Research Article

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Eco-Economy: Utilization of Sapwood Scraps for Sustainable Economic Value in Communities

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Abstract

The objective of this research was to design furniture products from the sapwood of teak trees aged between 7-14 years with lining up for planting. Moreover, the results of the newly developed furniture design were analyzed with a structural equation model from the required level for furniture products made from sapwood waste. The population comprised one hundred and two consumers of teak products who visited the exhibition from on 10th at Rajamangala University of Technology Isan in Nakhon Ratchasima Province. In addition, the sample group included eighty consumers of teak products who visited Exhibition on 10th using Krejcie & Morgan random sampling table and simple random sampling. In this case, the research tool was a structured questionnaire to be measured by using a 5-level Likert rating scale and a Cronbach's Alpha coefficient of 0.813. Accordingly, it was considered to be at a suitable level by using Confirmatory Factor Analysis (CFA) with the results shown as $\chi^2 = 15.703$, $df = 32$, relative $\chi^2 = .491$, $p = .993$, RMSEA = .000, RMR = .020, GFI = .967, AGFI=.920, NFI = .950, TLI = 1.137, CFI = 1.000. In this case, it can be concluded that the feelings that affect consumer demand for products consist of 4 main factors with the characteristics of the material, social currency factor, behavioral expression factor, and market demand factor, among others.

Keywords: *Eco-economy, Product design, Furniture, Teak, Sapwood, Designing*

1. Introduction

According to the Royal Initiative Plant Genetic Conservation Project of Her Royal Highness Princess Maha Chakri Sirindhorn, guidelines have been established for activities to promote environmental investment models as well as strengthen and create prosperity for the community of farmers participating in the economic teak planting project. Besides, it enables the promotion of the use of natural resources arising from the cultivation of the private sector's teak plantations jointly by expressing the intention to create a large number of green areas in Thailand. In the same way, it generates economic income for farmers in the private sector's Pasak plantation areas in a dependent manner. Thus, it has become a balance in the ecological economy that can conserve forests while generating income to nourish the community through a sustainable development approach. In this case, it can create sustainability in the community and enable the use of the teak planted economically to meet the market demand since the teak tree is unique to Thailand as a source for

gaining high economic value. Significantly, teak is strong and resistant to insects as well as having beautiful patterns. Consequently, it is preferred by furniture and home decoration factories. Therefore, it could be used to create economic value for Thailand in the form of export products because teak wood is unique and more colorful than other types of wood. Thus, it follows that teak trees are planted in private forest plantations, especially with the support from the government of Thailand, to enable the area of private forest plantations to be continuously expanded. nowadays, farmers are turning to occupations at teak plantations in large numbers in the northern and northeastern regions of Thailand, which involve planting at teak plantations economically. On the other hand, it concerns the Sustainable Forest Management (SFM) principles in line with the global environmental volatility of the 21st century, which aims to 1) maintain teak, 2) increase economic value, 3) strengthen the society, and 4) conserve the environment of the forest area and others. Thus, it requires the needs of human beings in the present and future in the manner of balancing forest conservation and the sustainable use of forests under the Convention on Biological Diversity (Sessin-Dilascio *et al.*, 2015). Further, it was established by the International Union on Conservation (IUCN) which has guidelines for sustainable forest management on biodiversity and people's livelihoods (Sustainable Forest Management, Biodiversity and Livelihoods). In the same way, teak forests will be prepared every 5 years continuously until the teak trees reach the age of 20, after which the teak trees are cut and sold as high-value sheet lumber (Nolte *et al.*, 2018). When it reaches 1-20 years, farmers will cut the extended terms four times in spans of 5 years, 10 years, 15 years and 20 years. Finally, it will be completed to expand the rows planted with numerous teak trees. As a result, a large number of young teak logs can reach the market each year. On the other hand, the teak that can be cut and carded does not generate much income for farmers due to the young age for expanding with the planting rows with limitations: 1) The size of the small trunk is below standard for wood sheet processing, 2) not much usable wood, 3) the excessive softness of wood, and 4) more wings for trunks than the wood and others. In this case, the research aims to develop a process for using sapwood and young teak aged between 7-14 years from the cutting process during the planting phase to be used for planting. Besides, it is related to the production of furniture products to meet the needs of consumers by presenting the process of sapwood scraps from teak wood with sizes from 1-3 cm to add value to production from doing research (Egwutvongsa, 2021).

Figure 1: The process of pruning teak trees in the planting area
Source: Author

Figure 2: Teak logs obtained from the cutting phase: Part of the Wing of Teak and Part of Teak
Source: Author

The research was carried out under the concept of creating a link between the forest and the people surrounding the economic forest plantation area, where teak is planted for the benefit of both parties. Moreover, it involves the nature of the balance between conservation and sustainable use following the Convention on Biological Diversity and the International Union for Conservation (IUCN) (Kumar *et al*., 2019). The leftover teak wings from wood plank processing can be used again by transforming the sapwood, and teak can be recycled by modifying the material's characteristics to reflect environmental responsibility while reducing the potential environmental impact on a sustainable basis. Thus, it is possible to search for ways to create furniture from sapwood and young teak wood using a conceptual framework for designing furniture that is suitable for the needs of consumers in the market. This was reflected through research concerning the way of learning, awareness and practice that led to the development of furniture design patterns made from sapwood in accordance with young age from the present and the future (Egwutvongsa *et al*., 2021; Anand *et al*., 2010).

2. Objectives

1. To design furniture made with sapwood from young teak aged between 7-14 years old.
2. To model a structural equation for the feeling of need for furniture made from sapwood teak.

3. Research of Conceptual Framework

The opportunities for economic competition focus on exporting furniture by showing the identity of one's locality to the world market, including the creation of opportunities to bring the displayed products for expressing responsibility to the environment. Besides, it shows the strength of the locality to be able to build socio-economic stability appropriately with new advantages from the creation of the model furniture in the industry to help promote opportunities. Then, it can be successful in a highly competitive market by learning and developing their own furniture for market demand during that time (Porter, 1985).

It has the creativity to stimulate innovations that appear in the form of new products and new processes to represent novelty while adding value to innovations: 1) Creating Benefits for Users, 2) and Creating an Increase in Economic Value for Producers (Egwutvongsa, 2021). The details are as follows:

- Developing a new and more efficient production process to increase productivity as well as reduce production costs and other aspects by using systematic troubleshooting techniques to find the possibility of designing new products; it becomes a solution to the design problems.
- Innovation development aims to meet the needs of consumers by expressing the desire to be successful per these details: 1) Creating value for users (User Desirability), 2) Creating more business value (Business Viability), 3) Technical feasibility, and 4) Having the participation of related parties (Collaboration).
- Developing innovation to help create added value for the economy until becoming a new business, called Business Model Innovation, that expands the market or its consumer group to a greater number.

Table 1: Conceptual Framework in the Research

Consumer Demand Towards Furniture from Scraps of Young Teak aged between 7-14 Years Old		
Development of Material Forming Techniques	**New Furniture Design**	**Structural Equation Modeling**
1.Trimming a Piece of Wood 2.Drying the Wood to Maintain the Condition and Reduce the Warping of the Wings of Teak (sapwood) 3.Bonding by Pressing Technique to Make the Sheet Material to be Interlocked (Ntalos *et al*., 2002; McKillop *et al*., 1980).	1.Find Solutions to Design Problems with Quality Function Deployment Method: QFD. 2.Apply the Resulting Solution to the Product Design (Jafari, 2013; Zare Mehrjerdi, 2010; Gremyr *et al*., 2013).	Finding the factors that affect the feeling of wanting to use new furniture of consumers. that show demand has been met by new products, (Yuan *et al*., 2006): 1)Price 2)Convenience 3)Experience 4)Ease of Use 5)Reliability 6)Product Quality 7)Product Performance 8)Consistency with Lifestyle

Source: Author

4. Research Scope

1. Scope of research on furniture design made with sapwood from young teak aged between 7-14 years, and obtained from cutting the spacing between rows of teak planting by developing a method for the utilization of young teak sapwood and solving problems in the design of furniture that use such materials, or called the coordination of teak scraps.
   - The population is the consumers of teak products participating in the Thai Resources Exhibition: Overflowing Potential at Chulalongkorn University in Saraburi Province, Thailand in the exhibition booth at King Mongkut's Institute of Technology Ladkrabang totaling 150 people.
   - The sample group comprised the consumers of teak products who participated in the Thai Resources Exhibition: Overflowing Potential at Chulalongkorn University in Saraburi Province, Thailand in the exhibition booth of King Mongkut's Institute of Technology Ladkrabang, totaling 108 people using the random sampling table of Krejcie & Morgan with a sample size error of 0.05 as well as random sampling with a simple example, or Simple Random Sampling.
   - The research tool was a structured questionnaire that asked for information concerning consumer demand for furniture from teak wood chips by measuring the values using a 5-level Likert rating scale with confidence with an alpha coefficient (Cronbach's Alpha) = 0.809 to be considered at a suitable level.
   - Analysis is an examination using the Quality Function Deployment (QFD) Method.
2. Scope of research modeling for the structural equation with the feeling of need for furniture made from young teak sapwood will be searched for new furniture design factors that can meet the needs of consumers.
   - Population is consumers of teak products participating in Exhibition on 10th with title "Thai Resources Thai Villagers Benefit" at Rajamangala University of Technology Isan in Nakhon Ratchasima Province, Thailand totaling 102 people.
   - The sample group is consumers of teak products participating in the Plant Genetic Conservation Project Exhibition under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn on the 10th at Nong Rawiang Center Rajamangala University of Technology Isan in Nakorn Ratchasima Province, Thailand totaling 80 people by using Krejcie & Morgan's random sampling table with a sample error of 0.05 and Simple Random Sampling.
   - The research tool was a structured questionnaire that asked for information on consumer

perceptions of furniture usage from teak wood chips. Moreover, the ratings comprised a 5-level Likert scale with Cronbach's Alpha coefficient = 0.813, which was considered to be a suitable level.

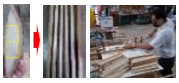
- Analyses were Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA).

5. Results and Discussion

The results of furniture design from teak sap scraps between 7-14 years old arising from cutting the distance between the rows of teak planting can be classified into 4 steps as follows:

Step 1: Development process of forming materials from sapwood scraps and young teak trees obtained from teak plantations in Nakhon Ratchasima Province, Thailand by cutting the distance between the teak planting rows. Moreover, the teak was processed into ready-to-use teak sheets and the fraction of sapwood was taken on four sides of the teak trunk to prepare for transformation.

Table 2: Process of Transforming Sapwood Scraps, Young Teak Plants from the Spacing Process between Planting Rows

Attribute	Analysis of Results
The process of cutting the overgrowth 	◦ It spaces between the teak planting rows for the 7th and 14th years of teak planting. ◦ Farmers growing teak cut incomplete or overgrown teak branches from the fields to prevent insects and allow sunlight to reach the ground.
The process of processing wood from teak trees 	◦ It has brought the teak trunks from the cuttings during the 7-14 year period to transform into teak boards for sale. Then, the processing will have leftovers, such as the wings of teak on the sides of the trunk on all 4 sides, which is a lot of leftovers. and not being used ◦ As for the wood, there are few small samples. They are not the same size, so it is difficult to transform wood sapwood scraps for use.
Procedure for preparing wood chips before processing for use 	◦ It involves the separation of wood chips with wood attached to form and dry to reduce warpage when forming. ◦ The wood shavings have an average size of 10 x 8 x 200 centimeters, with only 50 % of the wood inserted in the sapwood, and the remaining 50 % being the teak bark.
Process of transforming teak wings 	◦ It involves the transforming of the slats into smaller pieces, trimmed pieces of wood with an average size of 1.5 x 1.5 x 120 cm. ◦ It obtained logs from sapwood, teak, and dry the wood completely to prevent warping of the logs.
The process of brazing in the forming of teak boards 	◦ Make the transformed teak logs into small logs and bind them together with a polymer wood binder to be soldered for 24 hours. ◦ Remove the bonding veneer from the hydraulic press and leave it for 24 hours for the veneer to join together and dry completely.

Source: Author

Step 2: QFD analysis to find problems of traditional furniture that exist in the market today with consumer demand

a. The process of listening to the needs of consumers (n=108), where consumers express their opinions on the demand for furniture from sapwood, teak from the voices reflecting the needs and factors affecting the decision to buy furniture from consumers.

Table 3: Consumer Demand in the Process of Listening to Consumer Feedback (VOC)

Entry-level Requirements	Secondary Requirements	Problem Solving Needs
Material specifications	A1: It has the material of sapwood, young teak with a soft wood texture.	It has produced products that do not require strength.
	A2: The size of the wood is small.	It uses the veneer forming technique.
	A3: The material of sapwood or teak must be transformed before being used.	It has easy transformation and convenient forming.
	A4: The material is not popular in the market.	The shape of the product is suitable for the era.
	A5: The wood is not strong and can bear little weight.	It has wood drying and dehumidification.
	A6: The wood has few patterns and light colors.	The product does not focus on showing the wood.
Production process and creation	B1: Multiple transformation processes are required.	It can reduce the transformation process.
	B2: It has high conversion costs.	It can reduce processing costs
	B3: It requires high-level artisan skills to transform.	It has an easy production process.
	B4: It requires a machine to participate in the transformation.	It uses fewer tools to transform.
Economic teak farmers	C1: There is a large amount of sapwood and teak left over from wood panel processing.	It has the cost-effective use of materials.
	C2: Waste sapwood waste is low price and the market doesn't need it.	It can add value through creativity.
	C3: It is difficult to separate the teak from the bark.	It is transformed to have the same characteristics.
	C4: Waste sapwood, leftover teak is in various sizes	Separating the wood is usable.
	C5: It is sold as a piece of wood only.	It has the utilization of all parts of sapwood and teak.
Teak wood furniture market	D1: No sapwood and teak scraps are used at present.	It uses natural raw materials.
	D2: It is not popular to use teak wing scraps to produce products.	There are environmental standards to support.
	D3: The pattern of sapwood, and teak wood is unclear.	It can create a product that does not focus on showing the pattern of the wood.
	D4: The scraps of sapwood and teak left over are small and difficult to use.	It has the wood Interlocking Forming.
	D5: The production is complicated.	It focuses on production with easy technology.
Consumer Products	E1: Consumers are not confident in the strength of sapwood, and teak.	It can build a strong product shape.
	E2: There are few products made from teak sapwood on the market.	It can create a variety of products.
	E3: The current product does not correspond to the way of life.	It can be used in daily life.
	E4: Products from teak are not modern.	The shape is outstanding following the era.
	E5: Teak products are heavy.	The product is the right size.
	E6: The product has a higher selling price than other types of wood.	It has the average selling price.
	E7: It can find that the product is difficult.	It is easy to be delivered to consumers.
Carriers and Distributors	F1: Furniture is heavy and difficult to transport.	Furniture is not heavy. and easy to move
	F2: The size of the furniture does not correspond to the transportation.	The furniture can be disassembled.
	F3: It has the size, furniture and waste of space in transportation.	The furniture is small and can be easily transported.
	F4: It must be packaged to protect the goods.	It can build confidence in the strength.
World product Design Trends	G1: It has an Earth-friendly stance.	The furniture is consumer-friendly.
	G2: It has Environmental Responsibility.	There is a low production cost.
	G3: It has a demonstration of social responsibility.	It is shown that it is environmentally friendly.
	G4: The shape does not correspond to the current way of life.	It has a modern shape.

Source: Author

b. The VOC Formulation Steps to Classify with Consumer Needs include 1)Primary Requirements with 7 Factors of Consumers, 2)Secondary Needs of Consumers with 35 Indicator Variables, and 3)Problem Solving of Consumer Demand with 35 Solutions with Indicator Variables. Besides, it is based on customer requirements and the solving method of furniture from sapwood and teak using a structured questionnaire (Cronbach's Alpha = 0.809). In this case, the questionnaire had a suitable level of reliability as collected from a sample of 108 sets.

Table 4: IMP Technical Requirements for Furniture Design from Young Sapwood Scraps (n= 108)

nature		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12
Material specification	A1	4.60	3.66	3.40	4.33	4.20	3.73	4.50	1.32	1.00	6.072	0.026	11
	A2	4.46	3.55	3.93	3.73	4.53	4.66	5.00	1.27	1.00	5.664	0.024	13
	A3	4.33	3.44	2.60	4.13	4.26	4.46	4.50	1.73	1.00	7.490	0.032	6
	A4	3.80	3.03	3.13	4.46	4.06	4.00	5.00	1.44	1.00	5.472	0.024	13
	A5	4.66	3.71	3.40	3.86	4.60	3.86	4.50	1.44	1.00	6.850	0.030	7
	A6	4.60	3.66	2.26	4.26	3.80	4.13	4.50	1.99	1.00	9.154	0.040	4
production and creation	B1	3.80	3.03	2.66	3.86	4.33	4.40	5.00	1.69	1.00	6.422	0.028	9
	B2	3.13	2.49	2.46	4.60	4.66	4.53	4.50	2.03	1.00	6.353	0.027	10
	B3	3.06	2.44	3.46	4.46	4.26	4.13	5.00	1.30	1.00	3.978	0.017	19
	B4	2.73	2.17	3.06	3.80	3.66	4.60	4.50	1.63	1.00	4.449	0.019	18
Economic teak farmers	C1	3.06	2.44	2.73	4.33	4.26	3.86	4.50	1.65	1.20	6.058	0.026	11
	C2	2.26	1.80	2.20	3.33	3.93	3.86	5.00	2.05	1.50	6.949	0.030	7
	C3	2.53	2.01	2.33	3.86	4.60	4.00	5.00	2.14	1.00	5.414	0.023	14
	C4	2.60	2.07	2.60	3.73	4.66	4.46	4.50	1.92	1.20	5.990	0.026	11
	C5	2.73	2.17	3.06	3.86	3.80	3.86	5.00	1.47	1.20	4.815	0.021	16
teak products market	D1	2.06	1.64	3.13	4.26	4.60	4.00	4.50	1.59	1.20	3.930	0.020	17
	D2	2.60	2.07	3.26	4.33	4.46	4.26	4.50	1.38	1.00	3.588	0.015	20
	D3	4.73	3.77	3.60	3.46	3.80	4.40	5.00	1.25	1.00	5.912	0.025	12
	D4	2.80	2.23	2.73	4.60	4.26	4.06	4.50	1.83	1.00	5.124	0.022	15
	D5	2.93	2.33	2.60	3.80	3.86	3.73	4.50	1.73	1.00	5.068	0.022	15
product consumer	E1	4.06	3.23	2.80	4.46	3.73	3.33	4.50	1.60	1.00	6.496	0.028	9
	E2	3.93	3.13	3.93	4.26	4.06	3.73	4.50	1.14	1.20	5.376	0.029	8
	E3	4.26	3.39	2.86	3.33	3.86	4.33	4.50	1.57	1.00	6.688	0.029	8
	E4	4.73	3.77	2.53	4.13	4.40	4.33	5.00	1.78	1.00	8.419	0.037	5
	E5	4.20	3.34	2.06	4.73	4.33	4.46	5.00	2.43	1.00	10.206	0.044	2
	E6	4.33	3.45	3.06	4.86	4.26	4.13	4.50	1.63	1.20	8.469	0.037	5
	E7	4.20	3.34	2.66	3.46	3.80	4.00	5.00	1.69	1.20	8.517	0.037	5
carrier and distributor	F1	4.73	3.77	2.80	4.26	4.13	4.66	5.00	1.79	1.00	8.466	0.037	5
	F2	4.66	3.71	2.26	3.86	3.93	4.60	5.00	2.21	1.00	10.298	0.045	1
	F3	4.06	3.23	3.13	4.33	4.60	3.93	4.50	1.59	1.00	6.455	0.030	7
	F4	2.93	2.33	2.20	4.13	3.80	3.46	4.50	2.05	1.00	6.060	0.026	11
world design trends	G1	2.73	2.17	2.46	4.73	4.06	3.73	5.00	2.03	1.00	5.541	0.024	13
	G2	3.66	2.91	2.06	3.86	4.33	4.26	4.50	2.18	1.20	9.574	0.043	3
	G3	3.40	2.71	2.33	4.33	4.13	3.33	4.50	1.93	1.00	6.562	0.030	7
	G4	2.66	1.80	2.40	4.60	4.46	4.13	5.00	2.08	1.20	5.640	0.025	12
		125.61	100.00	98.14	144.38	146.47	143.37	165	60.58	37.30	227.46	1.000	

** H1: Importance to Furniture Users, H2: Percentage (%), H3: User Satisfaction Survey, Original Teak Furniture, H4: Satisfaction Survey. Teak Furniture Competitors1, H5: Satisfaction Survey of Competitors Teak Furniture 2, H6: Competitor Satisfaction Survey of Teak furniture 3, H7: Design Aims or Goals, H8: Furniture Renovation Ratio, H9: Furniture Selling Points and Highlights, H10: Raw Score, H11: Normal Raw Score (Technical Requirements: IMP). H12: Priority

Source: Author

c. The process of summarizing the normal raw scores by calculating the significance of each variable: In this case, it was found that the sum of the normal influence score brought the results to the design requirement that considered the level of the relationship between Voice of Customer (VOC) and Technical Requirements (IMP) to find influence and normal influence values. Moreover, the problem of consumer demand with the highest normal influence affects the decision to use furniture, which will create a feeling of satisfaction if the problem is solved.

Table 5: Influence and Normal Influence on New Furniture Designs

	factors affecting	consumer demand problem	how to fix the need	influence	normal influence
[1]	teak furniture market	D1: No sapwood scraps are used at present.	The scraps of sapwood left over from the cutting.	4.00	0.060

	factors affecting	consumer demand problem	how to fix the need	influence	normal influence
[2]	Economic teak farmers	C5: Yes, it is sold in scrap wood only.	Applying to product design	2.82	0.042
[3]	Economic teak farmers	C3: Difficult to separate the teak from the bark.	Transforming to have the same physical attributes	2.70	0.041
[4]	Economic teak farmers	C1: There is a large amount of teak sap left over from the processing of wood planks.	Cost-effective use of materials	2.64	0.040
[5]	Economic teak farmers	C2: The waste of teak sapwood has a low price and the market does not need it.	Adding value through creativity	2.61	0.039
	Material specification	A2: The size of the wood is small.	Using the technique of forming plywood sheets	2.58	0.039
[6]	teak furniture market	D4: The discarded teak sapwood is small. difficult to use	wood interlocking forming	2.43	0.037
[7]	Material specification	A3: Teak sapwood material must be processed before use.	Easy transformation and convenient forming	2.25	0.034
[8]	product consumer	E1: Consumers are not confident in the strength of the teak shards.	Building a strong product shape	2.22	0.033
[9]	Manufacturing and Creativity	B1: Requires a multi-step transformation process.	Reducing the process of transformation	2.14	0.032
	Economic teak farmers	C4: The leftover wings are available in various sizes.	Separating usable wood	2.13	0.032
[10]	world design trends	G2: Product Environmental Responsibility	There is a low production cost.	1.98	0.031

Source: Author

Step 3: The furniture design process applies the guidelines derived from the QFD technique that arises from the importance of consumer demand problems with the shape of the product in the design process as follows:

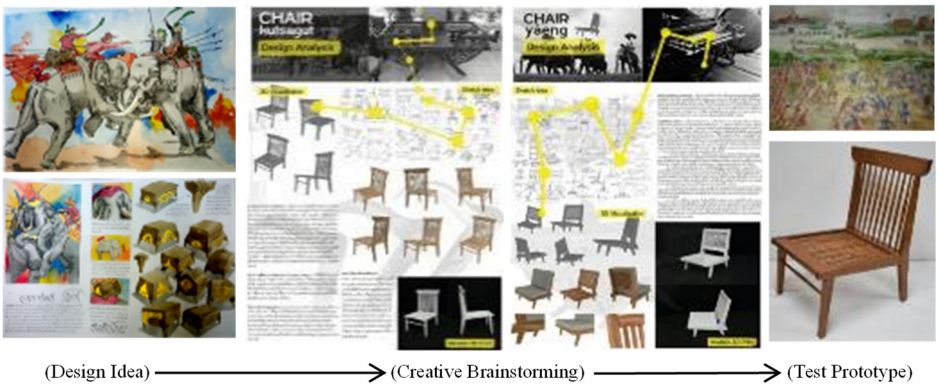


Figure 3: Responding to the needs of consumers through the design process.
Source: Author

Figure 4: Furniture made from young teak wood.
Source: Author

Step 4: Exploratory Component Analysis

The furniture prototypes were tested with consumers in a real environment by assessing the feelings of consumers and identifying the factors affecting the design of furniture made from young sapwood fractions. Besides, it can describe the relationship between all observed variables according to the Exploratory Factor Analysis (EFA) to explore the variables and identify the common factors in each variable. In this case, the EFA analysis reduces the number of observable variables by reconstructing the observable variables as a common component by showing the relationship between each component to measure the resulting evaluation score. Thus, it also involves the indicator to check: 1) Preliminary agreement before research, 2) Correlation test procedure and correlation grouping of observable variables (Joreskog *et al*., 1996; Sessin *et al*., 2015).

a. Steps before EFA analysis: Preliminary Agreement Review. 1) All common variables must be independent of each other, and all common factors must be related to each other. 2) All observable variables are directly influenced by common components. 3) All observable variables are indirectly influenced by common components. 4) Every variable is independent of each other and independent of all common components.
b. EFA analysis step consists of 4 steps: 1) Prepare the correlation matrix, 2) Extract elements, 3) Estimate the parameters and verify the conformity of the model, and 4) Rotate the axis of the element.

In this case, EFA analysis is suitable for checking structural validity with the clear theory or concept of the relationship between the components to be measured with the indicator score by conducting the analysis as follows:

1. Determine the variables studied with twenty observable variables from the QFD technique (35 variables were grouped to reduce to 20 observable variables).
2. Determine the minimum number of reliable samples so that this research should have a minimum sample totaling 80 people.
3. Verify the compatibility of the variables used to describe the factors that should have values > 0.5. The KMO and Bartlett's Test were found to be greater than 0.5. Thus, it explains that the analytical data could show the association between the variables for finding the furniture design factors.

Table 6: KMO and Bartlett's Test with the Feeling of Applying Furniture from Teak Wood

KMO and Bartlett's Test of Sphericity	
Approx. Chi-Square	665.120
Df	190
Sig.	.000
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.503
* Significance. 05	

Source: Author

According to the analysis of KMO and Bartlett's Test, it was shown that Kaiser-Meyer-Olkin = .503, which was greater than 0.50, and the furniture made from young teak sapwood, which the survey components were analyzed (Chi-Square = 665.120; Sig. = 0.000). Then, it was concluded that the 20 factor variables were related, and all data can be used to analyze the survey elements appropriately.

According to 8 factors determined by the researcher, therefore, it showed the result of rotating the axis predicting factors and interpreting factors by rotating the axis two times. It was then concluded that the 20 variables observed can be divided into 8 factors to be weighted for importance: Factor 1 is the most important to describe the variance of the data at 9.200%, while Factor 2 is at 8.750%, Factor 3 is at 8.532%, Factor 4 is at 8.192%, Factor 5 is at 7.897%, Factor 6 is at 7.632%, Factor 7 is at 7.312%, and Factor 8 is at 6.789% and others by appearing as the forecast value of 64.303. Then,

Screen Plot Analysis showed that the Eigenvalue of all twenty variables for all eight factors that are appropriate and the twenty observable variables were able to correlate with each other by showing a graph with a slope from factors 1 to 8.

Table 7: Rotation Factor of Weight Value with Verimax Method and Set Element Weight of 0.05 or Higher

The results of the grouping of the observed variables.		*F/1*	*F/2*	*F/3*	*F/4*	*F/5*	*F/6*	*F/7*	*F/8*
Factor 1									
A1	Distinctive features of young teak with 7-14 years old.	.690	-	-	-	-	-	-	-
A2	Processing of young teak wood and product forming.	.637	-	-	-	-	-	-	-
Factor 2									
B1	Daily Use Needs.	-	.714	-	-	-	-	-	-
D3	Craftsmanship Skills are suitable for young teak wood properties.	-	.639	-	-	-	-	-	-
C1	Conservation and Environmental Responsibility Trends.	-	.582	-	-	-	-	-	-
Factor 3									
C2	Modern Style of Young Teak Furniture.	-	-	.692	-	-	-	-	-
C4	The shape of the furniture is consistent with the properties of the wood.	-	-	.669	-	-	-	-	-
C3	There is a production method suitable for the future world.	-	-	.561	-	-	-	-	-
Factor 4									
B3	The use of furniture from teak wood, young age, comfortable.	-	-	-	.751	-	-	-	-
M5	Create economic added value for young teak wood.	-	-	-	.568	-	-	-	-
M4	It can show the unique identity of the young teak material.	-	-	-	.555	-	-	-	-
Factor 5									
A3	In line with the needs of consumers in the current market	-	-	-	-	.827	-	-	-
B4	Create a user-friendly feeling for furniture.	-	-	-	-	.752	-	-	-
Factor 6									
M2	The process of forming young sapwood is unique.	-	-	-	-	-	.820	-	-
M1	Distinctive physical properties of young teak	-	-	-	-	-	.687	-	-
Factor 7									
B2	Characteristics of use, furniture, teak wood suitable for a young age.	-	-	-	-	-	-	.874	-
D1	Fast assembly and use of furniture	-	-	-	-	-	-	.538	-
Factor 8									
A4	The different identities of the young teak patterns.	-	-	-	-	-	-	-	.684
M3	The production process is suitable for young teak wood.	-	-	-	-	-	-	-	.631
D2	Size and weight of furniture suitable for use.	-	-	-	-	-	-	-	.533

Source: Author

Table 8: Analysis of Anti-image Matrices from the Measures of Sampling Adequacy: MSA

	M1	M2	M3	M4	M5	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3
M1	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M2	.000	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M3	.270	.208	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M4	.005	.199	.313	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
M5	.015	.088	.261	.365	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A1	.062	.179	.125	.029	.000	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A2	.222	.421	.176	.045	.021	.000	1.000	-	-	-	-	-	-	-	-	-	-	-	-	-
A3	.139	.016	.030	.120	.070	.048	.158	1.000	-	-	-	-	-	-	-	-	-	-	-	-
A4	.276	.232	.025	.169	.164	.018	.036	.053	1.000	-	-	-	-	-	-	-	-	-	-	-
B1	.112	.082	.202	.134	.217	.194	.160	.127	.255	1.000	-	-	-	-	-	-	-	-	-	-
B2	.003	.140	.014	.152	.183	.330	.010	.136	.442	.014	1.000	-	-	-	-	-	-	-	-	-
B3	.057	.242	.177	.001	.000	.234	.333	.121	.000	.000	.289	1.000	-	-	-	-	-	-	-	-
B4	.340	.332	.355	.011	.079	.070	.032	.000	.000	.001	.345	.034	1.000	-	-	-	-	-	-	-
C1	.006	.013	.069	.004	.022	.071	.052	.205	.490	.001	.124	.209	.024	1.000	-	-	-	-	-	-
C2	.237	.349	.110	.185	.468	.420	.339	.327	.202	.043	.156	.429	.425	.369	1.000	-	-	-	-	-
C3	.391	.022	.351	.030	.208	.047	.000	.126	.053	.000	.464	.207	.274	.000	.000	1.000	-	-	-	-
C4	.423	.003	.050	.186	.006	.062	.120	.105	.032	.018	.422	.002	.077	.057	.000	.000	1.000	-	-	-

	M1	M2	M3	M4	M5	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3
D1	.288	.174	.116	.001	.046	.248	.015	.404	.302	.020	.000	.024	.076	.006	.004	.319	.084	1.000	-	-
D2	.126	.096	.451	.291	.182	.050	.054	.491	.005	.378	.079	.200	.017	.117	.032	.000	.023	.102	1.000	-
D3	.479	.221	.488	.000	.312	.016	.083	.131	.214	.000	.022	.124	.217	.011	.301	.139	.313	.001	.425	1.000

Source: Author

According to the conclusion of the correlation for the observed variables in factor 1, it consists of A1, A2, while factor 2 consists of B1, D3, C1, factor 3 is composed of C2, C4, C3, factor 4 consists of B3, M5, M4, factor 5 consists of A3, B4, factor 6 consists of M2, M1, factor 7 consists of B2, D1, and factor 8 consists of A4, M3, D 2. In this case, it includes Confirmatory Factor Analysis (CFA), and the variables are controlled by combining the variables with high correlation from 20 observable variables. In the same way, the remaining variables with the highest correlation between the 12 variables can be observed and taken into the next step to confirm the observed variables.

The procedure for reviewing the data before the CFA analysis is based on statistical agreement with the probability of the data. In this case, it can check for KMO and Bartlett's Test to be found that the observed variables were appropriate because KMO = .765. Thus, Bartlett's Test = 688.622 (Sig. = .000), and the correlation were sufficient for the analysis of CFA.

Review of Confirmatory Factor Analysis (CFA) Guidelines and Create Structural Equations was done to model the structural equation for the feeling of needing furniture made from sapwood teak. At this stage, the number of correlated factors was reduced to the same group. Thus, 8 factors obtained from EFA can be reduced to build a structure in CFA of 4 factors. In addition, it appears Cronbach's Alpha=.819, indicating that the questions used to collect data are at a suitable level and can be used to collect information. Thus, it shows the results for the analysis of the factors affecting consumer choice by testing with the measurement model from four factors. In addition, it affects the selection of furniture made from sapwood scraps and young teak wood caused by cutting the row to space of teak plants. As a result, it is the co-influence analysis of the observed variables that affect the selection.

Table 9: Analysis of Second-Order Components form Confirmatory Factor Analysis (CFA)

Latent Variable	Material			Social			Behavior			Market			
Observable Variable	β_i	b_i	SE	β_i	b_i	SE	β_i	b_i	SE	β_i	b_i	SE	r^2
A1 (Material 1)	.37	.91	.280	-	-	-	-	-	-	-	-	-	.138
A2 (Material 2)	.30	.82	.287	-	-	-	-	-	-	-	-	-	.092
A3 (Material 3)	.38	1.00	-	-	-	-	-	-	-	-	-	-	.142
B1 (Social 1)	-	-	-	.84	1.00	-	-	-	-	-	-	-	.701
B2 (Social 2)	-	-	-	.52	.67	.159	-	-	-	-	-	-	.274
B3 (Social 3)	-	-	-	.55	.71	.164	-	-	-	-	-	-	.303
C1 (Behavior 1)	-	-	-	-	-	-	.52	.40	.112	-	-	-	.274
C2 (Behavior 2)	-	-	-	-	-	-	.44	.39	.123	-	-	-	.198
C3 (Behavior 3)	-	-	-	-	-	-	.97	1.00	-	-	-	-	.937
D1 (Market 1)	-	-	-	-	-	-	-	-	-	.47	.56	.166	.218
D2 (Market 2)	-	-	-	-	-	-	-	-	-	.56	.89	.239	.315
D3 (Market 3)	-	-	-	-	-	-	-	-	-	.70	1.00	-	.483

latent variable	Feeling and need			R^2
	β_i	b_i	SE	
Material	1.51	.73	.184	2.281
Social	.83	.74	.151	.683
Behavior	.69	1.00	-	.478
Market	.88	.74	.181	.780

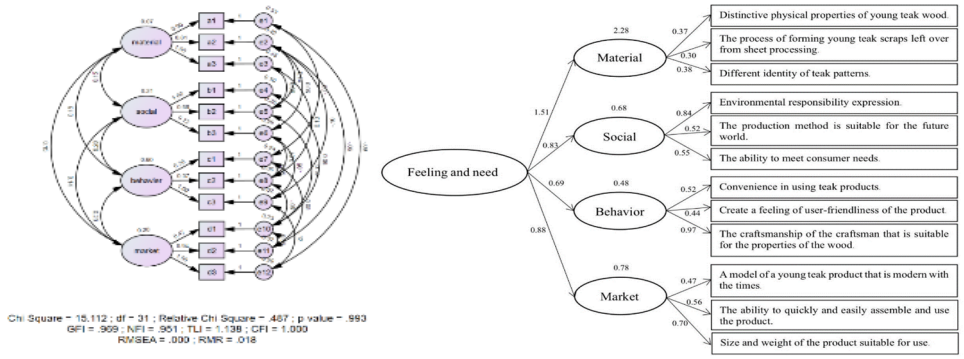
χ^2 = 15.703, df = 32, relative χ^2 = .491, p = .993, RMSEA = .000, RMR = .020, GFI = .967, AGFI = .920, NFI = .950, TLI = 1.137, CFI = 1.000

** P < .05 ; ** P < .01*

Source: Author

The second analysis results of components show the feelings of consumer demand for furniture. Using the AMOS program, the model conformance index was obtained according to Schumacker's criteria & Lomax, (Schumacker *et al*., 2010) to be shown as follows χ^2= 15.703, df = 32, relative χ^2= .491, p = .993, RMSEA = .000, RMR = .020, GFI = .967, AGFI = .920, NFI = .950, TLI = 1.137, CFI = 1.000 where the conformity index meets the specified criteria, relativeχ^2 less than 2 indexes RMSEA and RMR is less than .05 and GFI, AGFI, NFI, TLI is greater than .95, and AGFI is greater than .90 corresponding to the concept of Diamantopoulos and Siguaw, (2000) and Kelloway (2015). Feelings among consumers that affect the need for furniture from young teak sapwood consist of 4 components: Material attributes (Material), social trends (Social), behavioral expression factors (Behavior) and market demand factors (Market), etc. All 4 affect the likelihood of feeling a desire or feeling of satisfaction with newly-developed teak furniture. When arranging the factors influencing the desire to use the furniture from highest to lowest, they were ranked as 1) Material Characteristic Factors (1.51:2028), 2)Market demand factor (0.88:0.78), 3) Social currency factor (0.83:0.68), and 4) Behavioral expression factor (0.69:0.48), etc., which can be presented in a structural equation model, as shown in Table 10.

Table 10: Structure Equation Model Factor affecting the selection of furniture from young sapwood scraps.



Source: Author

6. Conclusion

1. Furniture design from young teak sapwood scraps between 7-14 years old can be cut from the distance between the teak planting rows, meaning teak logs left over from the thinning process. Moreover, productivity comes from the 7th-14th years; the agriculturists have altered the times to cut into each plot throughout the year. This affects the young teak logs between 7-14 years for coming out to the wood market regularly. Besides, it is related to the method of processing into wooden planks and selling as processed teak boards. In this case, there will be about fifty percent waste when transforming the logs of the teak trunks into planks, which are part of the sapwood. In the same way, on all four sides of those young teak logs, they have been trimmed without being used to increase economic value. Thus, according to the test results of transforming the sapwood residue, it remains for the wood that is separated from the sapwood only and removing the bark. It will involve transforming to have an average size of 1.5 x 1.5 x 120 cm before being put through the drying process of lumber. In this case, the humidity is not more than 20 percent, so the pieces of teak are

qualified and suitable for growing. In addition, the interlocking form is in the concept of developing the properties of wood sheets before use (Li *et al*., 2022).

The wood can then be properly molded into furniture that does not require much pressure, and the results are consistent with the concept of applying wood that can help maintain the shape and create the properties of wood boards that are suitable for various applications (Xi *et al*., 2022; Lubis *et al*., 2022; Egwutvongsa, S., 2022).

2. According to the results of solving the problem for teak furniture in the market, the design factor was created for teak furniture from scraps of sapwood by the cutting method. In addition, data has been collected from consumers to analyze with the QFD technique based on the study of Voice of Customer (VOC) needs. In addition, it involves the approach to address the needs of consumers with the ten most normal influences, whose prioritized outcomes are directly influenced by consumer demand (Li *et al*., 2022). Besides, it affects the decision to use products from teak, especially for a complete design problem to be solved; consumers will feel satisfied when they receive a response. What is more, the top 10 with the highest normal influence are introduced into the new furniture design process, while the process consists of 1) the presentation of design ideas, 2) brainstorming on design, and 3) production, test prototypes. (Karasan *et al*., 2022; Kelloway, 2015).
3. According to the findings for factors affecting furniture design from the residue of sapwood. In this case, the Exploratory Factor Analysis: EFA was classified from 20 observable variables and showed high predictive values with 8 factors that help a teak furniture designer to be able to work according to the 8 factors of the design. Thus, there will be a high chance of success, especially from the 8 factors that reflect the consumers, directly and indirectly, with the decision to use furniture made from scraps of sapwood. (Aktan *et al*., 2022), so the designers can apply all eight factors in designing new furniture to meet the needs of consumers. What is more, this is a fact-finding management process based on the diversity of consumers' emotions and feelings (Amirkhizi *et al*., 2022).
4. The modeling for the structural equation with the feeling of furniture desire made from sapwood of teak trees was based on the 4 factors, and it arises from the EFA by linking the factors that are close to each other's coherence index. Thus, it can be summarized as factors affecting furniture design from the remaining sapwood that is from 4 main factors, it can be confirmed for the correctness of the structural equation model by proposing the feelings that affect the needs of teak furniture for consumers. Therefore, it appears that the newly developed structural equation model is consistent and can be used in the design of teak furniture (Nikolić *et al*., 2022; Hair *et al*., 2006). This case indicates that the factors for consumers' decision-making opportunities to purchase or use the newly developed teak furniture are consistent with all four factors, including the facts about attitudes that exist in abstract forms within the minds of consumers. Further, it is considered an important factor in the decision-making of consumer choice (Lyer *et al*., 2022; Mehrens *et al*., 1973). Noor Afza Amran (Amran *et al*., 2021) presents a viewpoint that is consistent with the concept of human feelings that can be expressed through behavior to be observed and assessed to present solutions to the problems encountered. Therefore, the characteristics of human demand forecasting can be appropriately applied to the process of designing teak sapwood products that can satisfy the feeling of wanting to conserve the environment and the need for teak products for everyday use. This is in line with Mohammad Hamed Patmal's concept of collective responsibility for the environment (Patmal *et al*., 2021; Intezar *et al*., 2019). In summary, constraints for the design of eco-friendly products made from teak sapwood consist of 4 main factors and 12 sub-factors that can directly affect the success of teak sapwood in new product design. This is in line with Songwut Egwutvongsa's concept of creating green products (Egwutvongsa *et al*., 2021; Egwutvongsa, 2021; Diamantopoulos *et al*., 2000).

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