Chapter

The Creation of Furniture Products from Rice Stubble

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Abstract

The objective of this research was to develop the transformation procedure of rice stubble in the dry season of Thailand. This would be significantly used for the creative building processes of furniture products for earning increased economic value for the people and the communities. Fiber was applied in the transformation procedure for the rice stubble, including the cementing of the formation procedure in the boiling and soaking methods. From the results from using both procedures in this research, it was found that knock-down furniture sheets had the ability to be formed as standard furniture products with JIS A 5908–1994 for the customer groups who had the most level of satisfaction to rice stubble furniture. Therefore, this resulted in a positive result affecting the reduction of the ratio of burning of rice stubble in terms of preparing the area for planting in the next season on a large scale, including decreasing the occurrence of the PM. 2.5 problem in Thailand in every winter season. As a result, this research could be considered as another choice as a proposal to present the solution guidelines for solving the PM. 2.5 problem sustainably.

Keywords: Products from rice stubble, the creation of furniture, furniture design, rice stubble, material transformation

1. Introduction

From predicting the result of the in-season rice production for Thailand for the period of 2016–2020, it was found that there was an increasing ratio of 0.14% for each year. Additionally, this demonstrated that the amount of rice production was approximately 25.522 million tons, or an increasing production ratio of 6.06%. As such, it could be seen that currently Thailand is a world-class rice producing country with the amount of exported rice being second to India, or with approximately 7.58 million tons, which is the increasing trend for the exporting ratio in every year [1].

This further presented the promotion by the Thai government for boosting agriculturists to cultivate rice in the North-eastern region and the Central region of Thailand. Thus, nowadays, this cultivation has contributed to the country gaining large areas of rice fields, especially for the remaining rice stubble, which is approximately 72.321 million tons from the agriculturists' harvesting in each season. Moreover, this stubble is utilized for the mixing of straw mushroom cultivation or soil adjustment before the next season. However, this still leaves large amounts of rice stubble, so the agriculturists would remove it from their areas; such as, bringing

Figure 1.
Problem of burning rice stubble that results in PM 2.5 in Thailand.

the soil for cultivating other plants; namely, beans and other short harvesting cycle vegetables. As a consequence, this would enable the agriculturists to increase their income after doing the rice cultivation in the dry season without burning the rice stubble in the North-eastern or Central regions in the same way. In addition, this material always contributes to dust called polycyclic aromatic hydrocarbons (PAHs), or PM 2.5 that is a size less than 2.5 microns, which is the dust from burning monoculture plants [2]. This would eventually be fed into the supply chain of the agricultural food production amounting to more than 209,937 tons per year, as well as being released into the world's atmosphere to become an annual environmental effect at a high level. Furthermore, this has had an impact on the Mekong River's region. Unfortunately, according to the checking of the quality index from the Pollution Control Department for the period of 2016–2018, it was found that the value of the Air Quality Index (AQI) was way below the set standard of the World Health Organization (WHO), which in turn would have a negative impact on people's health in the area of the rice fields of the Northern and North-eastern regions of Thailand [3].

These problems have also continued to occur in every dry season to become severe environmental and health problems for the people in these areas (**Figure 1**).

Therefore, the government sector has a policy to promote resolving these problems sustainably by encouraging the people to bring the remaining rice stubble to increase the income from agriculture, including encouraging the agriculturists to bring the rice stubble to be transformed into community products to be sold and allow them to earn more agricultural income. Therefore, this could reduce the chances of burning the rice fields by the agriculturists prior to cultivating in the next season. This was conducted according to the National Strategy 2018–2037. Additionally, it could be considered as having a leading role in the determination of the direction toward the United Nations' Sustainable Development Goals (SDGs). This could also be initiated to prepare for the structural adjustment for Thailand 4.0 in the future [4]. Thus, the government has aimed at the alteration based on the potential of the communities and local areas to utilize rice stubble in the rice fields to be transformed into a positive aspect of the sustainability development of the lifestyle and economy of the agriculturist communities [5]. As the result, this has depended on having the appropriate technologies with the potential of the community's people and expression through a participatory procedure until gaining a modern method with the tools and the specificness for the suitable uniqueness for increasing their own lifestyles' sustainability together with rice cultivation [6].

2. Objectives

To develop the transformation procedure from the remaining rice stubble to be wood substitute material.

To create furniture products for children from the remaining rice stubble and predict the solutions with the customer groups' requirements affecting the new products.

3. Scope

1. Scope of the Procedural Development from the Remaining Rice Stubble as a Wood Substitute Material

   This would have the objective to develop the transformation procedure of remaining rice stubble in the cultivation areas of the North-eastern region.

   The population of agriculturists cultivating the fields in the North-eastern region is 3,741,346 people [7].

   The group sampling consisted of 100 agriculturists of the North-eastern region with the level of discrepancy being 100% by using stratified random sampling that divided the cultivation areas of each province in Thailand [8].

   A structured questionnaire with a checklist of a five-point Likert scale to rate the levels of satisfaction in the transformation procedure for the newly developed rice stubble was used as the research tool [9]. Additionally, this used the statistical value from the confidence value of 10 group samplings with the value of Cronbach's alpha at a level of 0.873 by using the data analysis of the statistical descriptive value; such as, the mean, standard deviation (S.D.), and one way or single factor ANOVA [10].

2. Scope of the Production of Furniture Products for Children from the Remaining Rice Stubble and Predicting the Solution with the Customer Groups' Requirements That Affected the New Products

   This aimed to present the designing procedure for the furniture products by using wood substitute material from rice stubble to be an invention of the communities for producing small industries inside the households.

   The population comprised 9,183 customers interested in furniture who visited the product booths in the Furniture and Electronic Fair 2018 in Khon Kaen province, Thailand. Stratified random sampling was used to find 100 people as the discrepancy level of 100% [8].

   A structured questionnaire with a checklist of a five-point Likert scale to rate the level of satisfaction of newly developed rice stubble furniture that utilized wood substitute material was used as the research tool [9]. This used the statistical value from the confidence value of 10 group samplings with the value of Cronbach's alpha at a level of 0.786 by using data analysis of the statistical descriptive value; such as, the mean, standard deviation (S.D), and dependent t-test [10].

4. Framework

The framework properties with the causes and results from studying the phenomenon [11], and the development of the transformation procedure from remaining rice stubble in Thailand were applied. Moreover, wood substitute material for the furniture industry was used by dividing into the influencing factors of designing and creating (**Table 1**) [12].

Causes of Rice Stubble Material Development	Utilization Development Procedure	Results
Factors of the Community's Context 1. Occupations of the people. 2. Salary of the people. 3. Potential of substituting materials to apply in the communities. 4. Technological potential that communities enable to apply. 5. Potential of the skills of the people.	**Creating and Designing the Concept** Brainstorm, create idea techniques, and innovative development for the transformation of rice stubble as a friendly wood substitution material.	**Development of an Economic Community** 1. People in the communities have increased income. 2. Social section in the communities has good strength. 3. Ratios of unemployment in the communities is reduced. 4. Gather in groups by creating community products from their potential.
Factors of the Environmental Impacts 1. Impact from the remaining rice stubble in the area. 2. Impact from burning rice stubble with a negative effect on the climate. 3. Increasing opportunities for the transformation of rice stubble as environmentally friendly products.	**Selection of the Product Pattern** Decision analysis procedure. **Model Product** Effectiveness assessment with new procedures of the eco-industry development procedure.	**Sustainable Development** 1. Stability of future occupations. 2. Stability of future income. 3. Stability of future generations. 4. Feeling of own value. 5. Sustainable problem-solving ways of the PM 2.5 dust environment.

Table 1.
Research framework to present the development.

5. Results

5.1 Development of the result of the transformation procedure from the remaining rice stubble as wood substitute material

Development of the requirements of rice stubble were studied in the communities of the North-eastern region of Thailand. This could promote the lifestyle of the people in the communities to gain more opportunities from earning income with the increasing valuable furniture products, including increasing the opportunity to burn the rice stubble that affected the overall environment in the country. However, this was based on the problem-solving method and the management from the high quantity of rice stubble in each season. Normally, the agriculturists would always manage to do this through three methods: 1. To let the rice stubble decompose naturally, 2. burn the rice stubble, and 3. till the rice stubble into the ground [13]. Similarly, these three methods may have different effects on the agriculturists and society according to the selection of the guidelines for removing the rice stubble in the next season prior to cultivating the rice (**Figure 2**).

This research process aimed at applying the benefits of the rice stubble in terms of developing manufactured products easily without the complexity of the production procedure. Similarly, this also promoted the people in the communities in a positive way they reduced rice stubble burning in the rice fields in the dry season by creating the good well-being of the people in the future. Consequently, this could

Figure 2.
Agriculturists cultivate rice in the dry season of north-eastern areas of Thailand.

increase quality environmental conditions and boost the effective economy and other fields.

Hence, overall, this would generate integrated development in the system and sustainability for the communities based on the potential of the people; namely, lifestyle, environment, and economy. Additionally, this was considered as sustainable development based on the input factors that caused the alteration and output factor to represent the early successful result, intermediate successful result, and final successful result.

Therefore, this would take place from people in the model communities who were participating in the study by applying the problem-solving methods to stimulate the alteration sustainably and continuously (**Table 2**).

Table 3 presented the requirements to bring the rice stubble in the agriculturists own cultivation areas to be applied to the transformation process. The group sampling had the requirement to increase the value in the transformation for handicraft products that had the most level of requirement (mean = 4.530; S.D. = 0.559), followed by the transformation to be agricultural products that had an excellent level of requirement (mean = 4.100; S.D. = 0.541), the tilling or implantation had an excellent level of requirement (mean = 3.560; S.D. = 0.729), and burning had a moderate level of requirement (mean = 2.990; S.D. = 1.159). Therefore, overall, this showed that the community groups had the requirement of the feeling to bring the rice stubble to be applied as a new method more than the original one; namely, tilling or burning. In fact, these two methods caused direct effects to the agriculturists, except for having the requirement to increase the rice stubble more than in

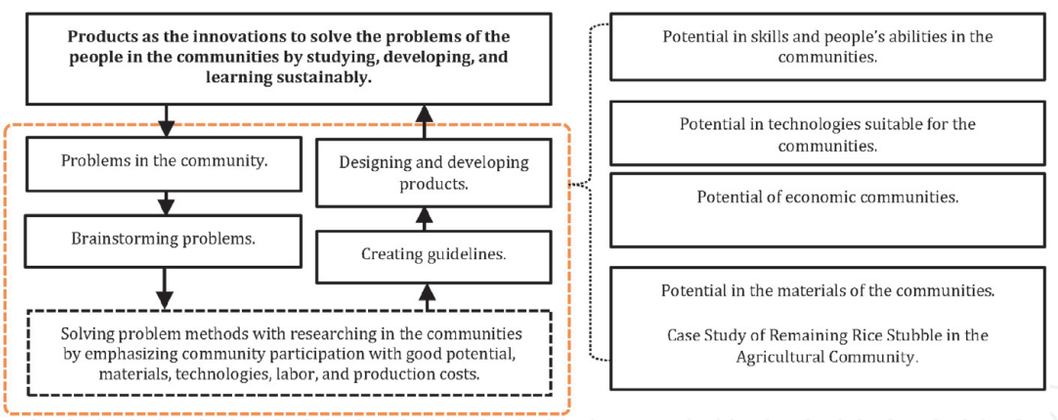


Table 2.
Creating the direction of the method for rice stubble furniture products in rice cultivation in the north-eastern region.

Method to apply	Mean	S.D.	S.E.	Level
1. Transforming to be industrial hand products.	4.530	0.559	0.056	Most
2. Transforming to be agricultural products.	4.100	0.541	0.054	Excellent
3. Tilling or implantation.	3.560	0.729	0.073	Excellent
4. Burning.	2.990	1.159	0.116	Moderate
Overall	**3.795**	**0.975**	**0.049**	**Most**

Table 3.
Opinions of agriculturists affected by bringing the rice stubble to apply to the transformation process, (n = 100).

the past. Thus, the researcher brought the requirement result from the community groups prior to applying with the transformation procedure of the rice stubble fiber.

From **Table 4**, the two-tailed test for the significance value found that the value F = 0.000 showed the mean of at least one pair with a level of significance of .05 by using multiple comparison. As such, there were four method patterns that used the statistical test of Fisher's least significant difference (LSD) to make a comparison between the differences of the mean with the pairs. Similarly, according to the test result, it was found that every compared pair had the value Sig. in the test with the least significance of .05, and these four methods could be applied with the opinions of the agriculturist community groups with a level of significance of .05.

Most of the agriculturist groups had similar opinions to the stimulation trend for bringing the rice stubble to apply with the transformation. Likewise, this could generate higher economic value with a positive image to the income after applying it in beneficial ways.

The rice farmer group had the requirement to bring the rice stubble in their cultivation area to do an activity in an agricultural way; such as, planting mushrooms or making fertilizer. Then, these farmers had few requirements due to the less economic incentives for applying with the transformation than doing in other ways. As such, this was affected by the price of agricultural crops in the areas which existed to have low crop prices, so the farmers group did not have the incentive for being interested in the use of rice stubble in agricultural crops. Additionally, in the tilling process, it showed that the farmers in the research area would not bring the materials to apply with the transformation because this would result in the increasing of rats living in the rice fields leading to an epidemic of leptospirosis disease for the local areas [14, 15]. Significantly, normally the agriculturists, especially the rice farmers did not plow the rice stubble but considered the rice stubble burning process as the popular method because it could quickly eradicate rats that lived in the rice fields, so the farmers could do agriculture in the next round on the rice fields. Therefore, burning was an agricultural method that was extensively used in Thailand; unfortunately, in the year 2020, the country was faced with air pollution problems in the form of dust particles or PM 2.5 until it affected the health of the people in the North, Northeast, and Central areas. Hence, this was a health problem that created a health disparity among the general population until it became a national problem that all people had to work together to reduce the impact. Furthermore, nowadays, most farmers have not burned the rice stubble since the beginning of the year 2020 until now. This presented the causes and effects combined with the global trend for conserving the environment. Then, it could initiate the ideas of the development process for making use of rice stubble that required a simple process without any complications, and this enabled needy farmers in Thailand to apply these newly developed processes to meet their own need, including adding value to the economy as a form of income generated from rice. As a result, this could use products made from rice stubble in the form of wood substitute

	Sum of the squares	df	Mean square	F	Sig.
Between Groups	133.650	3	44.550	71.849	0.000
Within Groups	245.540	396	0.620		
Total	379.190	399			

Critical value (0.05. = F-table = 2.627).

Table 4.
Analysis of the differences for the four method variables.

material and furniture made from rice stubble to create opportunities for increasing the income of farmers in the local countryside as another way, including helping bridge the social gap in Thailand.

5.2 Development of the transformation procedure of rice stubble as wood substitute material

This demonstrated that the creating of the transformation procedure for rice stubble resulted in suitable and environmentally friendly wood substitute material [16]. Additionally, this was based on the transformation to be a result of the wood substitute material with specific properties; such as. fineness and beauty, smoothness, strength and colors in the materials, and other related aspects [17]. Then, the researcher made the comparison of the boiling procedure to peel off the tissue by using the water immersing procedure for peeling tissue as two parts (**Figure 3** and **Table 5**).

Table 5 shows the development of the transformation procedure for the rice stubble. The properties for the fiber were obtained by two methods. This were considered as suitable methods with the potential of the communities to bring the remaining rice stubble from the rice fields in the communities to apply to the transformation procedure. Later, it was transformed to be fiber with good properties; such as, fineness and suitability to be formed as wood substitute material for creating furniture products. After that, the fiber from the rice stubble utilized the pressing sheet procedure through the peeling of the tissue and bleaching methods.

This used the ratio of 7% of seven kilograms of rice stubble before mixing with isocyanate adhesive and spraying glue in a rotary grinder for 12 minutes. Later, the rice stubble tissue was mixed with the isocyanate adhesive again by being formed as wood substitute material as a wood block with the dimensions of 45 cm x 120 cm and a thickness of 15 ml. Then, it used heat pressing at 150°C under the pressing pressure of 35 kilograms/cm.^{2} (**Figure 4**).

The test results of the wood substitute material from the newly developed remaining rice stubble had the standard of JIS A 5908–1994. Then, it was found that there was a specific gravity value of 0.75, and the properties of the density quantity was 8.85% that passed the standard, including the properties of the modulus of rupture (MOR) that had a level of 5.67 MPa, the properties of the modulus of elasticity (MOE) that had a level of 319.95 MPa, which was lower than the standard, the compression stress in the levels of 11.59 MPa and 5.97 MPa, and hardness in the level of 3,949.49 N by testing the decomposition of the wood substitute material from the rice stubble [18]. Therefore, this resulted from the decomposing phenomenon as the pattern of the brash tension and simple tension as the weakness of the wood substitute material made from the newly developed rice stubble at this time (**Figure 5**).

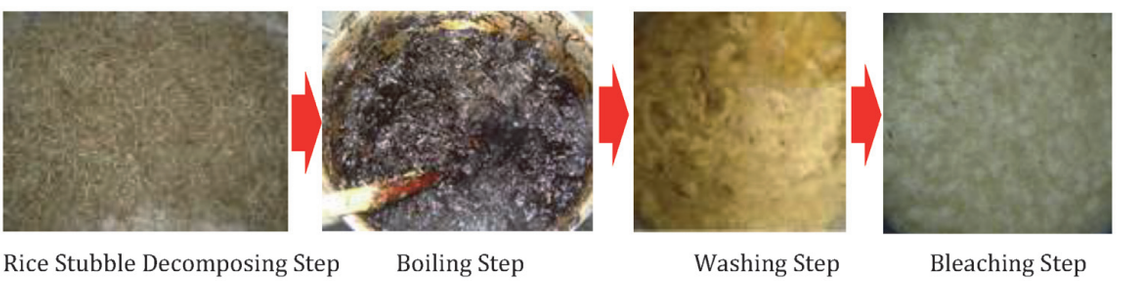


Figure 3.
Transformation procedure of rice stubble fiber in the dry season.

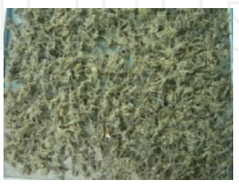
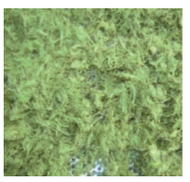
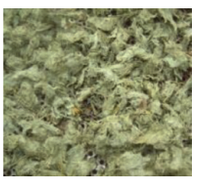
Analysis factor	Boiling procedure	Immersing procedure
Line Separation Step of Rice Stubble Fiber 	1. 1 cm of rice stubble was decomposed. 2. The rice stubble was boiled in water by mixing with 0.5% of sodium hypochlorite. 3. It was boiled under a temperature of 95–100°C for two hours. 4. 40 kg. of rice stubble was boiled in 30 liters of water.	1. 1 cm of rice stubble was decomposed. 2. The rice stubble was immersed in water by mixing with 0.5% of sodium hypochlorite. 3. It was immersed and mixed in a 100-liter tank for 40 days. 4. 40 kg. of rice stubble with 30 liters of water.
Rice Stubble Fiber Characteristic 	1. Fiber had the high level of fineness with a soft texture. 2. When the fiber was dried, it had a soft weight. 3. The fiber was spun and decomposed by screening through a 1.5 mm. sieve to gain 15.3 kg.	1. Fiber had a moderate level of fineness. 2. Fiber had strength on the segments, bodies, and roots of the rice stubble. 3. When the fiber was dried, it had a soft weight. 4. The fiber was screened through a 1.5 mm. sieve to gain 16.8 kg.
Fiber Characteristic from the Transformation Procedure of the Rice Stubble	 	 
Preparation procedure of the rice stubble fiber formed by using wood substitute material and isocyanate adhesive.    		

Table 5.
Development of the transformation procedure of rice stubble.

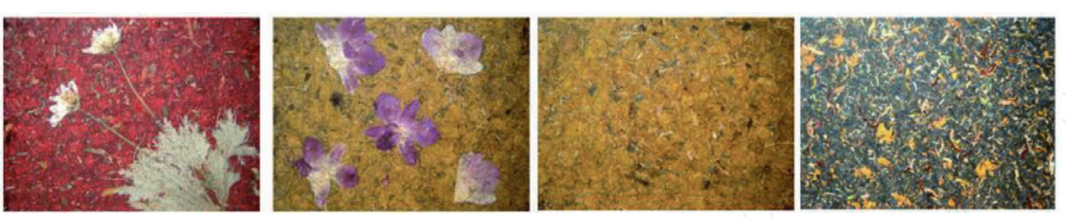


Figure 4.
Wood substitute materials from heat pressing with rice stubble fiber.

Figure 5.
Decomposing trace of newly developed wood substitute material from rice stubble.

From the using of wood substitute materials from rice stubble, this presented the resistance from pressing with the least level than the standard. Likewise, this was caused by the external peeling for the rice stubble surface fiber for its shortness and smallness appearance. Moreover, this resulted in the high level of flexibility for the wood substitute material through the heat pressing of the isocyanate adhesive,

except for the less effectiveness from over pressing. Thus, this made the rice stubble fiber have softness and stickiness in a least level than normal with the effect on the wood substitute material to have a less bonding force and adhesion for the wood substitute material as the standard.

However, if the community group that wanted to apply rice stubble fiber in real life by producing products to sell for increasing the community's strength and force more than the past, they could so by using the following methods:

1. Increase the quantity of the isocyanate adhesive by 7% to have more mixing ratio by adding better properties of the wood substitute material from the rice stubble to gain the strength and active force with the higher level of the production costs.

2. Increase the length of the rice stubble fiber more than in the past to add the strength and effectiveness for the active force with the wood substitute material. The drying step to reduce the weight of the crushed rice stubble to 30 kilograms showed the remaining rice stubble to have a weight of seven to eight kilograms, which was suitable for being boiled or immersed to peel the tissue.

3. Creating the steps of the furniture products from rice stubble fiber

   This was based on the creative ideas in the designing step of creating the newly developed rice stubble products into two patterns. Then, it could respond to the furniture product requirements for the customer groups. Therefore, this depended on the presentation of the brainstorming procedure through the drafting of the furniture model products by using the wood substitute material from the rice stubble fiber (**Figure 6**).

   Table 6 presented the test of the differences for the mean satisfaction to the furniture product patterns from the remaining rice stubble. The first pattern had the mean satisfaction at a moderate level of 3.38, and the furniture product patterns from the remaining rice stubble in the second pattern had the mean satisfaction at an excellent level of 4.18. The result of the t-test showed that the mean between the furniture product patterns of the

Figure 6.
Draft of the furniture products made from wood substitute material from rice stubble.

New developed furniture	n	Mean	S.D.	Mean difference	t	df	Sig. 1 tailed
Design Development 1	100	3.38	0.81	−0.80	−7.139**	198	0.000
Design Development 2	100	4.18	0.77				

***Statistical significance in the level of .01.*

Table 6.
Selection result from the furniture product patterns of newly developed rice stubble.

remaining rice stubble in the second pattern was at a higher level than the first pattern with a statistical significance level of .01.

Adopting the furniture product patterns in the second pattern could produce the rice stubble furniture products to be applied in real life. Thus, the researcher produced the models of the community groups in Khandong Subdistrict of Buri Ram province, where the community groups transformed the rice stubble to be wood substitute material for the handicraft industry. Finally, this enabled the researcher to make the summary of the economic values occurring from the rice stubble transformation (**Table 7**).

Table 7 displays the value of the wood substitution material production from rice stubble per sheet with boiled and peeled tissue to gain the fiber. Then, it was brought to the pressing procedure from immersing the tissue to peel off the rice stubble fiber that amounted to 3 Baht per sheet. This was considered as gaining a lower level of production costs from the selling standard of the wood substitute material in the market. Then, the wood substitute material made from the rice stubble seemed to gain suitable properties for the handicraft industry in the communities, so that the agriculturists could bring the rice stubble to be purchased by businesses with a positive trend to increase more income for their communities.

Therefore, this could produce model furniture products from rice stubble by using the wood substitute materials with the dimension of 150 mm. As a result, it applied the abstract guideline and concrete guideline in real life prior

Producing procedure	**Boiling from peeling the tissue by using wood substitute material**	**Using wood substitute material from immersing to peel the tissue**
1. Preparing the material step (tissue material replacement of wood)	A. Fuel prices for boiling: 23 Baht B. Coloring procedure: 32 Baht C. Labor costs for 1 hour: 20 Baht D. Material costs (rice stubble): 0 Baht	A. Tissue crushing procedure: 0 Baht B. Coloring procedure: 32 Baht C. Labor costs for 2 hours: 40 Baht D. Material costs (rice stubble): 0 Baht
2. Heat pressing step (isocyanate adhesive)	A. Glue: 35 Baht B. Labor costs per sheet: 10 Baht	A. Glue: 35 Baht B. Labor costs per sheet: 10 Baht
Total Costs	120 THB (4 USD)	117 THB (3.90 USD)

Table 7.
Comparison of the costs of the production with the sheet dimension of 120 X 60 cm. From wood substitute material of boiled rice stubble with peeling tissue and immersing the tissues to be peeled.

Figure 7.
Model furniture products from rice stubble fiber.

to bringing the model to be assessed for the effectiveness and satisfaction scores (**Figure 7**).

4. Predicting the solution steps of the satisfaction values for rice stubble furniture customer groups

   For the step of the influencing assessment factor of the rice stubble furniture production customer groups, the model furniture was brought to test with the targeted customer groups. For this study, it was brought to be tested in the furniture and home decoration booths in the Furniture and Electronic Fair 2018 in Khon Kaen province, Thailand. This also included making an assessment of the customers' feelings after testing the furniture product from the new rice stubble (**Table 8**).

As can be seen from **Table 8**, the assessment result of the four input factors demonstrated that the test group had the satisfaction from the most to the least levels; namely, factor X4 or the interestingness and the novelty had the most level of satisfaction (mean = 4.600; S.D. = 0.603), followed by factor X2 or worthiness to be transformed that had an excellent level of satisfaction (mean = 4.400; S. D. = 0.711), factor X1 or beauty also had an excellent level of satisfaction (mean = 3.970; S.D. = 0.784), and factor X3 or the convenience to apply had an excellent level of satisfaction (mean = 3.540; S.D. = 0.744). Therefore, when the researcher had classified the satisfaction assessment values with the rice stubble furniture product models, it presented the most level of satisfaction (mean = 4.530; S.D. = 0.627), including the result of the satisfaction assessment with the interestingness and novelty interests from the new procedure to the new model in similar levels. Moreover, the presentation of the Sig. value from the test of F = 0.00 demonstrated at least one pair of correlation gaining the differences of the level of significance with .05 by applying the multiple comparisons and LSD (**Table 9**).

From the conclusion of **Table 9**, it could be seen that the factors involved with the variables and satisfaction toward the furniture model from rice stubble for the customer groups consisted of worthiness to transformation (X2) and interestingness and novelty (X4). These two variables were considered as the correlation with the satisfaction to the customer groups while using the new rice stubble furniture model. There were also two noninfluencing factors; namely, beauty (X1) and convenience to apply (X3) that had a statistical significance of .05.

Table 10 displayed the factor result with the co-efficient of the decision (R^2) by gaining the value of 0.4442, or the factor test with the rice stubble furniture designed at this time. Then, it could explain about the satisfaction change in the level of 44.42% by bringing the influencing factors to the satisfaction of the new

Influencing factors of the satisfaction of furniture made from rice stubble	**n = 100 People**		**Satisfaction level**
	Means	**S.D.**	
Satisfaction toward the furniture model from rice stubble.	4.530	0.627	Most
X1. Beauty.	3.970	0.784	Excellent
X2. Worthiness of the transformation.	4.400	0.711	Excellent
X3. Convenience to apply.	3.540	0.744	Excellent
X4. Interestingness and novelty.	4.600	0.603	Most

Table 8.
The mean, standard deviation (S.D,), and influencing factors toward the satisfaction of furniture of newly developed rice stubble from the customer groups.

Variable	X1	X2	X3	X4	Y
X1. Beauty.	1.000				
X2. Worthiness of transformation.	0.000*	1.00			
X3. Convenience to apply.	0.000*	0.000*	1.00		
X4. Interestingness and novelty.	0.000*	0.033*	0.000*	1.00	
Y. Satisfaction toward the furniture model from rice stubble.	0.000*	0.172	0.000*	0.422	1.00

**Sig value: The test presented the significant level of .05; any pair that has less value than .05 showed the differences of significance to be .05.*

Table 9.
Test summary of Fisher's least significant difference (LSD) between two-way ANOVA.

Model	n = 234			
	R	R square	Adjusted R square	Std. error of the estimate
Test	0.6665	0.4442	0.4208	0.477

Table 10.
Co-efficient of the decision (R^2) for the influencing factors to the satisfaction of the newly designed rice stubble furniture model.

design for determining the regression solution that was ý = 1.473 + (0.271 X1) + (0.312 X2) + (−0.040 X3) + (0.163 X4).

Table 11 was based on the predictors consisting of X1. beauty, X2. worthiness of transformation, X3. convenience to apply, and X4. interestingness and novelty with the dependent variable; such as, satisfaction to the newly designed rice stubble furniture model. According to the analysis result of the F-test = 18.978 > F-table = 2.490, it was found that the independent variable (X) had at least one variable that correlated with the dependent variable (Y). After that, the researcher analyzed the dependent variable before making a regression coefficient by using the statistical value of the t-test for testing (**Table 12**).

Test	SS	df	MS	F	Sig.
Regression solution.	17.282	4	4.321	18.978	0.000
Discrepancy.	21.628	95	0.228		
Total	38.910	99			

Table 11.
Analysis of the correlation between the designing factors with satisfaction.

Predicting variable	*b*	*S.E.b*	*B*	*t*	*P*
Constant	1.473	0.405		3.638	0.000
X1. Beauty.	0.271	0.080	0.340	3.392	0.001
X2. Worthiness of transformation.	0.312	0.086	0.353	3.607	0.000
X3. Convenience to apply.	−0.040	0.079	−0.048	−0.505	0.615
X4. Interestingness and novelty.	0.163	0.092	0.157	1.768	0.080

Table 12.
The multiple linear regression for predicting the satisfaction of new rice stubble furniture to the co-design factors.

The multiple linear regression for predicting the variables with the customer groups' satisfaction to the new rice stubble furniture is presented in **Table 12**. This also involved the beauty (X1) to have a regression coefficient equal to 0.271 that regarded the importance of the beauty of rice stubble furniture by increasing by one unit.

Then, the customers' satisfaction to the newly designed rice stubble furniture had more chances to increase to 0.271 unit. Thus, according to the t-test where [X1] = 3.392 > t-table = 1.985, it was found that the beauty factor was correlated to the satisfaction factor of rice stubble furniture model.

The worthiness of transformation (X2) had multiple linear regression equal to 0.312. Then, whether there was importance on the transformation with the increasing of one unit, this would still indicate the customers' satisfaction to the new designed rice stubble furniture with more chance of 0.312 units. Additionally, according to the t-test where [X2] = 3.607 > t-table = 1.985, it was found that the worthiness of transformation was correlated with the satisfaction factors to the rice stubble furniture models.

The convenience to apply (X3) had multiple linear regression equal to −0.040. Then, whether there was the importance on the transformation by increasing one unit, this would present customer satisfaction to the newly designed rice stubble furniture with more chance of 0.312 units. Furthermore, according to the t-test where [X3] = −0.505 > t-table = 1.985, it was found that the convenience to apply was not correlated to the satisfaction factors to the rice stubble furniture models.

The interestingness and the novelty to apply (X4) had multiple linear regression equal to 0.163. Then, whether there was the importance on interestingness by increasing one unit would present the customer satisfaction to the newly designed rice stubble furniture with a greater chance of 0.163 units. Moreover, according to the t-test where [X4] = 1.768 ≤ t-table = 1.985, it was found that the interestingness and the novelty was not correlated to the satisfaction factors to the rice stubble furniture models. Therefore, this could make the following summary of the predicting solution of the rice stubble furniture design:

A. This could create the predicted solution from the raw scores as the coefficient of the decision that is R^2 by having the value of 0.4442 with the explanation to show the solution as follows:

   $$\acute{y} = 1.473 + [0.271\ (\text{beauty})] + [0.312\ (\text{worthiness of transformation})] + [-0.040\ (\text{convenience to apply})] + [0.163\ (\text{interestingness and novelty})]$$

   $$\acute{y} = 1.473 + (0.271\ X1) + (0.312\ X2) + (-0.040\ X3) + (0.163\ X4)$$

B. This could create the predicted solution as the standard scores from the coefficient of the decision to show the solution as follows:

   $$Z = (0.340\ X1) + (0.353\ X2) + (-0.048\ X3) + (0.157\ X4)$$

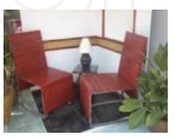
   $$Z = [0.340\ (\text{beauty})] + [0.353\ (\text{worthiness of transformation})] + [-0.048\ (\text{convenience to apply})] + [0.157\ (\text{interestingness and novelty})]$$

After that, the results of the assessment were used by classifying the details for the creative design. Then, this could be explained with the phenomenon of customer satisfaction to the transformation procedure of the rice stubble into product creation with patterns. In addition, it was based on applying the integration procedure by using the creative idea with multiplying the product patterns. Thus, a comparison between the rice stubble products for furniture and lamps could be made (**Figure 8** and **Tables 8** and **13**).


Home vase:

This soft weight and high force resistance model product was made from the fiber pressed with the rice stubble transformation of polystyrene (PS) using the forming technique to apply in multiple patterns.

Figure 8.
Vase products from rice stubble with polystyrene.

Assessment list	 Furniture from rice stubble			 Vase from rice stubble			Comparison	
	Mean	S.D.	Satisfaction	Mean	S.D.	Satisfaction	t	Sig.
1. Novelty	4.18	0.69	Excellent	4.25	0.73	Excellent	−0.698	0.243
2. Beauty	4.04	0.74	Excellent	4.55	0.58	Most	−5.453	0.000*
3. Worthiness of the procedure	4.03	0.76	Excellent	4.52	0.54	Most	−5.324	0.000*
4. Increasing values	4.72	0.47	Most	4.55	0.52	Most	2.419	0.008*
5. Customer requirements	4.53	0.69	Moderate	4.36	0.67	Excellent	1.764	0.040
6. Environmentally friendly	4.47	0.50	Excellent	4.32	0.71	Excellent	1.727	0.043
7. Saving the world	4.06	0.65	Excellent	4.03	0.69	Excellent	0.317	0.376
Overall	4.29	0.70	Excellent	4.37	0.66	Excellent	−2.167	0.015

**Statistical significance in the level of .01.*

Table 13.
Analysis of the mean and standard deviation (S.D.) from customer satisfaction to remaining rice stubble materials in Thailand, (n = 100).

As shown in **Table 13**, the overall satisfaction for the vase from rice stubble had the most level of satisfaction (mean = 4.37; S.D. = 0.66). As such, it had a higher level than the furniture from rice stubble with an excellent level of satisfaction (mean = 4.29; S.D. = 0.70) with no significance of the level of .01. This could be classified as follows:

1. The increasing value found that the rice stubble furniture had a higher level of customer satisfaction than the vases with significance in the level of .01.

2. The novelty value showed that the vase had a higher level of customer satisfaction value than the rice stubble furniture with no significance in the level of .01.

3. The beauty value displayed that the vase from the rice stubble had a higher level of customer satisfaction value than the rice stubble furniture with significance in the level of .01.

4. The worthiness procedure value demonstrated that the vase from the rice stubble had a higher level of satisfaction value than the rice stubble furniture with significance in the level of .01.

5. The customer requirement value found that the rice stubble furniture had a higher level of customer satisfaction value than the rice stubble furniture with significance in the level of .01.

Basic knowledge	**Guideline into new research**
The wood replacement material often used heat compression that relies on digestion to contain small fragments of waste [19].	This aimed to present a way to digest rice stubble into smaller fiber by using the water immersion method mixed with sodium hyper chloride to get fiber with wool: a smaller size of 0.1 mm; the fiber was white as a feature available for the dye onto the fiber, and the rice stubble was tinted. Then, the obtained fiber was spun to make it look fluffy before being bonded to form as a special sheet material to be different from the normal particle board material [20], and the entire new sheet from rice stubble had vibrant colors with the same colors on the unrough texture for both inside and outside of the panels.
Today's furniture molding is preferable for using three-layered particle board that differed in physical appearance. Moreover, the outermost layer had a resolution in the middle part to be rough, and the outer surface was covered with a laminated board, which had the characteristics of overlapping sandwiches. Then, this resulted in higher cost wastage for the furniture manufacturing industry from the process and the precoat of the board was preferable to coat the front surface of the board as a special one [21, 22].	The sheet material was in the form of a particle board obtained from the rice stubble that had a unique feature: the boards were all the same color and texture. Therefore, it could reduce the cost of the precoat board by more than 3% of the normal production cost. Then, this helped to reduce the cost of expert technicians in painting, surface and application of baking furniture since the material made from rice stubble could be assembled as desired. Furthermore, this required only a smooth and varnished surface finish without having to paint on the furniture's surface because the material produced from the rice stubble was colorful, and the material was slick to be already in the permanent board [23].
This created the higher pollution impacts than a normal wood substitu- tion process [24].	These were the concepts of the transformation of waste from agricultural areas that were likely to cause impacts on the surrounding environment; such as, rice stubble. Then, if not converted to or encouraged to adopt, the farmers would have no choice but to destroy the stubble in their arable land [25, 26], and there was a tendency for farmers to burn the stubble in their own cultivated areas; this would affect the environment widely and severely, including affecting the environment, especially for the capital of Bangkok in the field from air pollution.
The coordination of wood substitutes in the production of partition boards would be divided into three layers of material with different textures, and the patch was then bonded with urea resin glue; when looking at the top surface, middle and bottom layers, it showed the difference of the texture of the resulting partitions, including the colors of the panels that were clearly different in color for each layer [27].	The offered products that were made to serve low-income or low-growing farmers would help create sustainable income opportunities in small localities in rural areas [28, 29], and the transformation process used was an easy process with the rest of the materials being found in the community that could be applied; this was a sustainable solution to the inequality problem that appeared in the country in order to do it another way [30].
	The physical properties of the newly developed sheet material was consistent in color across the sheet in both cross-sections, the front side of the sheet having the same color as the outer surface [31].

Table 14.
The issue of extending the current concepts into further research.

6. The friendliness value showed that the rice stubble furniture had a higher level of customer satisfaction value than the rice stubble furniture with significance in the level of .01.

7. The increasing value found that the saving of the world conformation had a higher level of customer satisfaction value than the rice stubble vases with no significance in the level of .01 (**Table 14**).

6. Discussion

In predicting the result for the years 2020–2021, Thailand would have a good trend of the expansion of the rice field area in the dry season because most people were eager to work. Furthermore, with the present situation, many jobs have ceased in large centers like Bangkok that has affected the movement of laborers back to their home town. As a consequence, the business sector in industrial locations has faced the retardation of the global economy after the COVID-19 crisis. This has resulted in many people moving back to work in agriculture, especially in cultivating the rice fields like their ancestors [32]. Therefore, the trend of remaining rice stubble would increase more than the previous cultivation season that would contribute to the preparation of the research and material development sector to gain more remaining rice stubble.

As a result, this could be applied to increase the economic value by reducing the ratio of the burning of rice stubble for preparing the cultivation area after harvesting, as well as reduce the chances of initiating the PM 2.5 problem in Thailand.

Therefore, the agriculturist groups cultivating rice in the North-eastern region of Thailand in the dry season had the trend of using the remaining rice stubble in cultivation, including transforming it to be handicraft products. Originally, they selected the tilling method that caused the problem of increasing rat infestation that resulted in the Leptospirosis infection. Then, the agriculturists selected to burn the rice stubble instead. However, provided that there was another method to remove the rice stubble from the cultivation, this would increase the income to return to the agriculturists in a suitable way. As the result, this was developed into creative rice stubble products in North-eastern Thailand.

The steps for the development of the procedure used this method to transform the remaining rice stubble to be wood substitute material by boiling. Then, the tissue was peeled for two hours, except for the immersing step that was conducted for 960 hours. These two procedures presented a similar result with small and soft fiber, especially for the fine spinning procedure into the pressing procedure [33]. Therefore, from the sheet pressing result, [34] the result of the analysis found the standard level value of JIS A 5908–1994. Similarly, the test result of the wood substitute material from rice stubble showed the specific gravity and the density quantity property through the standard that conformed with the test standard of industry products for particle board in Japan [35]. Additionally, the standard consisted of seven fields: 1) density, 2) quantity of the sheet density, 3) water absorption, 4) inflation during immersing with the mechanical property, 5) resistance of the bending strength, 6) internal bonding force, and 7) bonding force of the screw [35]. As a result, this showed the result from pressing when applying the wood substitute material procedure to use in the furniture industry [36].

When the remaining rice stubble was produced as the handicraft patterns, the customer groups showed satisfaction toward the furniture model from the rice stubble at the most level. Additionally, the customers displayed interest from the

aspects of the products with the high level of interestingness and novelty by giving importance from the most to the least levels: namely, interestingness and novelty, worthiness of the transformation, beauty, convenience to apply, and others. Then, this was conformed to the concept of handicraft products by focusing on the wood substitute material procedure by increasing the values to promote the communities and local area in suitable ways [37].

The two variables of the worthiness of the transformation and interestingness and the novelty presented the correlation with the satisfaction for new rice stubble products to the customer groups. However, beauty and the convenience to apply displayed no relationship with the customer groups' satisfaction for creative ideas as the direction of designing management for economic designs [38]. Furthermore, this included a new product development method based on the potential of the community and society to learn and develop together, which was the basic alteration for the various groups to gain sustainable development opportunities in the future for their societies and local areas [39]. Thus, it would be essential to have congruence with the environmental and economic conditions in those areas for producing the wood substitute material, and to base this on the analysis of the product with the wood substitute material design as an economic direction [40].

However, the predicted solution with satisfaction of the newly designed rice stubble furniture model could explain the alteration of the customer groups' satisfaction for the rice stubble furniture products with 44.2% of the solution that was $\acute{y} = 1.473 + (0.271\ X1) + (0.312\ X2) + (-0.040\ X3) + (0.163\ X4)$. Thus, this could be considered as the predicting procedure of product images that could be considered for the future trend of newly developed products [41, 42].

The test for applying the peeling tissue procedure with rice stubble enabled the creation of different products, and a presentation of the decorated vase made of rice stubble was made [43, 44]. Then, this was used as the assessment of the comparison for the customer groups' satisfaction, and it was found that the customer groups had satisfaction to the rice stubble furniture and the decorated vases at an excellent level. As a result, there would be a better trend if the customers had an increased satisfaction level of 1.6% to the rice stubble products by focusing on some creative ideas compared to the first model products.

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