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Application of Quality Function Deployment in Instant Rice Noodle Product Development

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ABSTRACT

Strategies for customer-oriented product development are an essential strategy for remaining competitive in a highly competitive business environment with changing markets. This research used instant rice noodles as a representative food product in a highly competitive market. The two main objectives were to analyze attitude and value awareness on target customers of instant rice noodle and to evaluate the potential of using Quality Function Deployment (QFD) in the product development process. The research began with a survey of target consumers (n = 300) on two contents of attitude distribution according to the concept of cross-cultural consumer characterization (4Cs) and the product quality requirements compared with other competitors. The information of product requirements and performance were used to develop new product concepts by QFD procedure. The attitude distribution survey found that the target customers of instant rice noodle product had attitude types mainly belongs to Reformer and Mainstreamer class. These types of attitude classes had a significant correlation to the product characteristics of sensory quality, added nutrition, convenience and price. Such information could be used for product communication. For QFD employment on instant rice noodle product development, it showed the potential as a product development tool, focusing on a customer-oriented direction. Based on customer requirements, the most important of product technical specifications found from QFD were packaging material, noodle rehydration time, and package form. The important process parameters related to such technical specifications were rice and seasoning specification setting and drying rate condition. The control plans were then developed according to the process parameters.

Key words: QFD, food product development process, instance-rice noodle, marketing research, customer-oriented

INTRODUCTION

Competitive businesses are able to maintain products with both high market share and growth rate in a market position known star phase. In the food industry, product development is a common strategic plan for keeping a product in a star phase (Kolter, 2000). Traditional food product development is a sequential working step among functional departments, mainly between marketing and research and development (R&D). This sequential working step creates a limited communication between these relevant departments. Food product concept can be

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prescribed from a marketing department or directly established by the R&D unit according to their own expertise. Either way, the development rarely occurs with systematically cross-functional communication among all relevant units such as marketing, R&D, production, engineering or quality control. Therefore, failure rate in traditional product development remains high due to problems with product planning, management, concept creation or product launching execution (Lord, 2000).

To improve the working framework of product development, Quality Function Deployment (QFD) has been introduced. QFD is a planning tool for consumer-oriented product development. It helps organize all related data from one department to the others using matrix correlation. A typical QFD contains four matrixes of product planning or concept, product part planning, process parameter planning and production control operation (Figure 1).

In a product-planning matrix called House of Quality (HOQ), the information of product requirement and product performance obtained from a marketing research is placed on a row position and interpreted for a set of measurable technical requirements located in a column position of the matrix. These technical requirements are ranked by importance based on customer needs and transferred to row position of the second matrix. The second matrix of product part or raw material planning uses this technical requirement to determine the ingredient or raw material specification located in the column position. Repeating the procedure as a previous step, the process parameter that related to the target raw material specification is set at the column position in the third matrix of process planning. Ultimately, the production control plan is established in the last matrix based on the required process parameter. Currently, QFD has been employed in food product development for low-fat bread spread, chocolate, and smoke fish product, however, it is mainly use HOQ matrix for development of product concept (Benner *et al*., 2003; Viaene and Januszewska, 1999).

Beside a tool like QFD, the success of product development depends on how the product is communicated to the target customers. Based on the concept of cross cultural consumer characterization (4Cs), customer can be segmented according to their attitudes and values awareness. The 4Cs explains that although the customers may have a same age or income level, they do not necessary to have the same buying behavior because of the different attitude and value awareness. A customer can have a combination of many attitudes listed in Table 1. Those attitude types are classified according to value awareness and behavior. Therefore the ability to identify the

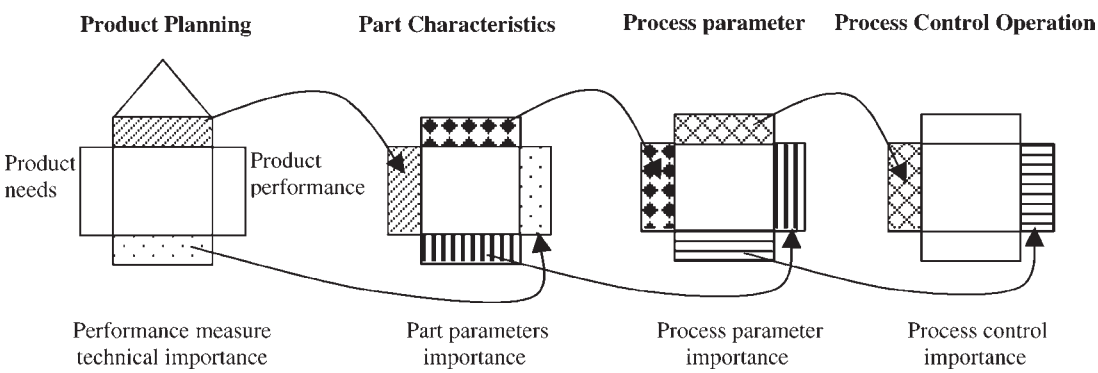

Figure 1 Quality Function Deployment model from product concept development to product part characteristic determination to process establishment and process control plan design.

Table 1 Customer segmentation based on cross cultural consumer characterization (4Cs).

Attitude class	Value awareness	Behavior example
1. Reformer	Enlightenment	Opinion expression, participate for a better society, environment, need quality time for living
2. Explorer	Discover	Looking for new experience or adventure activities
3. Succeeder	Control	High self-esteemed and income, looking for professional working, using health products
4. Aspirer	Status	Image is important, always use brand name and trendy products
5. Mainstreamer	Security	Prefer a regular life with family, not a risk taker, always compare the product quality and price
6. Struggler	Escape	Loss of opportunity for better life, insufficient income for living, always play lotto
7. Resigned poor	Survival	Relatively older aged, extremely conservative, no future and always avoid social activity

distribution of attitudes from the target customer will suggest which product benefits should be highlighted for communication (Pom, 2005).

To combine both concepts of QFD and customer segmentation on 4Cs, research was conducted on product development for instant rice noodles as a representative food product in a high competitive and changing market. The first objective was to evaluate the attitude distribution of the target customer and to correlate attitudes with value awareness for the product. The second objective was to study the potential for applying QFD to food product development from concept to production control.

MATERIALS AND METHODS

Instant rice noodle from 3 leading companies were labeled "product A", "product B" and "product C". Product A was selected as a case study product in order to identify customer needs. Product B and C were used to make performance comparison with Product A.

Sample selection

Random sampling was used to select 300 target customers who take care of household shopping and who were either college students, office workers, or supermarket customers. Market surveys were performed at multiple locations between October-November, 2005.

Analysis of cross cultural consumer characterization (4Cs)

Questionnaire 1 (Q1) was developed to collect demographic information and 4Cs of the target customers. In the 4Cs data collecting part contains several question groups of interesting activities, value awareness, lifestyle and opinion agreement. Based on this part analysis, the distribution of attitude characteristics of target customers were calculated as the geometric mean of each question group corresponding to their attitude classes.

Analysis of consumer needs and product performance

Questionnaire 2 (Q2) was used to determine factors for consumer satisfaction or

demands of the product and their attitude to the product performance according to their demands when compared with the other two competitive products. Factors associated with customer satisfaction and attitude characteristics from 4Cs study were modeled using linear regression in SPSS (Statistical Package for Social Sciences, version 11.0).

Technical specification

The technical specifications of Product A related to the customers' needs were provided by the company research and development department. Only color value (L*) was measured by spectrophotometer and sensory analysis was scored by a consumer panel.

Correlation analysis between class of 4Cs and product satisfaction factors

Linear regression was used to model classes of 4Cs and the satisfaction factors on product.

Integration in QFD product development system

Data of product needs associated with their weight of importance and data of product performance benchmarked with its competitors were input to the matrix of product planning. Then the corresponding technical requirements based on noodle, seasoning and packaging were supplied by the research and development unit with their specifications. The score of 1, 3 or 9 representing the correlation between product requirements and technical requirement were then assigned (Shin and Kim, 2000). The scores indicate how each technical requirement was calculated based on the interaction of product weight of importance, product performance ratio and correlation between product and technical requirements. Then the scores were ranked as the relative absolute importance of scores to indicate the importance of each technical requirement. These sets of product technical requirements were then transferred to the next process-planning matrix of noodle and seasoning production process. The step was repeated for determining the process parameters corresponding to the input product technical requirements. A correlation score of 1, 3 or 9 between these product technical requirements and process parameter requirements were then assigned. The priority of those process parameters were calculated based on important weight of product technical requirements and correlation values between such product and process requirement. The last matrix of process control was development in the same direction.

RESULTS AND DISCUSSION

Analysis of cross cultural consumer characterization (4Cs)

Based on 4Cs analysis, attitudes and value awareness classified as 7 groups. Figure 2 shows the 4Cs analysis of 300 customers from the market surveys. The results indicates that the target customers who have the dominant attitude and value awareness belong to the Reformer type 78.6% and the Mainstreamer type 75.86%. The remaining attitudes: Explorer, Succeeder, Aspirer, Struggler and Resigned poor are distributed in similar levels. Meaning the target customers of the instant rice noodle have the dominant attitudes as Reformer and Mainstreamer who have value awareness in highly independent, knowledge acquisitive, environmental concern, focus on product quality not external image and reasonable price.

Correlation between class of 4Cs and product satisfaction factors

Table 2 shows results from the regression analysis of product satisfaction factor to the attitude and value awareness class. The analysis results showed that different satisfaction factors correlated to different attitude classes of 4Cs.

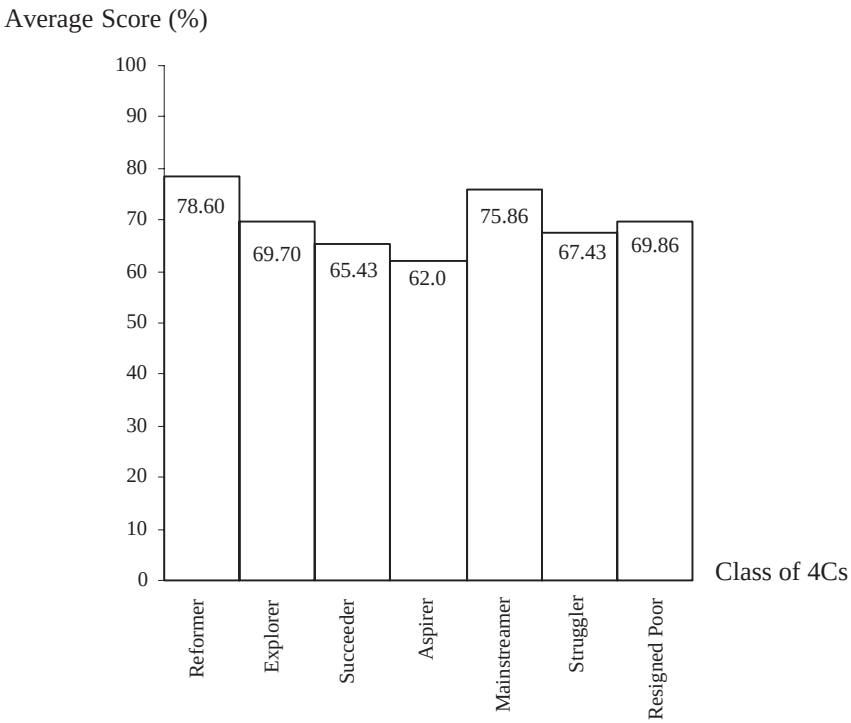

Figure 2 The distribution of seven attitude and value awareness contents among 300 target customers.

Table 2 Linear Regression Analysis of product satisfaction factor to the attitude and value awareness class.

Satisfaction factor	Multiple Regression Equation	F-value	P-value
1. Sensory	2.414 + 0.462 Reformer + 0.252 Resigned Poor + 0.143 Succeeder	19.280	0.000
2. Convenience	2.782 + 0.570 Mainstreamer + 0.201 Succeeder	15.308	0.000
3. Added nutrition	2.906 + 0.654 Reformer + 0.408 Resigned Poor – 0.230 Explorer	18.296	0.000
4. Packaging	2.193 + 0.459 Reformer + 0.268 Resigned Poor + 0.195 Struggler	20.112	0.000
5. Price	5.505 + 0.418 Mainstreamer	10.473	0.000

Reformer class had a correlation to nutritional value, sensory and packaging of the product while the Mainstreamer had a correlation to product convenience and price. From this linear regression analysis results, the different product benefit points can be adopted to communicate according to the attitude group of customer, although the communication was based on the same piece of product. For example, to promote the product to the Reformer, we should enhance the product characteristics of added nutrition and environmentally friendly packaging. For the Mainstreamer class, value of price and the convenience features of the product should be amplified.

Product development process through QFD Model

The product requirements and product performance when compared to the other two competitors were integrated to the first product-planning matrix. Product requirements were grouped as requirement on noodle, convenience, nutritional value and packaging. The associated weight of importance was shown in Figure 3. From the survey analysis, consumers showed more concern on the nutritional value in seasoning. The next was noodle softness and the ease of use for packaging. When benchmarking, the improvement ratio was used to link product performance with the other two competitors. This ratio is based on Product A product performance compared to the best product performed in class. An improvement ratio that exceeds 1 is interpreted to mean that case product would require improvement to become best in its class. The ratio was combined with the previous weight to form the improvement weight. This improvement weight contained both information on the level of customer requirement and product performance position in the market.

The improvement weight showed that the case product needs to be improved in terms of nutritional value in seasoning, serving size and softness of the noodle according to customer oriented product development concept. To control the consistency of product manufacturing, all customer requirements had to be converted to technical requirements with target setting values or specifications. The targets were set based on the experimental design. In this research, the targets were provided by the research and development unit of the company and from literature search. To identify the importance of technical requirements and specifications, the matrix correlations were used to represent the level of correlation between product and technical requirements (1 denoted a weak correlation and 9 denoted a strong correlation). The absolute importances of technical requirements were developed from the interaction between correlation and improvement weight. From the matrix in Figure 3, the most important technical requirements were packaging material, product rehydration time and package form. With this results, the technical people from R&D can see the direction of new product development and able to communicate with marketing unit systematically. Next, the technical requirements were ranked and transferred to the next matrix according to their importance. The technical requirements were used to plan for process parameter categorized by each raw material.

In Figure 4, the part characteristic and process parameter planning matrix contains the technical requirements from Figure 3 with their ranks for important level were ranked again by rescaling the weight from percentage to 5-scale. In this research, QFD will be used for food product development part therefore only technical requirements of food were transferred. From Figure 3, the rehydration time showed the most relatively important score, therefore its new important weight (IMP) was 5 and the rests were lower from 5-scale. Since food raw material does not need its own process like assembly line in automobile industry, the matrix of raw material planning and process parameter can be combined.

The results showed that of all product requirement the rice and seasoning specification setting had the highest impact. Drying rate condition had the second highest impact. Other factors had lower impacts to the overall product requirement; however, that does not necessarily make them negligible. With process parameter specification, the next step of process control can be developed in order to ensure that all process parameters were met consistently.

The example of process control plan can be assigned in Table 3. The operation unit can then use the assigned control plan to develop a working manual. According to data transferring from Figures 3, 4 and Table 3, QFD allowed systematic

			Technical requirement																								
			Noodle											Seasoning				Packaging					Rating				
			Sensory				Instrumental analysis																				
		IMP	color test	flavor	softness	chewiness	L* Value	amylose content	moisture content	peak viscosity	consistency	protein content	product rehydrated time	dried meat size	dried meat content	dried vegetable size	dried vegetable content	packaging form	packaging size	packaging material	labeling	packaging design	product A	product B	product C	Improvement ratio	Improvement weight
Noodle	softness	7.39			9	3		3	9	3	3		9					3		9			6.04	7.06	6.30	1.2	8.64
	chewviness	7.01			3	9		9	3	9	9	9	9					3		9			6.12	6.64	6.32	1.1	7.61
	natural favor	6.86		9					3									3		9			6.03	6.33	6.33	1	7.20
	natural color appearance	5.96	9				9	1	1			9						1		9			7.03	6.75	5.85	1	5.96
Convenience	short preparing time	6.53						9	1	9	9		9	9	1	9	1				1		5	5	5	1	6.53
	Long shelf life	6.27						3	9	3	3				9		9	9		9	1		5	5	5	1	6.27
Nutritional value	in seasoning	7.51											9	9	1	9	1			1	1		4.49	7.73	6.70	1.7	12.93
Packaging	Easy for using	7.11																9	1	9	3		5.83	7.40	6.63	1.3	9.02
	proper serving size	6.92											3					1	9				7.18	5.63	6.96	1	6.92
	good for environment	6.55																3		9			5.47	7.12	5.84	1.3	8.53
	clear product information	6.49											3					1			9		6.62	7.24	5.78	1.1	7.10
	Attractive design	6.34																3		3		9	7.18	6.22	6.43	1	6.34
Targets			0.61±0.18	8.94±1.37	6.65±1.04	6.54±1.56	82.28±1.04	28-32%	9.73%	200 (RVU)	220-420 (RVU)	< 7.14%	< 3 min	0.3-1cm	<= 6 gram	0.5-1 cm	<= 4 gram	cup	55 grams	paper	informative	attractive					
Absolute Importance			54	65	101	94	54	178	191	172	172	122	363	175	76	175	76	273	71	511	117	57					
Relative Importance (%)			1.73	2.09	3.25	3.05	1.73	5.75	6.17	5.55	5.55	3.94	11.74	5.66	2.45	5.66	2.45	8.80	2.30	16.50	3.77	1.84					

Figure 3 Product planning matrix of instant rice noodle development.

planning and communication from cross-functional unit from marketing to R&D to raw material procurement to production and control in order to employ customer-oriented product development process.

CONCLUSION

QFD has the advantage of allowing the integration of knowledge from different disciplines during the product development process. Useful information from marketing research can be

					Process Parameter									
					Noodle								Seasoning	
					1. rice specification setting	2. soaking time	3. specific gravity of soaking water	4. temp-time for pregel	5. mixing and noodle forming time	6. temp-time for steaming	7. gel setting time	8. temp-time for drying	9. seasoning specification setting	10. temp-time for drying
		Movement of Target				O	O	O	O	O	O	O	→	O
			Target	IMP										
Technical requirement	Noodle	rehydrated time	< 3 min	5.0	9					9	9	9		
		moisture content	9.73%	2.6								9		
		peak viscosity	200 (RVU)	2.4	9			9		3				
		consistency	220-420 (RVU)	2.4	9			3		9	3			
		amylose content	28-32 %	2.4	9		3							
		protein content	< 7.14%	1.7	9									
		sensory: softness	6.65±1.04	1.2	9	3								
		sensory: chewiness	6.54±1.56	1.1	9		3	3	3	3				
	Seasoning	rehydrated time	< 3 min	5.0									9	
		dried meat size	0.3 -1 cm.	2.4									9	
		dried vegetable size	0.5 -1 cm.	2.4									9	
		dried meat content	<= 6 gram	1.0										9
		dried vegetable content	<= 4 gram	1.0										9
		Targets			See manual	4 hr	19 - 22 Be'	80 - 85 °C, 20 sec	7 - 9 min	100 °C , 2.30 hr	4 hr.	60 °C, 2 hr., RH=70%	See manual	60 °C, 1 1/2 - 2 hr.
		Absolute Importance			145.8	3.6	10.5	32.1	3.3	77.1	52.2	68.4	88.2	18.0
		Relative Importance (%)			26.8	0.7	1.9	5.9	0.6	14.2	9.6	12.6	16.2	3.3

Figure 4 Part characteristic and process parameter planning matrix of instant rice noodle product development.

combined with the food product technology. Customers can be segmented through their attitude and value awareness as 4Cs concept. These attitude segmentations create a custom-made way for product communication since customers in different classes of 4Cs value different aspects of product characteristics.

Beside the integration of knowledge from both marketing and food technology, the QFD model allows a continuous improvement working

Table 3 Operation control planning of instant rice noodle based on process parameter.

Process parameter	Operation control planning			
	Raw material acceptance condition	In process inspection	Unit operation control plan	Finished product inspection
1. rice specification setting	✓			
2. soaking time			✓	
3. specific gravity of soaking water		✓		
4. temp-time for pregel			✓	
5. mixing and noodle forming time			✓	
6. temp-time for steaming			✓	
7. gel setting time			✓	
8. temp-time for drying			✓	✓
9. seasoning specification setting	✓			
10. temp-time for drying			✓	✓

cycle in food manufacturing according to quality assurance. The information from marketing research can be updated through the product-planning matrix of QFD in order to incorporate improvements into exiting products.

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