STRATEGIC DESIGN RESEARCH JOURNAL

Influence Factors on Industrial Handmade Products Designed from Sugar Palm Fibers

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ABSTRACT

The objective of this research was to study the results of a fibers transformation procedure from sugar palm leaves into product designs. The population group included the customer group that visited the exhibition at Chulachomklao Royal Military Academy in Nakorn Nayok province, Thailand with a total of 1,398 people, and the Multistage Random Sampling with 5-point Rating Scale questionnaires was used in this research. Additionally, the Cronbach's Alpha Coefficient value was analyzed for the Variance at the level of 0.85 in One-Way or Single-Factor ANOVA. In this case, it was found that the customers had the satisfaction with the products based on five attributes at the most suitable level, (Mean = 4.044, S.D. = 0.837), and in the comparative pairs, there were the differences with the significance of .05, except for the unique factors and the suitable applied factors having strong relationships and the significant connections to one another.

Keywords: Designing; Fibers; Green Products; Products; Sugar Palm.

1. POTENTIAL OF SUGAR PALM IN AGRICULTURAL AREAS

Strategy articulation a Sugar palm is regarded as one of the many plants growing in the area of the Southeast region of the continent of Asia where there is hot and humid weather. In this case, the sugar palm has become a common local plant of Asia and Thailand. Moreover, in Thailand, it appears that there has been a connection between the community lifestyle and the sugar palms for a long time as well as the beliefs for more than 1,000 years from the past until nowadays. Consequently, most agriculturists have always planted the sugar palms in the fields or nearby their own field areas. In the past, it was popular to plant the sugar palms during the Dvaravati period of the 6th to the 11th centuries as was found from the artifacts of the people in that period and from the plant propagation. Thus, in that period, the labor of cattle was used to plow the fields for farming, including the transporting of the seeds of sugar palms to be propagated in many areas of Thailand. Therefore, with the characteristics of the sugar palm that have the high quality fibers on the trunk, on the leaves and on the fruit components, this plant is suitable to be applied for the handmade masterpieces within the local community lifestyles (Egwutvongsa et al., 2018). However, the production of these products is based on the views of the creative designs from the designers as well (Tonetto et al., 2019), together with the combination of the community to build up the new design guidelines within the new contexts (Scaletsky et al., 2019; Egwutvongsa, 2021).

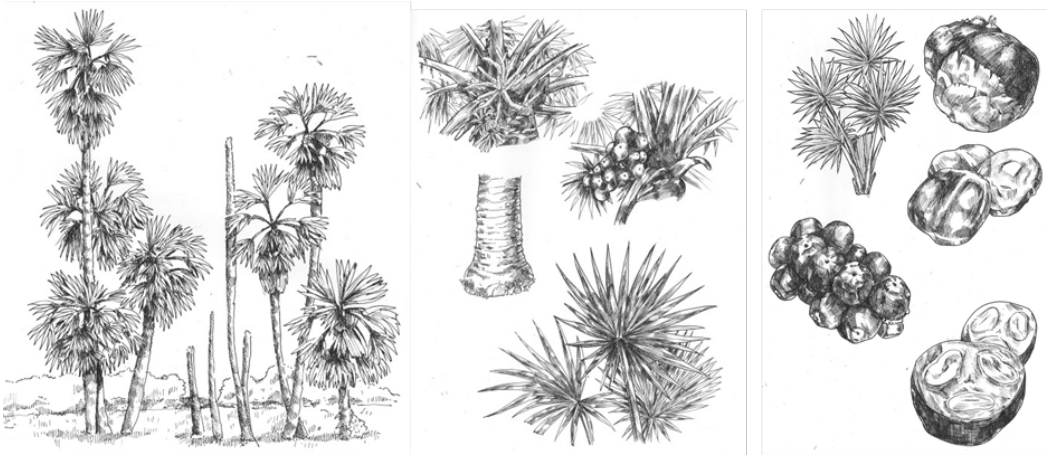

Figure 1: (a)Sugar Palm Cultivated Area and the Leaves: and (b) Fruit and Trunk Components of Sugar Palm

All components of sugar palms are beneficial in multiple ways, especially for the application in the characteristics of various handmade products for households. Moreover, from the past until nowadays, there has been a lack of leaf fibers that can be applied because the agriculturists still trim their trees frequently because the trimming of the leaves with only the top of the trees having 18 to 20 leaves remaining enables the enhanced stimulation of the growth of the sugar palms. In addition, the agriculturists always peel off the old leaves that are covering the trunks in order to gain the large and more developed trees without trimming. Therefore, due to the trunk trimming procedure performed at the sugar palm plantations, there remains an abundance of leftover leaves. However, the agriculturists still usually burn all of them, which has become one of the causes that contributes to the small dust particles of PM2.5 in Thailand, including causing the long-term effects that result in global warming (Egwutvongsa et al., 2018).

Thus, this research is aimed at the development of a procedure to utilize the fibers of the sugar palm leaves to create industrial handmade products that will add the economic value to communities and the local areas. The findings will be able to contribute to the long-term development opportunities based on the application of their own potential in local areas to establish the creative combination. In addition, the burning of the leaves can also be reduced, which will provide the benefits for the environment (H. Baumanna et al., 2002) as well as the major opportunity to add the economic value from the creative processing of the natural fibers from the sugar palm trees. This can lead to the new fibers innovation for the markets that can be applied from the unique color of the sugar palm leaves with the use of the local intelligence in the communities. In this way, it can enhance the strength of the new innovative creations by allowing the community's entrepreneurs to manufacture the products with the full processing and production cycles (Howaldt et al., 2014). Thus, the people in communities can rely on their full potential, including the presenting of the uniqueness as the outstanding points in their local area by suitable adoption of the creative use of the fibers and the products made from the sugar palm fibers.

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2. OBJECTIVES

1. To develop the transformation procedure of the fibers with the design factors of the sugar palm fibers.
2. To obtain the satisfaction assessment results from the sugar palm fiber products.

3. SCOPE

1. The scope of the procedure for the development of the sugar palm fibers includes testing the pulling force of sugar palm fibers according to the testing standard of ISO 5079:1995(E) and the factors affecting the design of the products with the objective of the development of the leaf transformation procedure for improving the effectiveness of the fibers in the textile products as well as the study of the influence factors that can be applied within the potential of the communities for the newly developed fiber transformation.

   The population includes the community group with the resident population of 1,352 people located in Thungphra sub-district, Khonsarn district of Chaiyaphum province (National Statistical Office, 2019).

   The sample group comprises a group of 300 people living in the community in Thungphra sub-district, Khonsarn district in Chaiyaphum province. In addition, the Multistage Random Sampling with the Discrepancy Level of 5 percent according to the Table of Krejcie and Morgan was used.

   The research tool used was the structured questionnaire with a 5-point rating scale assessment including reliability by Cronbach's Alpha Coefficient at the level of 0.95 by analyzing the information with statistical values (Cohen et al., 1989), and the analysis of the information was based on the factor analysis (Norliza et al., 2019).

2. The scope of the satisfaction result assessment regarding the newly developed fibers of the sugar palm products with the study objectives of obtaining the satisfaction value level from the customer group included the comparison between the new and the old fibers by analyzing the factors in the selection of the purchasing of fibers of the sugar palm products from the viewers of exhibitions to show the creative national works (Sirin, 2020).

   The population group included the customer group that visited the exhibition on Academic Day at Chulachomklao Royal Military Academy in the auditorium in Nakorn Nayok province with a total of 1,398 people from 11th to 13th November, 2018.

   The group sampling comprised the participation group that visited the exhibition on Academic Day at Chulachomklao Royal Military Academy in the auditorium in Nakorn Nayok province with a total of 1,398 people from 11th to 13th November, 2018. Thus, the Multistage Random Sampling with the Discrepancy Level at the acceptable level of 5 percent according to the Table of Krejcie and Morgan was used.

   The research tool used was the 5-point Rating Scale questionnaires including reliability by Cronbach's Alpha Coefficient at the level of 0.85 by analyzing the information with statistics and the One-Way analysis of variance or Single-Factor ANOVA.

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4. FRAMEWORK

The objective of this research was to create the transformation procedure of sugar palm fibers with creative applications (Geoffrey, 1994). Moreover, the industrial handmade products are reliant upon the community and the local potential to provide the economic

value for the valueless leftover materials from the sugar palm leaves. Therefore, the research guidelines with the Mixed Methodology based on the learning requirements with the feelings toward the materials for identifying the physical material attributes and people's perceptions were used (Teixeira et al., 2019). In this case, there was also a focus on the creation of suitable products for the green markets with the environmental friendliness (Sumalee et al., 2020).

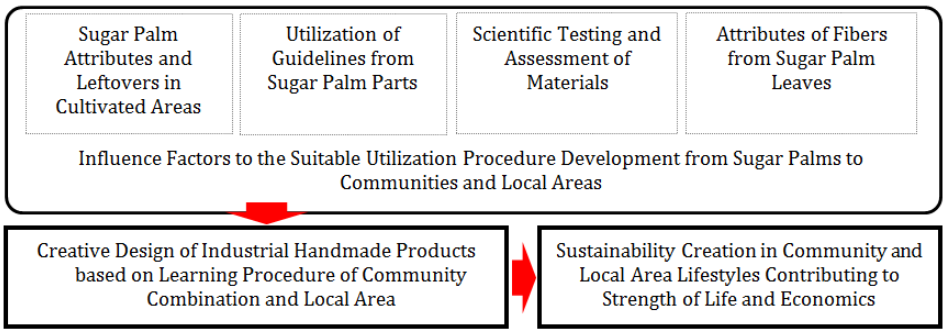

Figure 2. Relationships of the development of factor steps with the use of sugar palm leaf fibers.

According to the Operational Fr amework of the research conducted with the community participation (PAR), the focus is on knowledge creation to fulfill the research objectives and the local community development with the connection between the Social Theory and the Practical Theory. Furthermore, it is aimed at change with an emphasis on the fact that it is organic and the participation creation between the researchers and the informers as it is in collaboration with the research principles.

According to the framework of designing handmade products, the knowledge is applied to the new production method (Guilford, 1959). Besides this, it results from the participation development combined with the collaborative learning in a changing field to accept the new values from the community groups or local areas by using the development without obstructing the social community lifestyles (Lewin, 1946). In this case, it be can classified into three periods of research as the following:

1. Factual knowledge from new patterns of cognitive structure
2. Factual knowledge from new patterns in valence and value
3. Factual knowledge from motoric action

5. RESULTS

1. According to the development from the transformation procedure involving the fibers of sugar palm, there are the steps to set the goals for the transformation development of the fibers of sugar palms, including the testing of the properties of the fibers on sugar palm leaves as this part is potential in large quantities without being used by the agriculturists, except for the high effectiveness to process and utilize the fibers to add more economic value (Da Shinta et al., 2020). Thus, the transformation steps are as the following:

   A) The Trimming Step to select the effective parts is used to find the leaf parts and the bunch parts of the sugar palms that can be effectively transformed into the fibers created for the industrial handmade products with the small size and smooth beautiful surface.

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B) When peeling the leaf skin, it can be seen that the internal physical part is soft with the good suitability for boiling by peeling out the tissues where the external skin is smooth and shining.

C) Regarding the boiling procedure to peel out the fibers, it can only remove the stem on the leaves by boiling in water mixed with Sodium Hydroxide (NaOH) with 1 percent. After that, when boiling for 126 minutes, it can be seen that the stems become softer until numerous small white fibers can be seen. Also, this boiling procedure can conserve energy from the common boiling procedure by immersion for 672 hours as the replacement procedure.

A. Cutting B. Pulling Out Leaves C. Peeling Off the Skin D. Boiling E. Beating and Separating

Figure 3: Selection Procedure and Transformation of Fibers based on Community and Local Area Participation

Table 1: Comparison of Boiling Procedures to Peel Out or not Peel Out the Sugar Palm Tissues

Types of Sugar Palm Leaf Characteristics	Boiling Times (Stems of Leaves become soft and ready to be beaten)	Boiling Times (Beginning to Separate until Seeing the White Fibers on Leaves)
1. On Leaves without Peeling skin	290 minutes	347 minutes
2. On Leaves with Peeling Skin	69 minutes	126 minutes

Figure 4: Separating the Sugar Palm Fibers and Drying the Fibers Prior to Use

D) Boiling time can be reduced by the peeling method of the external surface prior to the boiling procedure for reducing the time to boil by peeling off the tissues by more than 50 percent. Then, the color of the tissues during the boiling procedure turn into dark brown. In this case, when beating them, the fibers can be separated out of the tissue parts on the leaves more easily.

E) The fibers on sugar palm leaves resulting from this procedure have the straight and long characteristics with the smoothness and shining. In addition, these fibers have the high abundance to be transformed that requires much time to beat, including the separation of the fibers from the tissues of the sugar palm leaves. However, it is possible to reduce the boiling times or immersion times of the leaves by beating the leaf skin to obtain the smaller size by splitting. Finally, the leaves will be boiled or

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immersed, which will reduce the time by more than 30 percent from the original time.

F) Test of the Properties of Sugar Palm Fibers with a Tensile Testing Machine (Instron Model 5566) at the speed ratios of 20 mm per minute and 20 mm for the distance

Fibers on Leaves (Having Potential) | Fibers on Bunches (Having Potential) | Fibers on Trunks (Having No Potential)

Figure 5: Physical Attributes of Fibers

Table 2: Fiber Analysis of Sugar Palm Leaves according to the testing standard of ISO 5079:1995(E)

Fiber of Sugar Palm Leave	Tensile	Quantity Potential
1. Fibers in Sugar Palm Leaf Bases with 35 cm	47.19 N	159 grams/on Leaves with Quantity of Average Fibers for 143 Lines
2. Fibers in the Middle of Leaves with 35 - 45 cm Coming from the Continuous Parts on the Bases	49.43 N	155 grams/on Leave with the Average Quantity for Fibers with 149 Lines
3. Fibers in the Top of Leaves with 45 - 60 cm Coming From the Continuous Parts of the Middle of Leaves	37.62 N	84 grams/on Leave with the Average Quantities for Fibers with 96 Lines
4. Fibers in the Trunks (obtained from the Side Part of Trunk)	41.33 N	2 kg with the Size of Wood as 2 x 10 x 25 cm with the Average Quantity for Fibers with 71 Lines
5. Fibers in the Sugar Palm Bunches	50.13 N	1 Bunch with the Diameter Size of 4 cm having the Average Quantity of 109 Lines

2. According to the factors of designing products from sugar palm leaf fibers, it was shown that the study of the satisfaction level with the fiber transformation procedure for 300 people in the community indicated that the fibers from the middle of leaves are at the highest level for 112 people, or with 37 percent, followed by the fibers on the base of leaves for 104 people, or with 35 percent, the fibers on the bunch of leaves for 48 people, or with 16 percent, and the fibers on the sugar palm trunks for 36 people as the lowest level, or with 12 percent.

3. According to the investigation by testing the statistics for Chi-Square equal to 59.467, it was found that the P-Value was less than 0.05. Thus, the assumption that the sugar palm fibers were similar without the difference with significance of 0.05 that results from the proportions to select the fiber type of sugar palms in different levels should be rejected. Moreover, the multiple comparisons with the use of the Marascuilo Procedure method can be made from the ratios of people living in the community with the interest to select the fibers from many parts of sugar palms (Arasti, 2014). In addition, it was found that the ratios of people selecting the sugar palm leaf bases and the middle of the sugar palm leaves were not at a different level. Thus, it can be concluded that the sugar palm leaf bases and the middle of sugar palm leaves have been selected as the most common method followed by the sugar palm bunches and the sugar palm trunks as the lowest ratios. Therefore, it is

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possible to analyze the influence factors on the selection of sugar palm fibers from the groups of people (Zellner, 2017).

4. According to the KMO value equal to 0.686 or (Sig. = 0.00), it can be concluded that the analysis of the factors was at a suitable level with sufficient samplings, and Bartlett's test value had the significance on the statistics to represent the correlation to enable the selection of the factors at an excellent level.

Table 3: The Removing of Factors by Selecting the Types of Sugar Palm Fibers

Rotated Component Matrixa				
Factors into Analysis of Procedure	Component			
	1	2	3	4
P1 : Physical Attributes of Materials and Safe Manufacturing for Materials	.784	.234	-.214	-.022
P2 : Durable and Strong Materials	.858	-.038	.152	.277
P3 : Materials are Easy for Maintaining and Applying	.701	.130	.422	.182
P4 : Materials are Long-lasting	.745	.230	.248	.307
P5 : Materials are Easy to Clean	.509	-.028	.147	.700
P6 : Suitable Materials to Produce Products	.410	-.045	.027	.856
P7 : Suitable Weight Materials to Produce Products	.009	.375	.146	.795
P8 : Materials with Beautiful Appearance	.064	.595	.139	.653
P9 : Materials to Produce Colors Attractive to Customers	-.023	.684	.299	.327
P10 : Materials to Produce Beautiful Patterns	.081	.720	.442	.177
P11 : Suitable Materials to Produce Creatively	.235	.896	.072	-.027
P12 : User-Friendly Materials	.413	.609	.451	.023
P13 : User-Friendly Procedures	.218	.323	.672	.296
P14 : It is suitable to add economic value	.048	.234	.892	.007
P15 : It is creative to add economic value	.089	.152	.872	.104

Thus, it can be determined that the variables are classified into the minor groups as the four factor groups consisting of the first factor group, which are P1, P2, P3, P4, and P5, the second factor group, which are P9, P10, P11, and P12, the third factor group, which are P13, P14, and P15, and the fourth factor group, which are P6, P7, and P8.

Table 4: The Variance of Sum of Squared Loading to Type Selection Factors for Sugar Palm Fibers

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.55	43.69	43.69	6.55	43.69	43.69	3.11	20.79	20.79
2	2.35	15.68	59.38	2.35	15.68	59.38	2.96	19.77	40.56
3	1.50	10.01	69.39	1.50	10.01	69.39	2.87	19.15	59.71
4	1.27	8.48	77.87	1.27	8.48	77.87	2.72	18.15	77.87
5	.80	5.34	83.22						
6	.67	4.50	87.73						
7	.47	3.17	90.90						
8	.37	2.47	93.38						
9	.25	1.69	95.08						
10	.22	1.47	96.55						
11	.18	1.24	97.80						
12	.12	.85	98.65						
13	.09	.61	99.26						
14	.06	.46	99.72						
15	.04	.27	100.00						

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In this case, the analysis of factors can explain the Variance of Sum of squared loading as equal to 77.877 percent. Furthermore, it assists with analysis of the structural equation with the satisfaction of the people living in the community with an interest in sugar palm leaf fibers. Thus, it is based on the results from the analysis of the four factor groups, and finally it can provide the conclusion for analyzing the causal structural equation to produce the industrial handmade products from sugar palm leaf fibers (Aryut, 2019).

Regarding the satisfaction of the people living in the community with the sugar palm leaf fibers (PScore), it consists of FP1, FP2, FP3 and FP4. Moreover, FP4 has the positive and direct influence on the fiber satisfaction of the people in the community at the highest level with the standard influencing coefficient equal to 0.84, followed by FP1 with the standard influencing coefficient equal to 0.51, FP3 with the standard influencing coefficient equal to 0.15, and FP2 with the standard influencing coefficient equal to 0.02.

Regarding the factor of FP4 (0.84), it consists of the suitable materials to produce products, the suitable weight of the materials to produce products, and the material attributes to produce products with a good appearance.

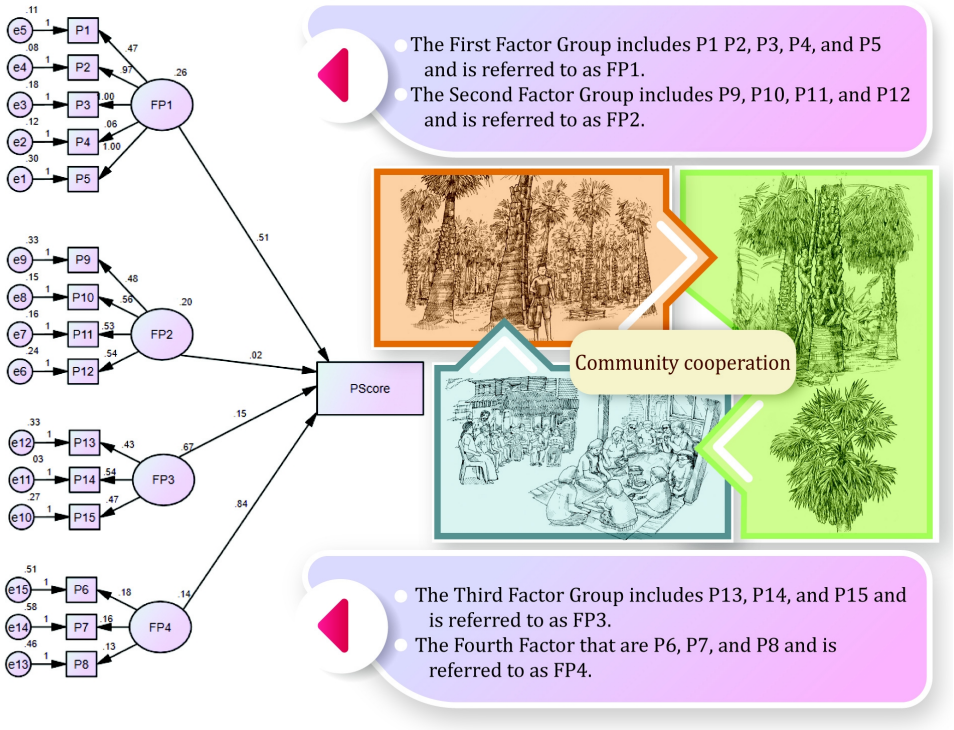

Figure 6: Pattern of consumer satisfaction towards sugar palm Leaf fiber .

In addition, it was found that the suitable materials to produce products have a direct influence on the factor of FP4 at the highest level with the standard influencing coefficient equal to 0.18, followed by the suitable weight materials to produce products with the standard influencing coefficient equal to 0.16, the material attributes to produce products having a good appearance with the standard influencing coefficient equal to 0.13.

Regarding the factor of FP1 (0.51), it consists of the physical attributes of the materials, the safety of the material production, durable and strong materials, materials that are easy for maintaining and use, and durable materials that are easy for cleaning. In this case, the materials should be easy for cleaning directly influences the factor FP1 at the highest level with the standard influencing coefficient equal to 1.00, followed by the durable and strong materials with the standard influencing coefficient equal to 0.97, the physical material attributes and safe production of materials with the standard influencing coefficient equal to 0.47, and the long-lasting materials with the standard influencing coefficient equal to 0.06.

Regarding the factor of FP3 (0.15), it consists of friendly materials, beautiful material suitable for adding economic value, suitable materials to produce for adding economic value, materials that are easy for maintaining and applying, durable materials that are easy for cleaning, and suitable materials to produce for adding economic value. In this case, the beautiful materials suitable for adding economic value directly influence the factor of FP3 at

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the highest level with the standard influencing coefficient equal to 0.54 followed by the suitable materials to produce for adding economic value with the standard influencing coefficient equal to 0.54, suitable materials to produce for adding economic value with the standard influencing coefficient equal to 0.47 and the friendly materials with the standard influencing coefficient equal to 0.43.

Regarding the factor of FP2 (0.02), it consists of attractive color materials to produce products, materials with beautiful and modern patterns, suitable materials to produce products with new development and user-friendly materials to produce products. In this case, regarding the user-friendly materials to produce products, it was found that the materials with beautiful and modern patterns had the direct effect on the factor FP2 with the standard influencing coefficient equal to 0.56, followed by the friendly material with the standard influencing coefficient equal to 0.54, the suitable materials to produce products with new development with the standard influencing coefficient equal to 0.53, and the materials to produce color products that are attractive to customers with the standard influencing coefficient equal to 0.48.

In this case, the influencing factors affecting the satisfaction of the people in the community with sugar palm leaf fibers as the creative designing framework were used (Roozenburg et al., 1995). In addition, these are the products of sugar palm leaf fibers that add economic value, including adding value to newly developed leaf fibers for responding to the customer requirements. In this case, they contributed to the fibers from the sugar palm leaves in the forming step for weaving as the products based on the testing of the effectiveness for the community groups in local areas. Thus, the testing of community groups for the mat weaving should be considered as the basic material fiber requirements with a high level of length and thinness plus low costs and easy availability in the community. As a result, the community groups still lack the raw materials to be woven as the selling products. Thus, nowadays they are interested in using the fibers from the sugar palm leaves to be formed into their mat weaving by the application of their own local wisdom patterns combined with the sugar palm leaf fiber formation. Finally, according to the results from the forming test combined with the cotton fibers, it was found that this method is finer than using the papyrus fiber material by two times because of the thinner and longer line attributes than when using the papyrus that the community groups normally use.

Figure 7: Sugar Palm Leaf Fiber Weaving Procedure from Transformation Method of the Community Group Based on Local Wisdom Combined with Creativity

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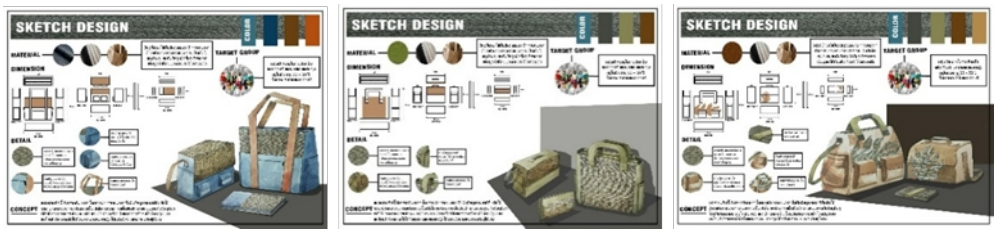
According to the steps of the creative designing procedure from sugar palm leaf fiber by applying the analysis of the design factors with the design principles (De Bono, 1999) as well as contributing to the improvement of the directional patterns and the trends of the requirements for the customers in the markets (Santos et al., 2019).

Table 5: Data Combination from the Theory Principles into the Creative Thinking Procedure

Step	Operating from applying the Principle Analysis and Design Theories for New Products
Brainstorm: Solving Problems Found in Theories (Editing)	
Designing Products: Finalizing into Creative Production	
Manufacturing in Industrial Handmade Systems (Model Manufacturing)	

According to the results from applying the sugar palm leaf fibers to add economic value from the leftover materials of the sugar palm cultivated areas by using the Recycle method, it conforms to the policy of the Ministry of Industry for the promotion of the Eco-Industry. Therefore, the leftover materials from agriculture work in communities and local areas can be beneficially applied (Wong, 2012), including with the 3Rs principle (Yoo et al., 1995).

Figure 8: Transformation Procedure and Application of Economic Benefits

In this case, the data analysis from variance with one factor of the fiber attributes applied in the five factors of the designed products has been represented (Pawinee, 2019).

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Table 6: Satisfaction Assessment Results of Customer Groups with Sugar Palm Leaf Fiber Products (n=300)

Model Assessment of Sugar Palm Leaf Fiber Products				
Assessment List	**Means**	**(S.D.)**	**Meaning**	**Std. Error**
1. Beauty Attribute	4.167	0.708	Very Suitable	0.041
2. Unique Attribute	4.423	0.626	Very Suitable	0.036
3. Attractive Color Attribute	3.333	0.916	Moderately Suitable	0.053
4. Forming Attribute with Interesting Products	3.850	0.741	Very Suitable	0.043
5. Suitable Attribute to Apply	4.447	0.607	Very Suitable	0.035
Totals	4.044	0.837	Very Suitable	0.022

As seen in Table 6, the Variance was tested by using the Test of Homogeneity of Variances with the statistics of Bartlett's Test. In addition, it was shown that the Bartlett's Statistic (BC) is equal to 67.327 and the value of Sig. is equal to 0.000 by it being concluded that the Variance value of attribution has the different factors.

Table 7: Analysis of Variances to Test the Factor Group Attributes with Customer Groups for New Products

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	259.129	4	64.782	122.290	0.000
Within Groups	791.966	1495	0.529		
Total	1051.096	1499			

Note: Critical Value (F-table = 2.377)

In this case, according to the value of significance (Sig.) from the test, it was found that F was equal to 0.000, which is less than .05, and it appeared that the mean of at least one pair had the difference with the level of significance of .05.

Table 8: Results of the Comparison Pairs of Factors

Comparison Pairs of Factors		**Mean Difference**	**LSD**	**p**
Beauty	Uniqueness	0.26*	0.12	0.000
Uniqueness	Colors of Fibers	1.09*	0.12	0.000
Colors of Fibers	Beauty	0.83*	0.12	0.000
Fiber Forming	Beauty	0.32*	0.12	0.000
Fiber Forming	Uniqueness	0.57*	0.12	0.000
Fiber Forming	Colors of Fibers	0.52*	0.12	0.000
Applying	Beauty	0.28*	0.12	0.000
Applying	Uniqueness	0.02	0.12	0.643
Applying	Colors of Fibers	1.11*	0.12	0.000
Applying	Fiber Forming	0.60*	0.12	0.000

According to the normal distribution, it was found that the mean for at least one pair had the differences by using One-Way ANOVA to test the statistics of Fisher's Least Significant Difference Test (LSD). Thus, comparison for the different results can be made in the pair factor comparison, as shown in Table 9.

Table 9: Multiple Comparisons of Satisfaction Values for Industrial Handmade Products Made from Sugar Palm Leaf Fibers

Fiber Attribution	**Beauty**	**Uniqueness**	**Color of Fiber**	**Fiber Forming**	**Applying**
Beauty		0.000*	0.000*	0.000*	0.000*
Uniqueness	0.000*		0.000*	0.000*	0.643
Colors of Fiber	0.000*	0.000*		0.000*	0.000*
Fiber Forming	0.000*	0.000*	0.000*		0.000*
Applying	0.000*	0.643	0.000*	0.000*	

According to the value of Sig., it represents the testing with significance of .05 from the

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means, in which if any different pairs of means have a value that was less than .05, it showed that there were the differences of significance for .05.

According to the results of the Multiple Comparisons, it was found that all of the comparison pairs had the differences without the relationship to each other. Therefore, it affected the increase of the response to any factor, except for the continuous satisfaction result toward the other factors. In contrast, according to the unique factor pairs and the suitable applied factors, it appeared that there is a connection between the factors.

In this case, when the designers produce the designs for the creation of industrial handmade products made from the sugar palm leaf fibers, they should focus on the response with suitable applications that increasingly gain the satisfaction values of the customers. However, if the unique factors have the satisfaction values that are decreasing, it results in there being fewer chances to apply the factors in a suitable way.

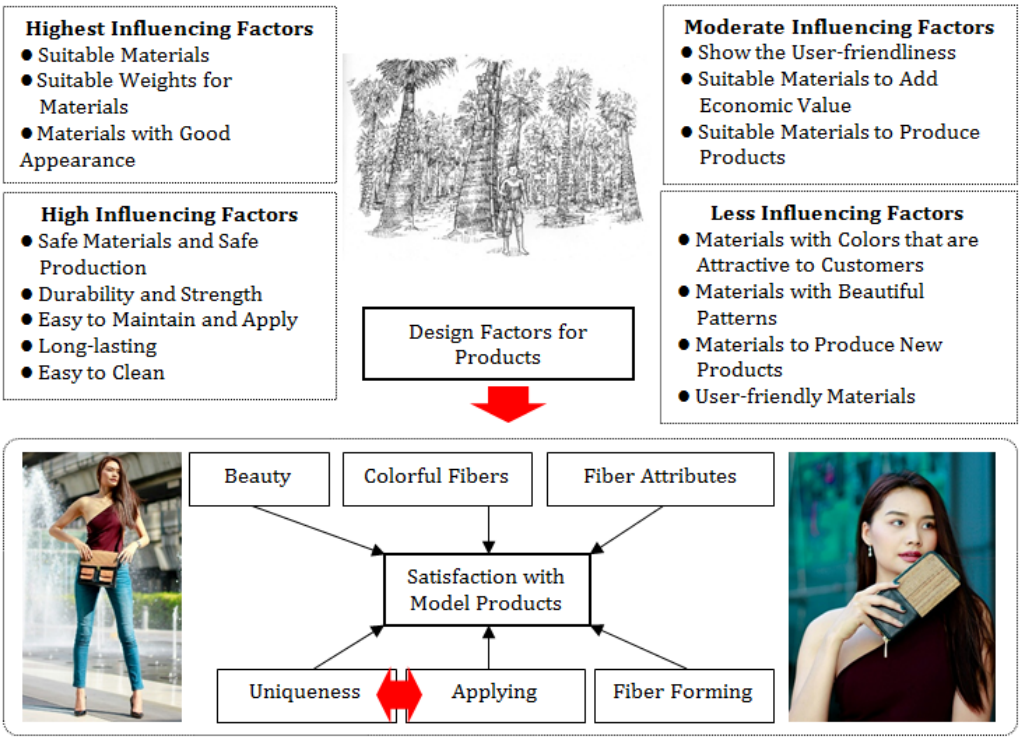

Figure 9.Relationship Structures Between the Factors and the Design of Products from Sugar Palm Leaf Fibers and the Influencing Factors on the Satisfaction of the Customers with the Products

6. DISCUSSION

According to the effective transformation method of sugar palm leaves, the leaves should be peeled off prior to beating the internal stems in order to separate them from each other. After that, they should be boiled in clean water and mixed with Sodium Hydroxide or (NaOH) at 1 percent for 126 minutes. In this case, this method causes the sugar palm leaf fibers to gain the most perfect level with the mean tensile property at the level of 44.746 N and the fiber quantities of 132.666 g per one leaf or the mean quantity of the leaf fibers at 129 lines per one leaf.

Consequently, with regard to the influencing factors on the opportunities for using the sugar palm leaves to be transformed by the people in the community groups, they can be divided into four factor groups. Furthermore, the fourth factor group or FP4 represents the chance effects for applying the leaves to the adding of economic value to the communities and the local areas that cultivate sugar palms at the highest level. Therefore, according to the above

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details, the following conclusions can be made: 1. The materials are suitable to produce products, 2. The weights of the materials are suitable to produce products, 3. The material attributes are capable of producing the attractive products, and others. Similarly, all three factors affected the leaf transformation opportunities in the community groups including the first, the second and the third factor groups as the support to cause the requirements to be effective for the leaf fiber transformation. Thus, it can also be applied in their own local community procedure. Furthermore, it contributes to the incomes and the stabilization of occupations increasingly conforming to the collecting of the concept problems to be defined prior to the design for achieving the higher effectiveness of providing solutions (Dundee, 1994).

According to the results of the fourth factor group or (FP4) and the first factor group or (FP1), it was indicated that the requirement has an effect on applying the fibers with the design and product creation based on the brainstorming procedure by integrating the solutions with the design theories. Then, it can be applied to the industrial handmade design products to create the testing models for the satisfaction assessment test with the customers at the level of the real experiment by using the customer models. In this case, it conformed to the guidelines of cooperative learning in communities and local areas with the creative integration (Mary et al., 1995).

According to the feeling factors of the customer requirements from the model products using sugar palm leaves, it indicated the satisfaction level of the customer groups in order from the highest level to the lowest level; namely, 1. suitable applying attributes, 2. unique attributes, 3. beautiful attributes, 4. interestingly formed products, and 5. colorful attributes. Additionally, according to all five attributes, it was found that all comparison pairs of the factors had the differences, except for, the unique factor pairs and suitable applying factor pairs, which are connected with each other.

According to the results of the design with assessment, it was shown that the customer groups had the satisfaction level with the bag products made from sugar palm leaves at an excellent level. In addition, according to the main opinions regarding the forming from weaving, it is based on the effectiveness of the community group skills that are received from the past. In this case, it had the most suitable level for the application to produce the new products, and it comes from the weaving procedures with the handmade characteristics that rely on the effectiveness of the local skills and abilities (Decker et al., 2019). Therefore, it is regarded as the cultural heritage transferred from the past to the subsequent generations who live in the community (Canaan, 2019). For example, it is involved with the materials made from the community skills conforming to the action research procedure (Jewpairojkit et al., 2019).

In this case, it indicates that the income earning results of the customer groups resulted in their satisfaction with the sugar palm leaf fiber products for the purpose of creating economic incomes for their community and the surrounding societies by the cultivation of the sugar palms with sustainability for both the humans and the environment (Fred, 2020).

In this case, the new developed transformation was capable of enhancing the chances of sustainable development in the communities, (Hall and Vredenburg, 2005). This enabled bringing the natural waste materials in their own local area for the conversion procedure for gaining suitable natural fibers, especially for producing handmade products by using a mat weaving skill. Therefore, this was accounted as the personal skill of the people in the

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community to make creative products by increasing income opportunities for themselves. Moreover, there were several materials in their cultivation area that would help to generate sustainable development. The differences of the people to cope with the present and future social changes would also be another factor for success (Jabareen, 2008). Finally, this resulted in reducing the social disparity of Thailand, (Motonishi, 2006) including bringing a creative designing procedure to help the community be elevated to a higher level of economics by solving their income problem and conforming to the concept of the reduction of disparity in society (Fujita and Hu, 2001). As the result, this provided the opportunity of developing the human potential of communities located in the countryside of Thailand as one alternative for conforming with the concept of creative innovation strategy and progress in the new age of the future (Jansen, 2003).

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