. Polishing a piece of product is done by a simple sanding technique only 1 round using coarse sandpaper and 1 cycle of lacquer paint. This takes 10 minutes.

The innovation that helps to enhance the product in the community market is the action innovation of changing the polishing process. It begins with the process of using fine sandpaper starting from Nos. 80, 320 and No. 400. This process helps to make the polishing more refined. Normally, only sandpapers No. 320 are used to sand the entire workpiece.

The use of technology to develop supply chains for covering the wood defects, polishing, and painting. A pre-assembly polishing step is added to reduce the polishing work of painters, the labor costs for painting, the polishing damages after fabrication, and the cost of painting. Coloring should focus on natural colors that show wood texture. It is recommended to use a high-resolution spray gun so that the colors are consistent.

The efficiency of covering wood defects, polishing, and painting of the traditional door has a total cost of 5,658.14 baht/cu.m., total revenue is 7,200 baht/cu.m., based on revenue above the cash cost of 2,169.17 baht/cu.m. and a total cost is 1,541.86 baht/cu.m. The Return on Investment (ROI) is 27.25%. As for the covering of wood defects, polishing, and painting of prototype doors, the total cost is 4,390.05 baht/cu.m., total revenue is 6,400 baht/cu.m., and the income above cash cost is 2,564.38 baht/cu.m., and the income above total cost is 2,009.95 baht/cu.m. A 45.78%. The Return on Investment (ROI) was found to have a positive impact on efficiency. The change in return on investment (ROI) was increased by 18.53%.

Chain 4: The market. There are 49 places selling products in front of the shops in Sung Men District, 9 places in Den Chai District, and 47 places selling the teak products online via Facebook. As for the product transportation system, the traders or the buyers take care of the transportation themselves. The retail market share is 32.50% while the wholesale products are produced by middlemen both in the provinces and upcountry coming to order the products and entrepreneurs produce products according to the orders. It is sold at a lower price than that of the retail due to being sold in large quantities and is transported by pickup trucks or large trucks. The wholesale market share is 77.50%. The products are sent to the central region, namely Bangkok and its surrounding areas, Ratchaburi and Chachoengsao, the eastern region, namely Chonburi and Rayong, the northeastern region, namely Mukdahan, Buriram, and Nakhon Ratchasima, the northern region like Chiang Mai, and Chiang Rai, and the southern region like Phuket, Nakhon Si-Thammarat, Pattani, Yala, and Narathiwat. Under the law by the Office of Natural Resources and the Environment in Phrae Province, to transport goods to other provinces legally, the traders must have documents such as a book of inventions, appliances, or any other thing made of restricted wood, trade license, or possession for commercial purposes of inventions, appliances or any other thing made of restricted wood and a list of inventions, utensils or any other thing made of restricted wood.

At present, there are 48 transportation operators by trucks, representing 88.89%. Some companies provide transportation for woodworking such as Nim See Seng Express.

There are 6 private transport companies representing 11.11% that provide wood product transportation by four-wheeled pickup trucks. Transportation price depends on the lowest cost price that occurs in the manufacture of a door (product) sized 1 x 2 meters which, on average, is 1,000-1,100 baht. There is no packaging in the community market. The products are stacked up in a truck for transportation and ready for sale.

The innovation that helps to upgrade the product in the community market is to increase the marketing options. by using the innovation of transport service operations of the entrepreneurs to have paint technicians going with the rucks. They are to repair the products when damage occurs during the transportation for the customers in case of, they buy them in front of their shops as an after-sales service.

Qualitative efficiency. The entrepreneurs who can do business for a long time in the market are those who can reduce the cost of their products to the lowest to sell them as many as possible. They expand their selling volumes more via online marketing channels to increase new customer bases. They make use of transport services of private companies to reduce the cost of buying a truck, to reduce the cost of time spent traveling to deliver goods, and to facilitate customers by home delivery.

In addition, if a transport company accepting the woodwork transportation has a skilled painter selected by the entrepreneur and going with the truck to repair the work when damage occurs during the transportation to the customer as an after-sales service. This is a way to create efficiency in reliability for the entrepreneur because their products are prototypes used for market testing using online questionnaires.

In the case that the selling price increases by 7.6% from the total cost, which is the normal selling price that the entrepreneur sells, the price of a prototype door is 3,500 baht with a total cost of 3,250.4 net income above the total cost of 249.6 baht. In case the selling price increases by 16.9 percent from the total cost, which is obtained from the selling price inquired online, the price of the prototype door is 3,800 baht, generating net income above the total cost of 549.60 baht. It was found that a positive impact on the efficiency in marketing is the price set in case the selling price increases by about 16.9% from the total cost, and this is the price that 79.3% of the consumers are satisfied with.

Chain 5: Consumers. Approximately, 93% of consumers want the wood that makes furniture of good quality (strong, durable, and aged wood), lightweight, and beautiful wood grain. About 77.5% of them want good design, modern, exquisite and beautiful furniture with a variety of styles, ease of use, just the right size, not too big and not too heavy. It should be used to decorate a variety of places and suit best their spaces. Besides, 90.9% of them think that the price of furniture sold in Phrae is appropriate for the quality of wood, designs, and types of furniture.

In addition, 41.7% of the consumers think that the problem of teak furniture in Phrae Province is that the designs are not

modern, the products have the same characteristics, their quality is fair and they are heavy. As for the market share, former consumers in the local market or northern wholesale market and northeast market buy teak products from Phrae because they are confident in the value of genuine teak and cheap prices. They want the products made from teak and paint it in a teak style and want to have transportation services and after-sales service.

The innovation that helps to enhance the product in the community market is the innovation of the product design implementation. More variety of information about the product properties such as using teak wood from private areas, dried wood, etc. is provided to consumers for their purchasing decisions.

Qualitative efficiency. The consumers have a demand for a variety of products to choose from and have confidence in the wood that has been dried to make the product have better quality. As a prototype product, the market was tested using online questionnaires. It was found that the consumers gave reasons for their decision to purchase teak products based on the price as their priority at 79.3%, followed by product styles at 17.8% and wood properties, and drying at 2.9%.

Picture No. 1
The traditional door

Picture No. 2
The prototype door

Discussion of the Findings

As for supply chain analysis, when the set hypothesis 1 (H1): "Supply chain innovation in the teak furniture industry has a positive impact on the supply chain efficiency in the teak furniture industry" was tested, it was found that the innovation development guidelines in the supply chain for the upgrading of Phrae teak furniture industry are as follows: (Table No. 1).

In Chain 1 is the choosing of teak logs or lumbers to make furniture products. Most of the teak is 10-15 years old. The carpenters must consider the properties of the teak wood such as its texture, color, and grain. The lumber must be considered to obtain a teak that is suitable for production (Thulasidas and Baillères, 2017, p. 75). This is in line with the research on mechanical properties testing of teak plantations in the Thong Pha Phum

Plantation Area in Kanchanaburi Province that (Pramchot, Piromgarn and Chavises, 2018, pp. 276-277) 15-year-old teak has medium hard-wood, its core is brown, and the sapwood is quite yellow-white to yellow-brown. There is a clear distinction between the sapwood and its core. It also had moderate natural durability. The result of the mechanical properties test reveals that its moisture content is equal to 11.83. The teak wood used as raw material in the production can enhance the product by increasing the cost of teak from 1,500 baht/cu.m. to 4,800 baht/cu.m. It will make the product have more quality in terms of wood. This is consistent with the work of the Forest Industry Organization (Promyanon, et al., 2019, p. 890) that it is planted and maintained according to academic principles until it has a size that can be a product. When it is at the age suitable for cutting, the teak tree will go into the production process to produce teak logs. This kind of teak wood management makes the forest parks sustainably according to international standards of the FSC (Forest Stewardship Council). This concept is corresponding to the teak furniture trade in Indonesia (Purnomo, Guizol and Muhtaman, 2007, p. 414) of SMEs groups that focus on the development of teak trees from planting to making good quality wood for premium grade products. This will raise the level of the teak furniture business equally and sustainably. An innovative approach to assessing the size of planks before fabrication by measuring the circumference of the log in 3 locations: trunk, middle, and tip. The carpenters should select the area with the smallest circumference and where the log is mostly straight. They also should choose the wood with the least defects such as gnarls, cracks, holes, etc. This is consistent with the work of Bennett (Bennett, 2014, p.2) who says that a log with a seam diagram when sawn by a flip saw technique, it results in a large quantity of processed wood. An assessment of the size of a plank from a teak log before sawing should consider the size of the saw kerfs and the bark section to reduce the loss of wood for it affects the efficiency to reduce wood loss and the Return on Investment (ROI) is 63.90%.

Chain 2: Product forming method. It contributes to different quality products due to the exquisite forming that differs from skilled craftsmen who require a longer working time doing each piece of a product including standardized wood drying before being formed. This process corresponds to the development of quality products by having teak wood dried before being used for production (Pankhaw and Suksard, 2014, pp. 33-34). This makes it possible to control the quality of the products according to the needs of customers and to make various types of products. As a result, it can be sold at a higher price than before. The same teak products of an entrepreneur may differ in patterns, carvings, and colors. A carpenter working longer hours to produce a workpiece with more details used to receive 300 baht/day for his wage, but it is increased to 400 baht/day. The supply chain management on product model affects supply chain management starting from the selection of raw materials, vendors of raw materials, and product distribution (Bumgardner and Nicholls, 2020, p. 4), as well as the use of pre-dried

wood as a raw material before forming the products, makes them have good quality. The products built along the concepts of Scandinavian minimalists should emphasize the practical and functional efficiency of each product which leads to its value-added. Consideration of the texture of wood leads to better product development (Dong, et al., 2020, p. 6) and innovative action adding flame retardant properties affects a positive impact on efficiency. The change in the Return on Investment (ROI) was increased by 6.44%.

Chain 3: Polishing and painting. When good wood raw materials and more refined forming are used, as a result, polishing and painting use fewer materials and equipment. It is an emphasis on showing off the golden teak texture rather than dyeing the wood. This agrees with the selection of natural colors for the pine furniture industry (Suwannasre, Egwutvongsa and Seviset, 2017, p. 153). Using a natural dyeing process makes furniture look like natural materials that show the colors and patterns of the material very well and have strength. Making dyes is the most suitable color-making process. In addition, the teak wood entrepreneurs of Phrae Province should emphasize the number of working hours of the carpenters to polish the whole workpiece neatly until they are shining. Polishers and painters have a labor cost of 300 baht/day and it was increased to 400 baht/day. Innovative action changes the polishing process yielded a positive impact on efficiency. The change in the Return on Investment (ROI) was increased by 18.53%/.

Chain 4: Marketing. The entrepreneurs who can reduce the cost to the lowest to sell their products as many as possible sell the products in front of their stores and booths to sell merchandise at festivals. The findings agree with what was found that most of the sales of wooden furniture were sold at festivals or from an invitation to attend the OTOP trade show from government agencies (Khanongnuch and Muangwai, 2020, p. 74). Thus, this kind of trading causes inventories which leads to a wasted cost of maintenance. Innovative operations to reduce costs to a minimum, and innovative transportation service of entrepreneurs to have painters going with their trucks to repair the products in case of installation in front of the shops as an after-sales service, affect performance efficiency. They create efficiency in reliability for the entrepreneurs and have a positive impact on marketing efficiency. That is the selling price level should be set to increase 16.9% from the total cost and this makes, 79.3 % of the consumers satisfied.

Chain 5: Developing product quality. This is done by drying the teak wood and informing the consumers of the properties of the products for their purchasing decisions. They also give reasons for their decision to buy teak products by considering their prices for the priority. This corresponds to the finding that the price affects the decision of customers to buy furniture and home furnishings. (Sriratana and Fusiri, 2020, p. 724). It is followed by product designs and other factors, such as the properties of wood and wood drying. Consumers emphasize most on the strength, durability, and long service life of the products,

a variety of designs to choose from, and their beautiful and modern styles (Mothong and Ngarmsak, 2017, p. 123). Besides, the findings from a research study on the development of the rubberwood furniture industry for export (Sangsuwan, Vuddhimethi and Jarusombuti, 2019, p. 82) suggest the customer relationship management on marketing and sales. It was found that each entrepreneur is responsible for marketing and distribution according to his/her knowledge and experience. This makes the knowledge of each business organization different. The products are then different according to the organization. As a result, it is difficult to inspect and measure production standards and product warranty depending on each manufacturer. There is a lack of a center for contacting customers related to the rubberwood furniture industry. A wide range of innovative product designs affects efficiency. This is to create efficiency in purchasing teak products. It has a positive impact on considering consumer behavior towards purchasing decisions. The consumers made their purchase decision based on the price of the product first at 79.3%, followed by product designs at 17.8% and wood properties and wood drying at 2.9%.

Table No. 1 Innovations Affecting Supply Chain Efficiency in the Teak Furniture Industry

Supply Chain	Innovation	Efficiency
Chain 1: Processing teak logs into planks	- An innovative approach to assessing the size of planks before processing.	- to reduce the loss of wood - ROI = 63.90% - The change in ROI remains the same.
Chain 2: Forming products	- Innovation of wood drying before being molded - Innovation in the design of prototype products in Scandinavian minimalist style - Innovative action adds flame retardant properties.	- ROI = 18.81% - Positive impact on performance. The change in ROI was increased by 6.44%
Chain 3: Covering defects, polishing, and coloring	- Innovative action changes the polishing process.	- ROI = 45.78% - Positive impact on performance. The change in ROI was increased by 18.53%
Chain 4: Marketing	- Innovative transportation service of entrepreneurs with painters going with the trucks.	- This is to create efficiency in reliability for entrepreneurs. - To have a positive impact on marketing efficiency, the selling price should be set to increase 16.9% from the total cost, which is a price that 79.3% of consumers are satisfied with.

Supply Chain	Innovation	Efficiency
Chain 5: Consumers	- Various product design innovations	- This is to create efficiency in purchasing teak products. - Positively affects the consideration of consumer behavior towards purchasing Consumers made their purchase decision based on the price of the product first at 79.3%, followed by product form at 17.8% and wood properties and drying 2.9%.

Conclusion

A summary of innovation development guidelines in each supply chain to achieve the efficiency in upgrading the Phrae teak industry in line with the changes of today's consumers in business, technology, and purchasing behavior can be divided into 4 areas as follows: 1) In terms of increasing productivity, improving quality, and reducing production costs, more steam plants for drying teak wood should be built to be sufficient for the development of Phrae teak product standards. Establish a quality certification standard for wood that has been dried to build consumers' confidence. Promote the integration of more community enterprises and strengthen the management within the organization. 2) As for research and development (R&D) and product design, there should be developed on knock-down furniture to be up-to-date and suitable for use in the present. 3) To have the added value of the product, there should be more promotion and training in product design to have more variety. Encourage entrepreneurs to realize the importance of proper packaging and the use of packaging to suit each type of product. Finally, 4) in terms of marketing system development, there should be a training course for entrepreneurs who are interested in developing online sales or finding an organization or network that provides entrepreneurs with no expertise to meet new web developers or new marketers. This is to make them have guidelines for developing sales channels to meet the needs of today's consumers.

Suggestions

1. Suggestions for applying research findings as guidelines for solving new supply chain problems.

For community markets in each supply chain, there are 5 chains as follows: **Chain 1: Teak Logs or Lumbers.** There should be sawmill skill development training for lumberjacks who estimate the size of the teak wood planks before sawing to reduce the loss of wood. Develop sawing technology to be more standardized, to make the planks have the right angles, and to reduce the loss of wood from sawing. **Chain 2: Forming products.** The wood should be dried before being formed a product. This helps to increase its quality. Make use of suitable materials and equipment for accuracy and precision in the measurement of wood,

for example, using vernier calipers, and angle gauges. Form more refined products using glue, screws, or dowels to make the product stronger. **Chain 3: Polishing.** There should be training for improving the craftsman's skill in polishing and making the paint more refined by using an appropriate sandpaper number in each step of sanding and using a spray gun to help smooth the skin. **Chain 4: Marketing.** There should be more online marketing channels to give more choices for consumers. Make more use of private transportation services to reduce the transportation cost of the entrepreneurs. **Chain 5: Consumers.** There should be a development of products quality by drying the teak wood and informing consumers of their properties for purchasing decisions including product warranty.

2. Suggestions for further research studies

There should be research studies on improving product quality with wood drying technology, establishing a quality certification standard for wood that has been dried to build consumers' confidence. There should also be research studies on the development and product design with the development of product designs that can be disassembled or "do it yourself" (D.I.Y.) to be up-to-date and suitable for today's use. Besides, there should be research studies on the development of the online marketing system of the teak furniture industry. This is due to the changing nature of the market in today's era that consumer behavior has shifted to more online shopping, to access to more consumers, and to create an understanding of the price and quality of the product that consumers will receive.

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