The Application of QFD and BMC for Furniture Development: A Case Study of Wickerwork Handicraft in Thailand

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Abstract
This research aims to present a new product design using the Business Model Canvas (BMC) technique and the Quality Function Deployment (QFD) technique. Designed furniture from Thai Puan wickerwork handicrafts, Pak Phli District, Nakhon Nayok Province. The research started by studying the needs of furniture users from Thai Phuan wicker handicrafts, Pak Phli District, Nakhon Nayok Province, using the BMC technique as a target group. Target audience Gathering demands from users of the Thai Phuan handicrafts group (Voice of Customer: VOC) and design values delivered to furniture users. It determines the population size and assigns a questionnaire to assess the degree of importance of each factor that meets. The furniture user's needs led the data to be analyzed in two separate QFD matrixes. Product planning matrix for analyzing quality characteristics and furniture product design matrix to analyze furniture designs from new wicker handicrafts. Analysis through the QFD technique yields results. There are issues of customer needs, including styles, materials, local identity. Utility, quality, etc. Design three types of Thai Puan wicker furniture products and survey customer satisfaction towards furniture products from Thai Puan handicrafts. The average joy of various attributes of furniture products from customers or general users of wicker handicraft furniture products was 4.80. The average satisfaction with the multiple features of furniture products from Thai Phuan wicker handicrafts can be designed to meet customers' needs at an excellent level.

Keywords
Business model canvas technique, Quality function deployment and furniture

1. Introduction
The production of local wicker handicrafts mainly focuses on utility based on the social conditions of each era due to the rapid social changes in the past half-century. As a result of industrial development policies that rely more on technologies and innovations, the need for direct use of woven handicrafts in daily life has decreased. Therefore, local wicker handicraft products have changed according to the changing conditions of Thai society as well. The utility is more widespread. Forms, shapes, and sizes have been developed to be different from the original and more suitable for social conditions. Making basketry handicrafts in every region of Thailand is closely related to the lives of the local people in harmony with the environment, processes, materials, and patterns of handicrafts that are available with characteristics and role models passed down from generation to generation, as shown in Figure 1. According to the data collected on the current problem, the case study of Thai Puan basketry handicrafts, Pak Phli District, Nakhon Nayok Province consisted of product design patterns. Furthermore, selling prices, cost distribution channels and marketing promotion under the constraints of community resources are also problems, with the most crucial problem being product design issues, because there are not many variations in production Mixing other materials to create new designs and skills in production has occurred as a result of the problems mentioned above The purpose of the research was to apply the principles of Business Model Canvas (BMC) and Quality Function Deployment (QFD) as tools to help design furniture from wicker handicrafts to fix the above problems and create new design guidelines with product prototypes for the basketry handicraft group to support and encourage the ability to compete and generate more income

2. Literature Review
The Business Model Canvas (BMC) is a tool for analyzing customer and product or service needs to create a business model through the relationship of target customer segments (Osterwalder 2010) and part of BMC's customer value design in addition to studying the Quality Function Deployment technique developed by Dr. Yoji Akao for the first time in the shipyard of Mitsubishi Corporation Japan in 1972. (Haren 2017).

Figure 1. Products of Thai Puan handicrafts

The Quality Function Deployment (QFD) technique helps design and develop the quality of products to meet customers' needs (Akao 2014). It is a technique that focuses on customer satisfaction and customer focus by taking feedback from customers to study and identify their actual needs and determining how to meet those needs appropriately. This has resulted in fewer mistakes in the quality of new products failing to meet customers' needs. It has also reduced product development time, making it possible to avoid design changes during the production process and creating teamwork (Maritan 2015).

The application of the QFD technique has attracted researchers and organizations to its application, such as improvements in service provision for companies that distribute products from the client's factory to the destination, which is the client's customers; as a result, service satisfaction has increased, and the number of complaints from the delivery service has decreased (Ji 2014) (Rawangwong 2020). (House of quality; HOQ), which is a matrix of QFD to develop rice packaging for souvenirs. In connecting customer needs to product design by assessing customer satisfaction, it was found that 83.11% of the prototype products were wedding favors, and 79.76% were gifts or souvenirs. This technique has helped develop product and packaging designs to meet users' needs (Sinthavalai 2018). In research related to pottery, the QFD technique has been applied in the design and development of automatic pottery wheels for small and medium-sized enterprises in India by collecting data and converting customer requirements into technical requirements before the design and development of an automatic pottery wheel.
2016).

3. Methods

In this study of applying the Business Model Canvas technique and Quality Function Deployment in furniture design from Thai Puan basketry handicrafts, the researcher set a framework for product design analysis. The scope of the study was to design furniture from Thai Puan wicker handicrafts by designing and developing products from product characteristics analyzed by applying BMC and QFD techniques derived from customer inquiries to produce new prototype products. Next, the satisfaction level on old and new products was measured and compared based on the study framework above. The guidelines can be detailed as follows:

3.1 Learning the Basics about the product

The data collected from the survey consisted of group interviews by asking about the opinions of the Thai Puan basketry handicraft group, Pak Phli District, Nakhon Nayok Province, on usage, problems, and consumer demands. A point of observation on the patterns and handicraft of basketry was set by recording the observation to apply the

information obtained in the study as a guideline for designing wicker handicraft furniture.

3.2 Customer Demand Survey

In the process of surveying to study the needs of users of furniture products from Thai Puan basketry handicrafts, the researcher requested assistance from the Thai Puan basketry handicrafts group to check the preliminary problems of the group's wicker products with experts in wicker production in consulting on issues in the development of various types of wicker handicraft products. The tool used to collect this data was the Business Model Canvas technique, which uses the relationship between two boxes, which are customer segments, to define the following target audience: Thai Puan Weaving Handicraft Group tourists related to the use of products from Thai Puan basketry handicrafts to bring inquiries, search and analyze the voice of customers or users that is occurring through main issues set up in interviews and analysis from users: 1) Customer Jobs are what customers or users do and an area where they need some help. 2) Customer Pains are the difficulties that customers or users often encounter, and 3. Customers or users expect to receive more significant amounts of customer gains. The benefit of user identification or analytics through audience segmentation is that it gives us physical insights into user behavior, needs, and goals.

3.3 Application of BMC Technique Applied Together with QFD

In product design data, by applying the BMC technique and the QFD technique by using boxes of customer segmentation and value proposition to study customer needs, pinpoint BMC's audience targeting, help with box assists in the study of customer needs (Rosnani 2020). In-product value creation data helped determine the value to be delivered to the customer in a product design solution.

4. Results and Discussion

The results of the application of the BMC technique together with QFD for furniture design from Thai Puan wicker handicrafts, Pak Phli District, Nakhon Nayok Province, were as follows:

4.1 Customer Demand Survey

Based on data collection on customer demand for furniture products from Thai Puan handicrafts, the survey results can be divided into three main business model components: product development, marketing activities, and building relationships with customer distribution channels. In total, 23 customer needs were identified by the data collection. The results from the 30 questionnaires can be used to calculate the geometric mean, which is used as essential values, and further apply the Qualitative Function Conversion technique.

4.2 Results of The Application of Qualitative Function Conversion Technique

The details on the results of bringing the data into the Product Planning Matrix or the House of Quality (HOQ) are as follows:

1) Customer Needs: The demands of 30 customers with 23 needs were placed on the left-hand side of the product planning matrix.

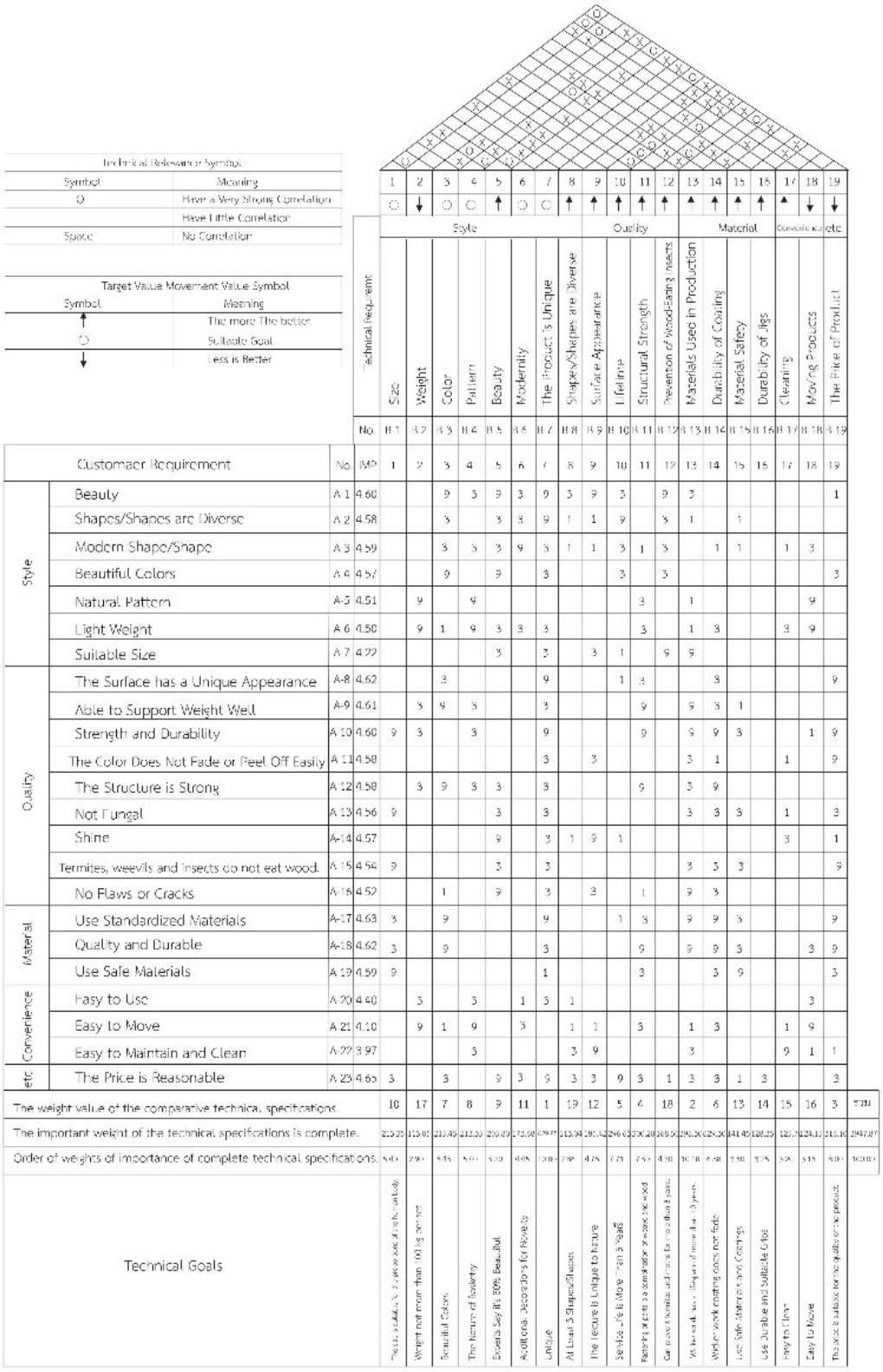
2) Creating a Planning Matrix: After the customer's requirements were met, the IMP value was the geometric mean obtained from the questionnaire to fit the needs of each customer. As shown in Figure 3, customers' needs have been focused on form and beauty as the number-one priorities.

3) Technical Requirements are techniques obtained from the brainstorming of the researcher, who analyzed the relationships to find methods capable of meeting each customer's needs. A technical target was then set by putting it to a measurable value. In addition, the researcher configured the movement of the target value to know the direction of improvement in which 19 technical requirements could be set.

4) Correlation Matrix Relationships rate the relationships between Part 1 (customer needs) and Part 3 (technical requirements) of the product planning matrix. This is achieved by rating the relationship of the product.

5) Technical Correlations - This section involved brainstorming with the researcher to determine the relationships of the techniques used in design to meet customer needs.

6) Priority Relationships Calculation from Table 1 and Figure 2 showed that the order of importance weights was compared. The highest score was for the unique product (10.80%), followed by the material used in production (10.18%). The third was the price of the product (8.00%); the fourth was structural strength (7.50%); the fifth was Lifetime (7.41%), and the sixth was the durability of coating (6.88%). The technical requirements were then sorted out, as shown in Figure 2, to have a method for designing furniture products from Thai Puan handicrafts.



Technical Relevance Symbol	
Symbol	Meaning
◎	Have a Very Strong Correlation
○	Have Little Correlation
Space	No Correlation

Target Value Movement Value Symbol	
Symbol	Meaning
↑	The more The better
○	Suitable Goal
↓	Less is Better

	Customer Requirement	No.	IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
				○	↓	○	○	↑	○	○	↑	↑	↑	↑	↑	↑	↑	↑	↑	↑	↓	↓
						Style							Quality			Material				Convenience		etc
	Technical Requirement			Size	Weight	Color	Pattern	Beauty	Modernity	The Product Is Unique	Shapes/Shapes are Diverse	Surface Appearance	Lifetime	Structural Strength	Prevention of Wood-Eating Insects	Materials Used in Production	Durability of Coating	Material Safety	Durability of Jigs	Cleaning	Moving Products	The Price of Product
		No.		B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15	B 16	B 17	B 18	B 19
Style	Beauty	A 1	4.60			9	3	9	3	9	3	9	3		9	3						1
	Shapes/Shapes are Diverse	A 2	4.58			3		3	3	9	1	1	9		3	1		1				
	Modern Shape/Shape	A 3	4.59			3	3	3	9	3	1	1	3	1	3		1	1		1	3	
	Beautiful Colors	A 4	4.57			9		9		3			3		3							3
	Natural Pattern	A 5	4.51		9		9							3		1					9	
	Light Weight	A 6	4.50		9	1	9	3	3	3				3		1	3			3	9	
	Suitable Size	A 7	4.22					3		3		3	1		9	9						
Quality	The Surface has a Unique Appearance	A-8	4.62			3				9			1	3			3					9
	Able to Support Weight Well	A-9	4.61		3	9	3			3				9		9	3	1				
	Strength and Durability	A 10	4.60	9	3		3			9				9		9	9	3			1	9
	The Color Does Not Fade or Peel Off Easily	A 11	4.58							3		3				3	1			1		9
	The Structure is Strong	A 12	4.58		3	9	3	3		3				9		3	9					
	Not Fungal	A 13	4.56	9				3		3						3	3	3		1		3
	Shine	A-14	4.57					9		3	1	9	1							3		1
	Termites, weevils and insects do not eat wood.	A 15	4.54	9				3		3						3	3	3				9
	No Flaws or Cracks	A-16	4.52			1		9		3		10		1		9	3					
Material	Use Standardized Materials	A-17	4.63	3		9				9			1	3		9	9	3				9
	Quality and Durable	A-18	4.62	3		9				3				9		9	9	3			3	9
	Use Safe Materials	A 19	4.59	9						1				3			3	9				3
Convenience	Easy to Use	A 20	4.40		3		3		1	3	1										3	
	Easy to Move	A 21	4.10		9	1	9		3		1	1		3		1	3			1	9	
	Easy to Maintain and Clean	A 22	3.97				3				3	9				3				9	1	1
etc	The Price is Reasonable	A 23	4.65	3		3		9	3	9	3	3	9	3	1	3	3	1	3			3
The weight value of the comparative technical specifications.				10	17	7	8	9	11	1	19	12	5	6	18	2	6	13	14	15	16	3	330
The important weight of the technical specifications is complete.				215.55	113.05	213.45	211.20	209.49	172.68	69.87	213.04	201.42	296.65	200.28	169.92	295.20	329.20	341.49	180.25	122.74	124.13	216.30	2947.07
Order of weights of importance of complete technical specifications.				5.45	2.90	5.35	5.00	5.20	4.05	1.80	5.29	4.25	7.21	5.01	4.30	10.18	8.68	3.80	3.05	3.10	3.15	5.50	100.00
Technical Goals				The size suitable for the person who will use the furniture	Weight not more than 100 kg per set	Beautiful Colors	The texture of Roderty	Events Say It, It's Beautiful	Additional Decorations for Novelty	Unique	At least 3 Shapes/Shapes	The texture is Unique to nature	Service Life is More Than 5 Years	Retaining agents as a combination of wood-eating insects	Can absorb humidity and move between seasons	When the work is Expected to last more than 10 years	Water-based coating does not fade	Use Safe Materials and Coatings	Use Durable and Suitable Glue	Easy to Clean	Easy to Move	The price is suitable for the quality of the product	

Figure 2. House of Quality for Furniture design

Table 1. Technical Requirement and Relative Weight

No.	Technical Requirement	Absolute Technical Requirement	% Relative Technical Requirement Important
B-7	The Product is Unique.	429.85	10.80
B 13	Material Used in Production	398.30	10.18
B 19	Price of Product	316.10	8.00
B 11	Structural Strength	300.20	7.50
B 10	Lifetime	296.63	7.41
B-14	Durability of Coating	269.30	6.88
B 3	Color	215.45	5.45
B-4	Pattern	213.35	5.40
B 5	Beauty	205.80	5.20
B-1	Size	185.42	4.75
B 6	Modernity	173.68	4.45
B 9	Surface Appearance	168.50	4.30
B 15	Material Safety	141.45	3.50
B-16	Durability of Jigs	128.35	3.25
B 17	Cleaning	125.70	3.20
B-18	Moving Products	124.15	3.15
B 2	Weight	113.05	2.90
B-12	Prevention of Wood-Eating Moths	80.99	2.00
B 8	Shapes/Shapes are Diverse	61.60	1.68

4.3 Product Design Results from Thai Puan Basketry Handicrafts

The design and development of furniture products from Thai Puan handicrafts begin with obtaining various technical requirements, and the researcher selected the following six technical requirements for the design:

1) Product Price - The product's price is determined according to the design, material selection, and product formation.
2) Materials Used in Production – Wicker, mostly rattan, is generally selected for durability in use.
3) Durability of Furniture Coating Solution - Appropriate coating solutions must be selected, so the coating does not peel or fade within five years.
4) Beauty - The product needs an attractive shape with an eye-catching weave pattern and exquisite adornment.
5) Service Life - Products should be designed and materials selected to last for more than five years.
6) Structural Strength - Products should be designed to have a strong structure with a continuous weave, tightness, suitability, and durable jig materials. Therefore, the researchers and furniture manufacturers from Thai Puan basketry handicrafts designed and formed furniture products from Thai Puan wicker handicrafts, which yielded three new styles as shown in Figures 3 and 4.

Figure 3. Preliminary design

Figure 4. Furniture from Thai Puan wickerwork handicraft

The results of the satisfaction assessment of the new products were as follows: Based on the satisfaction survey on furniture products from Thai Puan handicrafts in Figure 5, it can be seen that the customers have a relatively high satisfaction level concerning the features of furniture from Thai Puan handicrafts. The satisfaction values of various characteristics of furniture products from Thai Phuan wicker handicrafts averaged 4.80, which was an excellent level. The features drawing the highest level of satisfaction from customers was gloss (4.65), followed by structural strength (4.63), colors that do not fade or peel off (4.62) and are not moldy (4.62), which is noticeably consistent with the relationship of technical requirements in the design.

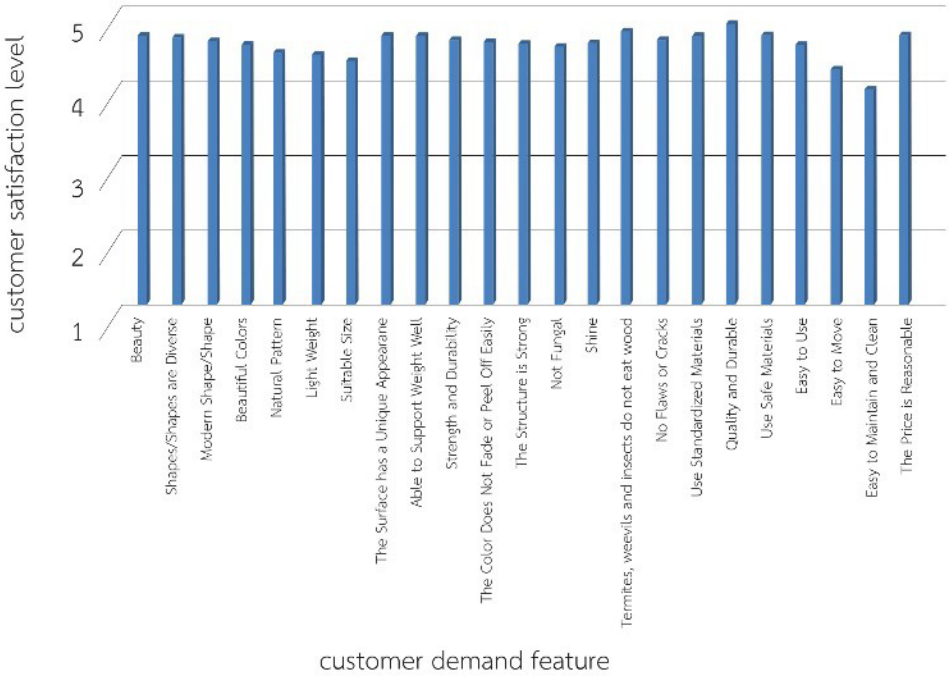


Figure 5. Customer satisfaction of preliminary product

5. Conclusion

This research involved the application of the BMC technique together with the QFD technique in the first phase on Houses of Quality (HOQ) for the design and development of Thai Puan handicraft furniture products of the Thai Puan handicrafts group, Pak Phli District, Nakhon Nayok Province. This research begins with a questionnaire design. A total of 23 customer requirements were then surveyed. The research data revealed that the top three IMP values, or highest priority values, were aesthetics (4.80), flat surfaces (4.65), and modern shapes/shapes (4.63), with a score equal to the standard for material use (4.62), indicating that the customers prioritized form, quality, and materials. The level of customer satisfaction and the customer's requirement attributes must be aesthetic appearance, smooth surface, modern shape/shape, and standard materials as an element in purchasing decisions. The next part was technical requirements. According to the findings of this research, 19 provisions in this section were defined, then the correlation matrix was analyzed (relationships) to identify technical correlations. As a future study, new experimental designed methods such as Taguchi design (Pasura 2021) (Ruekkasaem 2018), Triz developed (Vongvit 2019), and minimizing cost of production planning (Ruekkasaem 2020) were suggested.

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