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Article

Factor Affecting Elderly Consumer Testing on Thai Herb Ceramic Massage Product using Taguchi Design of Experiments

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Abstract: This study focuses on the OTOP (One Tambon One Product) Thailand product after selected group into five. Thai herb ceramic massage product was developed from statistic data selection previously. The experimental was decided for determination optimize consumer wanted as desirability value from using three nominal preference scales of performance, function and cognitive to create new response. Using a Taguchi design was used for design factors including the performance, function and cognitive. the experimental condition with full factional design 25 with 6 blockings was employed in the experiment for 6 samplings test as elderly 60-80 years old, males and females respectively consumers in northern Thailand in Chiang Mai. The result demonstrated that by using more ceramic, big ceramic size, Herbal ingredients #2, Fabric types #2 and Streamer to be heating source can optimize the desirability value for Thai Herb Ceramic Massage Product of 0.9 in the regression model with the optimizer method. Important factor is heating source, it was only significantly parameter to the response.

Keywords: OTOP Thailand; design of experimental; Taguchi methods; optimizer method.

1. Introduction

The OTOP was supported by Thai government since 2001. The program is like Japanese product development (OVOP: One Village One Product) (Kurokawa, 2009). To help local area and induce Thai economics with distribute invest to all around the country. The OTOP program is successfully to improve new Thai- entrepreneur generation also creating job in local area and new SMEs (Natsuda et al., 2012). The concept idea of OTOP is trying to develop product which is reflect the symbolic in the local culture or at present input innovation in their product making the different value compared with another area. It sounds

like this idea might be easy to make, easy to think. However, In Thailand this concept idea is not make as much as efficient to the local product. We can investigate from the similar product that develop in the concept as copy as the success case (Tuamsuk et al., 2013) from the first who enter the market. This increased the same product and the OTOP member just send it into the red ocean which dyed with blood from trade competition. There are strong needs of Thai government to study and understand the perception of consumer on the OTOP product. Anyway, OTOP handmade products have been can be exported into larger, export-focused market but some needs to develop for improve quality, make different by depend on customer (Thammasang & Poonikom, 2016). To develop new product, increase quality need to research or make experimental. However, the key of trade competition is time to market(Nonthawichai & Jaroenwanit, 2015). The design of experiment technique is interested by reduced sample for testing, cost and labor. The popular method in the beginning is Taguchi method (Pitjamit et al., 2016), it can help to design how many conditions need to test due to the amount of parameter or full factional design is the one of popular method which used for calculated with statistic idea to find regression model for optimize results. That can be applied to the develop product solution.

This experiment design was selected OTOP product as Thai Herb Ceramic Massage Product from the questionnaire results data (Phanphet et al., 2019) with sampling group of 3 provinces as Chiang Mai, Lamphun and Lampang (Thailand). The data can separate the potential product into 5 groups as (i) Food, (ii) clothes, apparels, and accessories, (iii) Beverages, (iv) Herbal products, and (v) Utensils. Furthermore, the expansion of the OTOP to larger market group is focused especially the growing market of elderly in Thailand (Ackaradejruangsri, 2013). And Thai Herb Ceramic Massage Product was selected to represent form the herbal product group. The design of experimental was success in many cases of research development or many applications for the example as to finding the ratio of Hydroxyapatite -Bioactive glass (Pitjamit et al., 2016), plasma sterilization (Vichiansan et al., 2018), production in industrial (Park & Ahn, 2004). The different from another technique is the design of experimental can optimized by created the model equation with full factional design and response optimizer.

The purposes of this paper are to predict a s the desirability value for Thai Herb Ceramic Massage Product of factors including the Ceramic amount, Ceramic size, Herbal ingredients, Fabric types and Heating solutions and an optimal desirability value method using optimizer function in MINITAB16 program to create the prediction model for predict trend of consumer desirability value with preference scales of Performance, Function and Cognitive.

2. Materials and Methods

2.1. Data Collection

The Thai product of OTOP are currently divide into 5 main groups of (i) Food, (ii) clothes, apparels, and accessories, (iii) Beverages, (iv) Herbal products, and (v) Utensils, Decorative items and Souvenirs. These five groups were defined as five alternatives for Thai government to improve the OTOP product development. Thai Herb Ceramic Massage Product was selected in this research for optimize the disability of customer to improve product quality due to customer wanted. This research collected 6 samplings for elderly 60-80 years old, males and females respectively consumers in northern Thailand in Chiang Mai. The respondents were asked to evaluate the need and preference in testing each group of products using three nominal preference scales of [Performance], [Function] and [Cognitive].

2.2. Experimental design

The effect of pressing conditions was investigated by using a design of experimental technique: Taguchi method. Table 1 describes the experimental design of factors including the Ceramic amount, Ceramic size, Herbal ingredients, Fabric types and Heating solutions. To perform the DOE, A full factorial design was used for the experiment by two levels as 25 with 6 blockings in order to identify Performance, Function, and Cognitive condition which would asking with optimal for each condition in Table 2, a total of 8 experimental were focused for the experiments with 6 sampling tests as 48 responses with the responses of desirability value can be calculated following in (1-2) equation. The response optimizer method on Minitab16.0 was used to determine the optimal conditions.

By given;

$$Y = d_1 \times d_2 \times d_3, \quad (1)$$

$$di = \frac{x_i}{maximum\ weight}, \quad (2)$$

Table 1. Experimental design of relevant factors and its levels

Factors	Level	
	Low (-)	High (+)
Ceramic amount (A)	Less	much
Ceramic size (B)	Small	Big
Herbal ingredients (C)	#1	#2
Fabric types (D)	#1	#2
Heating solutions (E)	Steaming	Microwave

3. Results

3.1. Taguchi L8 orthogonal array design with general full factorial and response optimizer results

The experimental results of performance based on the 6 samples group. The results shown in Table 2 that the ceramic massage herbal using less and much ceramic balls amount. Lowest and highest performance, respectively. These results show that the amount of added ceramic balls can increase the performance of the ceramic massage herbal desirability. After design the Taguchi L8 orthogonal array design.

Table 2. Taguchi L8 orthogonal array design with general full factorial

Run	A	B	C	D	E	Desirability value					
1	1	1	1	1	1	0.600	1.000	0.800	0.800	0.640	0.512
2	1	1	1	2	2	0.640	0.800	1.000	1.000	0.800	0.800
3	1	2	2	1	1	0.800	0.800	0.800	0.800	0.800	0.512
4	1	2	2	2	2	1.000	0.800	1.000	1.000	0.640	0.800
5	2	1	2	1	2	0.800	1.000	1.000	1.000	0.640	0.800
6	2	1	2	2	1	0.480	1.000	0.800	0.800	0.800	0.512
7	2	2	1	1	2	0.800	1.000	1.000	1.000	0.800	0.800
8	2	2	1	2	1	0.640	1.000	0.800	0.800	0.640	0.512

Table 3. Statistical Analysis of Variance on DOE

Source	DF	Coef.	Adj SS	Adj MS	F-Value	P-Value
Model	12	0.8035	0.78901	0.065751	5.78	0.000
Blocks	5		0.55270	0.110540	9.72	0.000
Linear	5		0.23464	0.046928	4.12	0.005
A	1	-0.0092	0.00403	0.004033	0.35	0.555
B	1	0.0108	0.00563	0.005633	0.50	0.486
C	1	0.0058	0.00163	0.001633	0.14	0.707
D	1	-0.0025	0.00030	0.000300	0.03	0.872
E	1	-0.0682	0.22304	0.223041	19.61	0.000
2-Way Interactions	2		0.00167	0.000833	0.07	0.930
B*C	1	-0.0042	0.00083	0.000833	0.07	0.788
B*E	1	-0.0042	0.00083	0.000833	0.07	0.788
Error	35		0.39818	0.011377		
Lack-of-Fit	47		1.18719			

Pure Error						
Total						
R-Sq = 66.46 % R-Sq (adj) = 54.96 %						

DOE (Table 3) results showed that R-square and R-square (adjusted) equal to 66.46% and 54.96%, respectively, which are both less than 80%. This indicates that the response, which is the responses of desirability value for Thai Herb Ceramic Massage Product, and the formulated mathematical model for this experiment were reliable at a 95% confidence limit. We designed our experiment with Taguchi design L8 for 6 samplings with full factorial and the analysis showed that the P-value of the 1-way interaction parameter A-D is less than 0.05 but parameter E is equals 0.000, 2-way interactions parameter BE and BC less than 0.05; therefore, the hypothesis was rejected related to the normal plot in Figure 1. Consequently, it can be understood that in generating the only parameter E is significantly effect on our experiment results at the 95%. Table 3 also shows the degree of the coefficients of the regression model for each main parameter and interaction parameter. Finally, the full linear regression model (Equation 3-4) was derived as follows:

$$Y = 0.8035 - 0.0092\ A + 0.0108\ B + 0.0058\ C - 0.0025\ D - 0.0682\ E - 0.0042\ B*C - 0.0042\ B*E \quad (3)$$

Reduced linear regression model, as seen in equation below:

$$Y = 0.8035 - 0.0682\ E \quad (4)$$

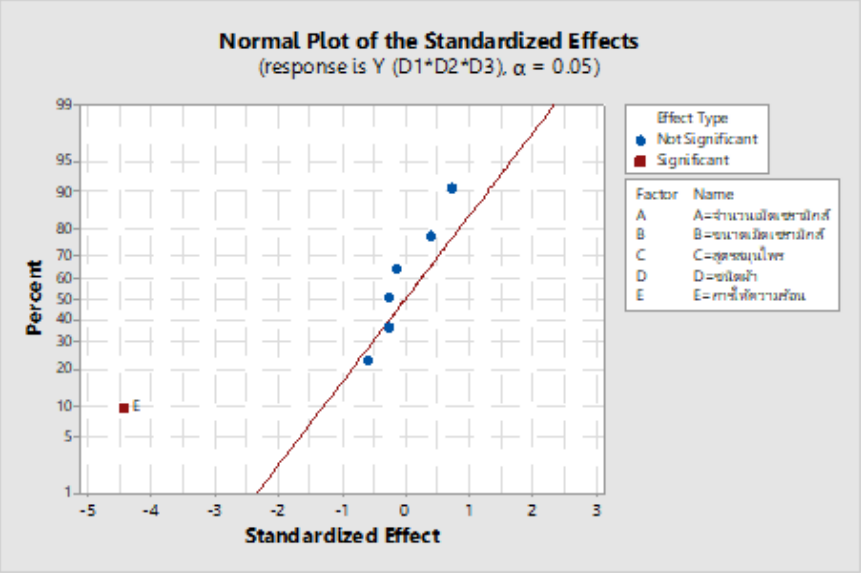

Figure 1. Normal plot of desirability value for Thai Herb Ceramic Massage Product

In Figure 2, the normal probability plot of residuals trended to be linear and the residual histogram presented a normal distribution with a bell shape.

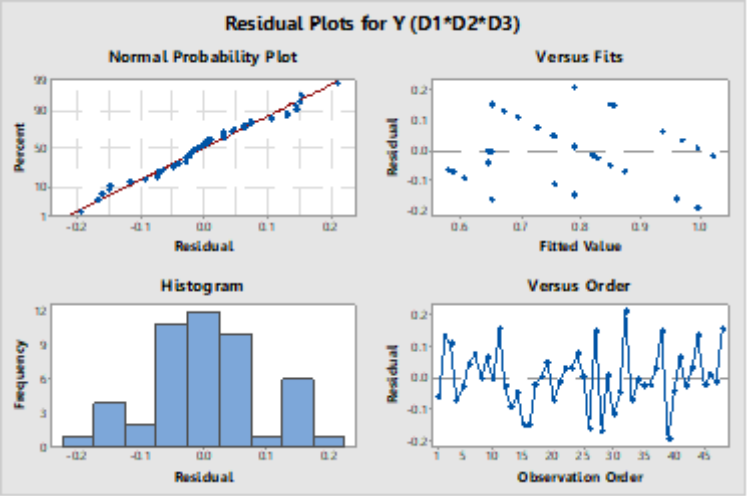

Figure 2. Residual Plot of the responses of desirability value

Lastly, plot of residuals versus the observation order of the data presented trended to be random, indicating that the results of the experiment were independent of the experimental sequence. Also, in the normal probability plot of residuals for after selected parameter (only E) is the same as before selected shown in Figure 3.

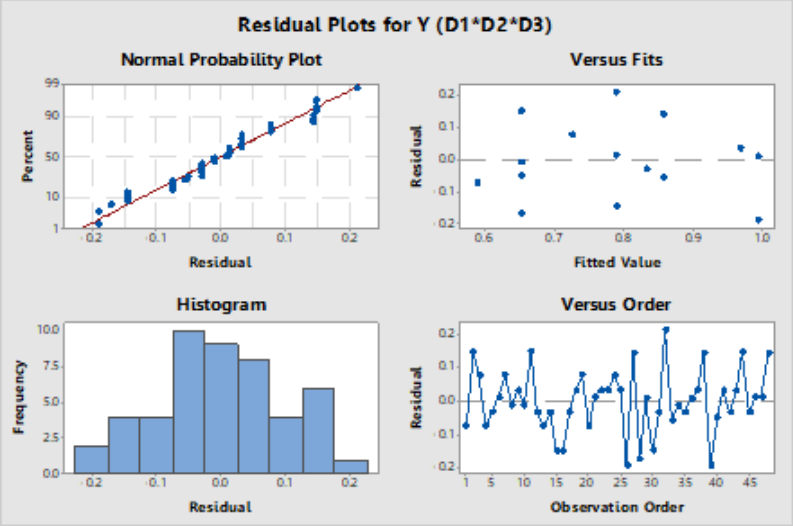

Figure 3. Residual Plot of the responses of desirability value for Thai Herb Ceramic Massage Product after selected parameter

After achieving the response model, the gradient search of Minitab16 was applied to determine the optimal values based on the response of desirability value for Thai Herb Ceramic Massage Product. The optimal set-up parameters constitute Ceramic amount = much, Ceramic size = big, Herbal ingredients = #2, Fabric types = #2 and Heating source = Streamer.

Table 4: Optimal parameters from response optimizer method.

Response	**Desirability value response (Y = 0.9)**
Ceramic amount (A)	More
Ceramic size (B)	Big
Herbal ingredients (C)	#2
Fabric types (D)	#2
Heating solutions (E)	Streamer

Figure 4. Graph showing the optimal parameters corresponding to maximize the response was the response of desirability value for Thai Herb Ceramic Massage Product.

Table 4 and Figure 4 display with the set-up parameters, the model provided 0.9 desirability value for Thai Herb Ceramic Massage Product. However, the replication of optimized model is necessary at least 3 times for compare the model precision.

4. Discussion

In this research, experimental design Taguchi L8 orthogonal array of the 2-level consisted of the low and high, 5 factors shown in Table 1. The effectiveness of the OTOP product development as Thai Herb Ceramic Massage Product was selected for develop to be the new product by using Taguchi experimental design technique in MINITAB16 software has been used in determining significant factors in various kinds of applications with statistical analysis reveals that the age and gender of elderly. After using DOE method analyzed the significantly selected parameter for finding the regression linear model for optimized disability value. The L8 orthogonal array of 5 factors: Ratio (A), Ceramic amount (B), Ceramic size (C), Herbal ingredients (D) Fabric types and (E) Heating source the response was the of desirability value for Thai Herb Ceramic Massage Product shown in Table 4 and Figure 5. Results showed that for the Performance, Function, and Temperature as one response that is desirability value from questionnaire data results. All 5 factors were statistically significant as the factors affect to the Performance, Function, and Temperature of the desirability results were the (A), Amount (B), Size (C), Ingredient (D) Fabric type and (E) Heating source. The Heating source was the most significant factor as Streamer while another is not significantly parameter.

In this study, the effects of user desirability conditions on product was investigated based on Taguchi statistically experimental design with full factional analysis. The optimal condition was found from the parameter with 1-way interaction as the Ceramic amount = much, Ceramic size = big, Herbal ingredients = #2, Fabric types = #2 and Heating source = Streamer for performance, Function and temperature. And 2-Way interaction has no significant effect to result. At this condition, the response was the response of desirability value for Thai Herb Ceramic Massage Product was 0.9. Further investigation for more sampling groups need to study soon and replicate the optimized response from the regression model at least 3 times for confirm the model prediction.

5. Conclusions

The effectiveness of the OTOP product development as Thai Herb Ceramic Massage Product was selected for develop to be the new product by using Taguchi experimental design technique. MINITAB software has been used in determining significant factors in various kinds of applications with statistical analysis reveals that the age and gender of elderly.

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