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Application of Quality Function Deployment in Sport Bra Product Development

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ABSTRACT

Apparel design and product development is complicate. The product itself is highly involved in functional, aesthetical and expression characteristic. In a large organization, the communication among all related units in order to develop a new product are inefficient. To promote a cross-functional working team, Quality Function Deployment (QFD) is applied on a sport bra product development of the leading sport bra manufacturing in Thailand. The study includes a marketing survey on target customers (judgmental sample size = 79) and a QFD application on product development planning process. The study shows the potential of using QFD as a tool for product development and it facilitates the communication and information transferred between marketing to research and development and to raw material unit, respectively. With this technological management tool, the product development process is more efficient.

Key words: QFD, product development in apparel, sport bra, fashion product, marketing research

INTRODUCTION

Unlike food product, apparel product is a high involvement commodity. It can be utilized through various characteristics such as function, aesthetic and expression. Function characteristic is straightforward. It is a product performance and can be set as product specifications. Aesthetical characteristic is abstract, since there is no single true opinion, mostly based on fashion and trend each year. Expressive characteristic is another issue. It is a characteristic indicating brand signature and expresses self-image or personality to the wearer (Yueh, 1995).

To develop an apparel manufacturing, it needs intensive involvement among various units of production. The new product should integrate all aspects of function, aesthetic and expression in order to satisfy the customers' demand. In addition, quality control for product consistency and cost effectiveness are the vital issues as well.

Quality Function Deployment (QFD) is adopted as an organizing tool for product development process. QFD consists of four steps: product design, raw material planning, process planning and production control process. Figure 1 shows how information is organized and transformed to four matrixes of QFD. We define each matrix as matrix 1, where i = 1, 2, 3 and 4, representing a product concept (customer needs and product technical requirements), a raw material plan (technical requirements and raw

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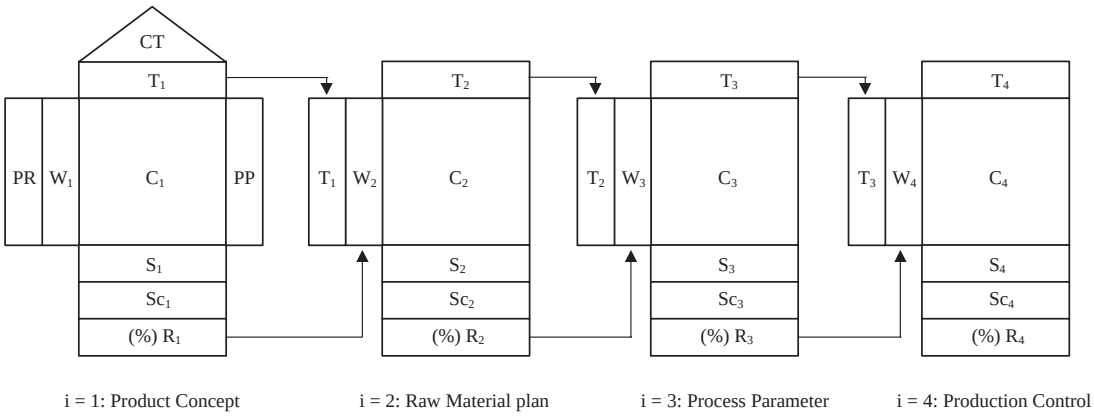

Marketing Research:

PR, PP = Product requirements and Product performance compared with competitive products
W_i = Important weight (W_1: Product requirements weight from marketing research, W_{2-4}: converted from R_{1-3}, respectively)

Brainstorm and technical test:

T_i = Technical requirement (T_1: Product requirement, T_2: Raw Material/part requirement, T_3: Process parameter, T_4: Production Control process)
C_T = Correlation between product technical requirement (T_i) (negative C_T means trade-off in product technical properties)
C_i = Matrix correlation (C_1: PR and T_1; C_2: T_1 and T_2; C_3: T_2 and T_3; C_4: T_3 and T_4)
S_i = Specification corresponding to Technical requirement (T_i)

Calculation:

Sc_i = Interaction between W_i and C_i for each requirement except for Sc_1 calculated from W_1, C_1 and PP
R_i = % relative absolute important of Sc_i

Figure 1 Four-phase Quality Function Deployment model.

material requirements), a process parameter (material requirements and process parameters) and a production control (process parameters and control processes), respectively. The work begins systematically from matrix 1 by identifying the product requirements and performance. Next we rate the importance of the requirements. Then, the brainstorming with other related working department for the consequent or related technical requirement (T_i) and setting the matrix correlation (C_i) between those requirements and technical impacts are proceeded. Technical specification (S_i) for technical target or control is then set. Finally, we prioritize those consequent technical impacts by using score (Sc_i), calculate the relative absolute importance value (R_i) and rank them as a final step. These relative absolute important values (R_i) of each technical impact (T_i) indicate the concerned priority. In matrix 2, 3 and 4 the raw material or product part, the process parameter and production control process are set as corresponding technical impact (T_2, T_3 and T_4) by a cross-functional product development team. Finally, all matrixes return the relative absolute important value (R_i) in order to determine which technical requirements should be transferred to the next matrix. With systematic working and communication, QFD allows the high cross-functional working team of product development and the record of product development process following the quality

assurance steps of Plan-Do-Check-Act working cycle (Hofmeister, 1991; Holmen and Kristensen, 1996).

This research applied QFD on sport bra as an example of apparel product development since all functional, aesthetical and expressive characteristics are required by customers. There are two main objectives. First, to compare the traditional product development procedures with the QFD application in product development in sport bra manufacturing. Second, to evaluate the potential usage of QFD as a tool in PD for sport bra production.

MATERIALS AND METHODS

The observation of the traditional product development process

We observe the PD process at the sport bra-manufacturing leader in Thailand. All information was collected by interviewing a manager from the department of marketing, research and development, raw material procurement, production and quality control.

The analysis of the product requirement and product performance

Questionnaire 1 (Q1) is developed for collecting data of customers' demographic, factors of buying decision and unsatisfying issues on sport bra. All Product requirement factors are ranked for the important level. Questionnaire 2 (Q2) is used for identifying product performance and for benchmarking with other two competitive products based on all satisfaction factors found in Q1. The survey used a judgmental sampling plan. Q2 is distributed to sport bra owner only. All data are collected at sport club, public park, public indoor stadium in Bangkok from November, 2005-January, 2006. All data are analyzed by using geometric means. Both questionnaires have been tested and adjusted until reliable at Cronbach's Alpha ≥ 0.8 (Churchill and Dawn, 2002).

The integration of all results in QFD model

The information of product requirements and their weight of importance and the performance compared with other two competitors are the input of the first product-planning matrix (Shin and Kim, 2000). From brainstorming and literature review, the research and development team convert these product requirements to technical requirements, and set the target specification and priority for each technical requirement in order to plan for raw material. The target specification is set for each material technical requirement. Finally, the importance of each raw material technique was calculated.

RESULTS AND DISCUSSION

The sport bra production and traditional product development process

The new product development sequentially initiates by marketing department assigning a product concept to R&D unit. The R&D unit consists of design part, raw material procurement, body contour research and pilot scale study unit. From the given product concept, designer will create a few sport bra designs. Then, the designed products are sent to the marketing unit for making a selection.

Next we consider the interaction among designer, raw material procurement person, body contour researcher and pilot scale study unit. Raw material procurement is searching for the proper specification of fabric material and assembling accessory. This unit also estimates for the raw material cost that must be approved by marketing department. Body contour research unit interviews and conducts a wearing test on a new product with the company's focus group customers. The process goes backward and forward for approving and readjusting until the new product is fit both in design and wearing test result. Then, a pilot scale study unit is in charge for setting the cutting and sewing pattern for mass production. Typical new

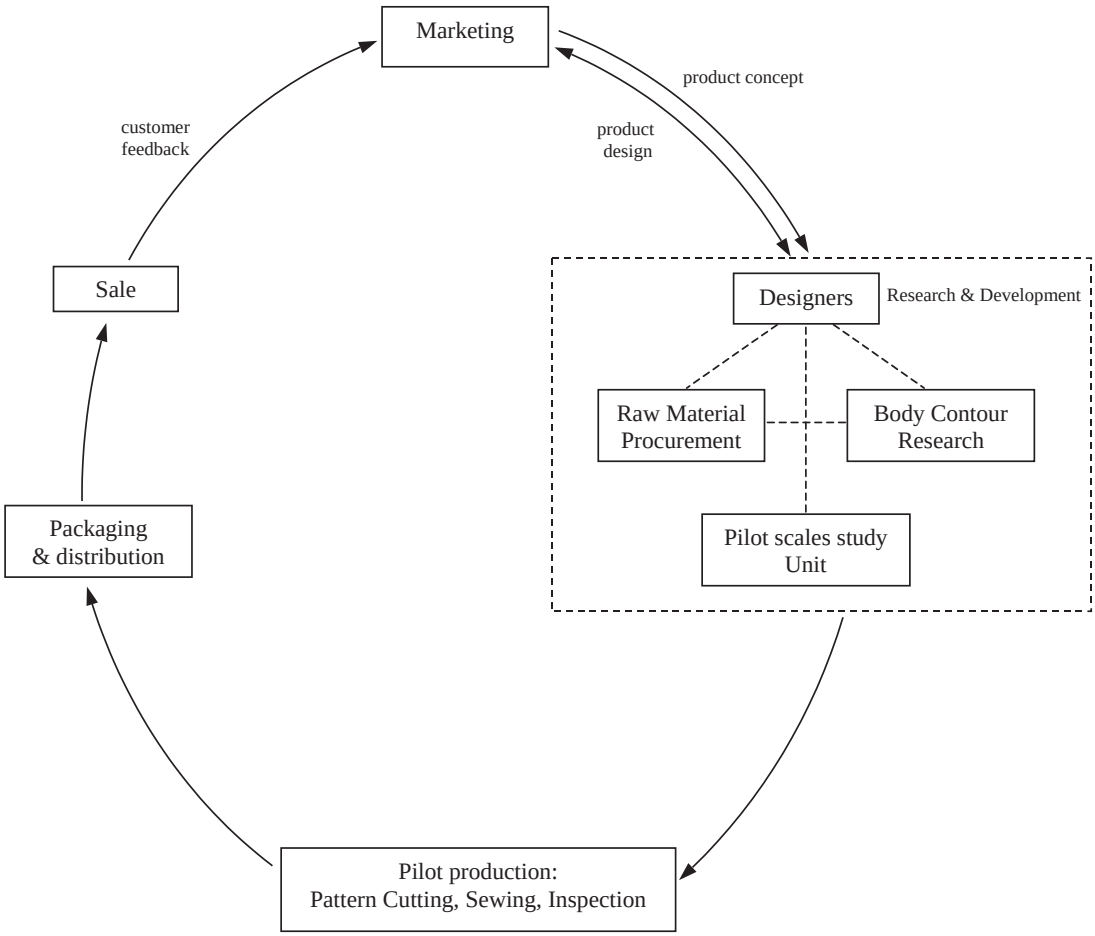

Figure 2 The sport bra product development and production process.

product must be finished every six months due to the policy of launching new collect to the market.

The problems found in the product development process are the meeting time constraints for the product development cross-functional teams, therefore final idea is hardly concluded and sometime six months was too short for a new product development. Other problems frequently occurred are the raw materials searching time consuming and the incompatibility between the design and sewing technique. Therefore, the adjusting process repeats many times between these two units.

The analyzing for customers' buying decision, unsatisfying factors, product requirement and performance

Seventy-nine people from sport clubs fill in Questionnaire (Q1). The results show that 70% of the sample belongs to the segment of enjoyment-sport participants who frequently do an exercise around 3-5 times weekly. The other 30% of sample belonged to the segment of the lifestyle adapters who sometime do exercise or play sport. These people need sporty image and depend on fashion. Therefore, they will frequently buy sportswear.

According to the segment of sportswear customer (Cholchartpinyo, 2006), the results of buying decision factors in Table 1 are corresponding to their expected buying behavior. The most important factors of buying decision are product quality and function, while the design is the second important buying factor. In a sport bra product, customer will expect product functional performance, as a minimum requirement while the design is the extra for more satisfaction. For a product unsatisfaction part, the most unsatisfying factors are the product design or product aesthetical characteristics. The product requirements and performance benchmarking with other two competitors are shown in QFD product development part.

The product development by QFD in sport bra product

Customer requirements on a sport bra (Figure 3) can be categorized to five parts: product, packaging, price, brand image and service. For the sport bra itself, the requirements were divided into a functional performance such as fitting and supporting properties, durability in terms of wearing and washing and aesthetical characteristics of a product design. The important weight (IMP) is assigned to each customer requirement. The marketing research also covered the performance comparison with other two competitive products (product B and product C) for each product requirements. The improvement ratio is calculated from the highest rating score of product A, B or C over the rating score of product A. According to the improvement ratio, the case product is now still relatively weak in requirements such as the cause of skin irritation, fungi problem on product fabric, design variety, price and sale service quality. To identify the improvement besides using the value of improvement ratio, the score of each product requirement benchmarking with others is important as well. For example, in the requirement of product color availability, the improvement ratio indicates the best in class level. However, the score on such requirement is only 5 from 9. This implies that all products in the market give average satisfaction to the customers and the company may consider improving its product to this channel. To integrate the product performance to the importance of each product requirement, the important weight is recalculated by interacting with the improvement ratio. From important weight on Figure 3, the most important requirement in customer and product performance point of view is the fabric fungi problem with the weight of 10.58.

Next, all these important information from the marketing are link to the product development and technical unit by assigning (1, 3, 9) correlation score as appeared in the matrix. For example, when customer said the product is durable, technical interpretations are fabric stretching stability and product shape stability. In addition, durability can be related to product color stability and other assemble parts stability under properly using and washing condition.

By interacting product important weight to the correlation value, the important requirement of each technological requirement can be calculated and ranked by using relative technical requirement value. Such value shows the importance of technical requirement test on

Table 1 Factors for buying decision and conditions of product unsatisfaction.

Buying Decision	Frequency	Product unsatisfaction	Frequency
Product function	43 %	Design: less variety	66 %
Design	27 %	Unreasonable price	20 %
Comfortability	17 %	Sale assistance	10 %
Reasonable price	13 %	Product quality: sewing technique	4 %

			Technical requirement																		
			Stretching stability: force, temp	Color stability: sweat, detergent	Shape stability: force, temp	Stability of assemble parts	Ventilation properties	Pattern and sewing technique	Fitting test	Muscle supporting test	Wearing comfortably	Chemical on fabric	Style availability	Color availability	Information on packaging	Personality of sale	Product knowledge of sale	Product A (case)	Product B (Competitive)	Product C (Competitive)	Improvement ratio	Importance weight
Customer requirements		IMP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15					
1)Product	fit with the body at side and cleavage part	8.21			9			9	9	9	9							8	7	7	1.0	8.21
1.1)Performance	not move when exercise	8.12	3		9			9	9	9	9							8	7	7	1.0	8.12
	allow free movement	8.01	3		9			9	9	9	9							8	8	7	1.0	8.01
	minimize breast shaking when jumping	7.93	3		9			9	9	9	9							8	8	8	1.0	7.93
	good heat ventilation	7.10		3			9		9		9							8	7	7	1.0	7.10
	soft and get comfortable when wearing	7.48	3		3			3	9		9							7	8	8	1.1	8.55
	good sweat absorbing and less muddy order	7.21							9		9							8	7	7	1.0	7.21
	dry easily	5.76			3		9	3	3		3							7	7	7	1.0	5.76
	not make skin irritating	7.66							9		9	9						6	7	7	1.2	8.94
1.2) Durability	durable	7.90	9	3	9	9												8	8	8	1.0	7.90
	not get old easily	7.95	9	9	3	9												9	9	8	1.0	7.95
	easy to clean and take care	7.62	3	3	9	3	1											8	8	8	1.0	7.62
	no fabric fungi problem	7.94		3			3					3						6	7	8	1.3	10.58
1.3) Design	look trendy, fashionable	5.96						9	3		3		9	9				5	5	6	1.2	7.15
	many color available	5.52												9				5	5	5	1.0	5.52
	various style to choose	6.94											9	9				7	7	7	1.0	6.94
	go well under T-shirt	6.64						9										7	7	7	1.0	6.64
2) Packaging and	explain for caring instruction	6.17													9		9	8	8	8	1.0	6.17
labeling	explain for product performance	6.98													9		9	8	8	8	1.0	6.98
3) Price	reasonable	7.63	3	3	3	3	9			3	3				3	3	3	7	7	8	1.1	8.72
4)brand Image	reliable	6.48							3	3	3				9	9	9	9	9	8	1.0	6.48
5) Service	good service and suggestion for product	5.97														9	9	5	6	5	1.2	7.16
	Target		in Table 2																			
	Absolute Technical Requirement IMP		289	197	523	192	234	457	635	336	661	112	127	176	203	149	267					
	Relative Technical Requirement IMP (%)		6.3	4.3	11.5	4.2	5.1	10.0	13.9	7.4	14.5	2.5	2.8	3.9	4.5	3.3	5.9					

Figure 3 Product design planning matrix that combines information from marketing research with information from product technology.

product. For example, the product-planning matrix shows that the measurement for product wearing comfortability is the most important and the next measurement is fitting test and test for pattern and sewing technique. The target or specification for each technical test on product is shown in Table 2. These values are set in order to meet the customer product requirement.

After finalizing for the product design, the next step is plan for raw material or part characteristic, determined by product technical requirement. Ten product technical requirements ranked by the important weight after converting from percentage unit to 5-scale by assigning the highest relative importance as 5 and the remaining are calculated accordingly. From figure 4, we found that only technical requirements related to all raw materials are transferred. The requirements related to design such as color and style availability, the packaging related and sale personal related requirements are separated. This information can be transferred directly to all related units. According to technical requirements, all relevant part characteristics are fabric material and assemble material. This matrix can help the raw material procurement unit to organize the specification of all materials required for the new product. According to the information transferring system, all planning is customer-oriented.

Since the current problem of the product development process in a raw material procurement process is time consuming, the QFD can facilitate the finalized product concepts with technical specification. Thus, these information will help the raw material unit to define the raw material specifications, thus the processing time is shorter.

The next process parameter planning and control matrix are not used since the process depends highly on skill workers of cutting and sewing unit. The control process is done by visual inspection of cutting part, sewing part and finished product.

CONCLUSION

Compared with the sequential product development process currently used in the manufacturing, QFD promotes the cross-functional working team and is suitable for product

Table 2 A target or specification setting for technical requirement in product planning matrix.

Technical requirement	Target
1. Stretching stability under force, temp	≥ 100 using times
2. Color stability under sweat, detergent	≥ 100 washing times
3. Shape stability under force, temp	≥ 100 using times
4. Stability of assemble parts	≥ 100 washing times
5. Ventilation properties	= the fabric specification
6. Pattern and sewing technique	= 90% acceptance from fitting test
7. Fitting test	= 90% acceptance from fitting test
8. Muscle supporting test	= 90% acceptance from fitting test
9. Wearing comfortably	= 90% acceptance from fitting test
10. Chemical on fabric	= regular standard
11. Style availability	≥ 3 styles per collection
12. Color availability	≥ 5 colors per collection
13. Information on packaging	= 90% satisfying by customer testing
14. Personality of sale	= 90% satisfying by customer testing
15. Product knowledge of sale	= 90% satisfying by customer testing

		Part characteristic						
		fabric material				assemble material		
Technical requirement	IMP	fabric specification setting	fabric composition	fabric fiber stability	chemical composition	assembly part specification	durability to washing	aesthetic characteristic
1. Stretching stability under force, temp	2.2	9		9				
2. Color stability under sweat, detergent	1.5	9				3	9	
3. Shape stability under force, temp	4.0	9		9			3	
4. Stability of assemble parts	1.4				9		9	
5. Ventilation properties	1.8		9					
6. Pattern and sewing technique	3.5	3	3					
7. Fitting test	4.8	3	9	3		9		9
8. Muscle supporting test	2.5		9	3				
9. Wearing comfortably	5.0	9	9	3	9	9		
10. Chemical on fabric	0.8	9				9		
Target								
Absolute Importance		146	137	93	58	100	38	43
% Relative importance		23.8	22.3	15.1	9.4	16.2	6.2	7.0

Figure 4 Raw material or part characteristic planning matrix.

development of high involvement in product demand aspects like sport bra. In order to cover all functional, aesthetical and expressional characteristic requirements from the customers, QFD shows a high potential for using as a planning tool especially in a large organization where the communication and making for a product conclusion across functional unit is inefficient.

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