DESIGN AND ANALYSIS OF ELECTRICAL APPLIANCE EXPERIMENT WITH TWO FACTORIAL DESIGN

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Abstract

A rice cooker or rice steamer is a self-contained electrical appliance, used primarily for cooking. Here are also microwave, gas, and open flame variants. The preparation of rice has traditionally been a tricky cooking process that requires accurate timing, and errors can result in inedible undercooked or burnt rice. Rice cookers aim to avoid these problems by automatically controlling the heat and timing in the preparation of the rice, while at the same time freeing up a heating element on the range. In these experiments, we use three branch of rice cooker that is; A, B, and C. This entire product has capacity 1.8 liter. The load cook divided in three-load level; 0.5 liter, 1.0-liter end 1.5 liters. Each level or load cook has two times experiments. Time of experiments for each product is the same, with stopwatch, the speed of cooking can be able to identify. So each product can looked at how long spent the time for cooking the rice.

Keywords: *Design, Analysis,Electrical Appliance*

Introduction

History of Rice Cooker

The idea of cooking rice with electricity was first conceived in the age of westernization during the Meiji era, and products called "electric stoves" and "electric rice tubs" were produced experimentally at the end of the Taisho era (mid 1920s). These were stoves and tubs to which heating coils were attached. In the late 1940s, Mitsubishi Electric Corporation manufactured an electric rice cooker, a pot incorporating a heating coil inside. Featuring no automation, this was simply a pot that used a heating coil instead of firewood or gas. The device was inconvenient, requiring attention from the time it was switched until the rice was done, and sold poorly. Rather than being remembered as the forerunner of modern rice cookers, the device was relegated to the status of a footnote in the history of electric appliances. In 1952, Matsushita Electric launched a Mitsubishi-type rice cooker, which was also poorly received. Sony's offering (an electronic rice tube) fared likewise.

Around July 1951, based on its conviction that electrical appliances would one day become a part of daily life in Japan, Toshiba tackled the challenge of creating a successful electric rice cooker, a product area where leading manufacturers Mitsubishi and Matsushita had failed. The project was led by Shogo Yamada, development manager of the electric appliance division.

In human being lives always are in change. One of impact in life process is technology become primarily need for people in this era, most people can’t do anything without technology, activities for the people depends for technology. Technology very important for this life. One of the results for technology is going to discuss in this chapter especially for electrical rice cooker.

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Typically, a rice cooker contains an insulated outer container containing a heating element, into which is fitted a non-stick or Teflon coated inner removable bowl, which often has graduations marked in cups of rice (white). Whereas less expensive and older models use simple electronics and mechanical and thermal sensors, high-end rice cookers use microchips to control the cooking process and often incorporate a timer which can be used to set the desired "ready time". Many rice cookers can keep rice warm safely for up to 24 hours. This helps to avoid the dangers of food poisoning due to *Bacillus cereus.* Rice cookers, when purchased, normally include a small "cup" measure and a plastic paddle for serving the cooked rice.

Restaurants that serve a lot of rice, particularly those specializing in Asian cuisine, often use industrial size rice cookers that quickly and cheaply produce large quantities of cooked rice. A rice cooker is a standard appliance in kitchens around the world, especially in Asian countries.

Small, basic rice cookers can be purchased in the US at discount retailers often for as low as $10-$15, and units with large capacity and different selectable electronically-controlled cooking cycles can cost up to $100 or more.

Basic principle of operation

The bowl in the rice cooker is usually removable, and beneath it lies a spring and thermostat. These form the main components of the rice cooker. The spring in the bottom is simply to ensure contact of the thermostat to the base of the cooking bowl. During cooking the mixture is continuously heated. The temperature cannot go above the boiling point of water—100°C (212°F)—as any energy put into the system at that point will only cause the water to boil. At the end of cooking all of the water will have been evaporated or absorbed by the rice. Once the heating continues past this point, the temperature exceeds the boiling point. The thermostat then trips, and switches the rice cooker to "warm" mode, keeping the rice no cooler than approximately 65°C (150°F). Simple rice cookers, like the one below, may simply turn off at this point.

Cooking rice with a rice cooker

To cook white rice, the rice is measured and added to the inner bowl. Cold water is measured and added or simply added up to the appropriate graduation in the inner bowl. Sometimes there are separate scales for brown rice (as more water is required) or for cooking other foods in the appliance. Once the lid is closed and the cooking cycle has been activated, the rice cooker does the rest. Fancy models give a countdown in minutes to the "ready time," and beep when done, whereas less expensive and older models simply click or ring a bell when done. A rice cooker or rice steamer is a self-contained electrical appliance, used primarily for cooking. Here are also microwave, gas, and open flame variants.

Rice cooker techniques

Rice cookers are typically used for the preparation of plain or lightly seasoned rice, but more elaborate recipes are possible using a rice cooker, and there are cookbooks devoted entirely to dishes prepared using a rice cooker. One of the more unexpected dishes that can be made in a rice cooker is a beef. By simply adding ingredients and setting it to "warm", a rice cooker would cook that at about 65°C (150°F). In few hours, the stew is fully cooked and ready to eat. Some rice cookers are designed to accommodate a basket above the rice. This basket is generally used to steam vegetables, holding them in the steam coming off the rice. Some vegan cooks consider rice cookers to be an invaluable tool in the preparation of vegan meals. They find it extremely versatile, allowing a variety of meals to be cooked with minimal preparation and no attention during the cooking process.

Target of Research

Main target of this experiment is how to investigate the different time of cook of three of product. Two factorial designs become basic for calculating the time end the load rice in rice cooker. Speed the cooking in process even though doesn't necessary but for costumer that too busy end need effectively product that reduce time end cost of Costumer want to get information the product efficient end able to cook the rice faster than other products. That why, we try to do experiments with factorial design end seek for effect for load the rice cooker every product with speed the cook in minute. These experiments are going to recommended product that has high speed in process in cook.

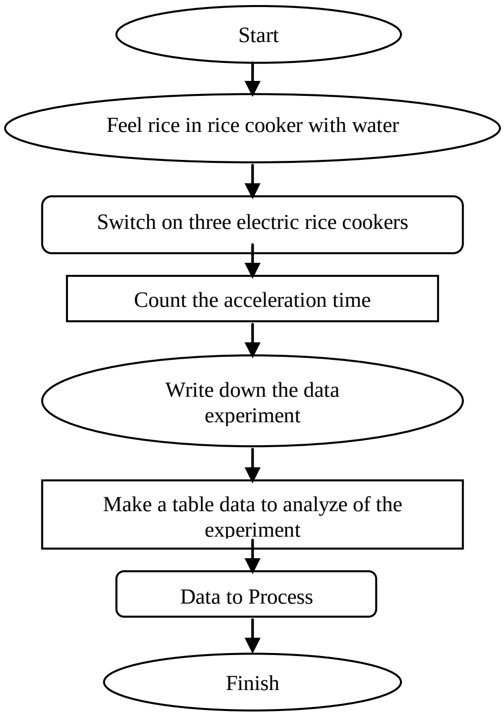
Research Method

In these experiments, we use three branch of rice cooker that is; A, B and C. This entire product has capacity 1.8 liter. The load cook divided in three-load level; 0.5 liter, 1.0-liter end 1.5 liters. Each level or load cook has two times experiments.

Time of experiments for each product is the same, with stopwatch, the speed of cooking can be able to identify. So each product can looked at how long spent the time for cooking the rice.

To get the perfectly conclusion for this research, we are going to process all data by using Two-factorial design. Two factorial design is used in an experiment that has two effecting factor. Based on the result from the data processing. We could know if which the product that high speed in cook. Or there is not different all product with speed of cooking.

Flowchart



Source: Self compiled

Figure 1. Data Sampling flowchart

The Two – Factorial Design Theory

Our experiment is about the main effects and interactions between the brands of rice cooker towards acceleration of cook. Beside that, we also want to know if the load of rice cooker also influences the acceleration of each product. From the experiment, we can see that there are two factors known. Do these two factors influence the acceleration and is there any interaction between both of them? We use the two factor design method to answer this question.

The simplest types of factorial design involve only two factor or sets of treatments. There are levels of factor A and b levels of factor B, and these are arranged in a factorial design; that is, each replicate of the experiment contains all *ab* treatment combinations. In general, there are n replicates.

This design is a specific example of the general case of two-factorial. \to pass to the general case, let y_{ijk} be the observed response when factor A is at the ith level (I = 1, 2, ……, a) and factor B is at the jth level (j = 1,2,…..,b) for the kth replicate (k = 1, 2, …..,n). In general, a two-factorial experiment will appear as tab2. The order in which the abn observations are taken is selected at random so that this design is completely randomized design.

The observation in a factorial experiment can be described by a model. There are several ways to write the model for a factorial experiment. The effects model is

$$y_{ijk} = \mu + \tau_i + (\tau\beta)_{ij} + \varepsilon_{ijk} \begin{cases} i = 1,2,\ldots.,a \\ j = 1,2,\ldots.,b \\ k = 1,2,\ldots.,n \end{cases}$$

Table 1. General Arrangement for a two-factor factorial design

		Factor B			
		1	2	….	b
Factor A	1	$Y_{111}, y_{112}, \ldots, y_{11n}$	$Y_{121}, y_{122}, \ldots, y_{11n}$		$Y_{1b1}, y_{1b2}, \ldots, y_{1bn}$
	2	$Y_{211}, y_{212}, \ldots, y_{21n}$	$Y_{221}, y_{222}, \ldots, y_{22n}$		$Y_{2b1}, y_{2b2}, \ldots, y_{2bn}$
	.				
	.				
	.				
	a	$Y_{a11}, y_{a12}, \ldots, y_{a1n}$	$Y_{a21}, y_{a222}, \ldots, y_{a2n}$		$Y_{ab1}, y_{ab2}, \ldots, y_{abn}$

Source: Self compiled

Where µ is the overall mean effect, τ_i is the effect of the ith level of the row factor A, β_j is the effect of the jth of the column factor B, $(\tau\beta)_{ij}$ is the effect of interaction between τ_i and β_j and c_{ijk} is a random error component. Both factors are assumed to be fixed and the treatment effects are defined as deviations from the overall mean. Since there are n replicates of the experiment, there are *abn* total observations.

In the two factor factorial, both row and column factor (and treatment), A and B, are of equal interest. Specially, we are interested in testing hypotheses about the equality of row treatment effects, say

$$H_0 : \tau_1 = \tau_2 = \ldots = \tau_a = 0$$

$$H_1 : atleastone \tau_1 \neq 0$$

In addition his equality of columns treatment effects, say

$H_0 : \beta_1 = \beta_2 = ...== \beta_j = 0$

$H_1 : atleastone \beta_1 \neq 0$

We also interested in determining whether row and column treatments interact, thus, we also wish to test

$H_0 : (\tau\beta)_{ij} = 0$

$H_1 : atleastone (\tau\beta)_{ij} \neq 0$

Table 2. Statistical Analysis of the fixed effects model

Source of variation	Sum of Squares	Degrees of Freedom	Mean Square	Fo
A treatments	SS_A	a - 1	$MS_A = \frac{SS_A}{a-1}$	$F_0 = \frac{MS_A}{MS_E}$
B Treatments	SS_B	b - 1	$MS_B = \frac{SS_B}{b-1}$	$F_0 = \frac{MS_B}{MS_E}$
Interaction	SS_{AB}	(a – 1) (b – 1)	$MS_{AB} = \frac{SS_{AB}}{(a-1)(b-1)}$	$F_0 = \frac{MS_{AB}}{MS_E}$
Error	SS_E	ab (n – 1)	$MS_E = \frac{SS_E}{ab(n-1)}$	
Total	SS_T	abn - 1		

Source: Self compiled

The total sum of square is computed s usual by

$$SS_T = \sum_{i=1}^{a}\sum_{j=1}^{b}\sum_{k=1}^{n} y_{ijk}^2 - \frac{y_{...}^2}{abn} \quad (1)$$

The sum of square for the main effects is

$$SS_A = \frac{1}{bn}\sum_{i=1}^{a} y_{i..}^2 - \frac{y_{...}^2}{abn} \quad (2)$$

And

$$SS_B = \frac{1}{an}\sum_{j=1}^{a} y_{.j.}^2 - \frac{y_{...}^2}{abn} \quad (3)$$

It is convenient to obtain the SS_{AB} in two stages. First we compute the sum of squares between the ab cell totals, which is called the sum of squares due to" subtotals".

$$SS_{Subtotals} = \frac{1}{n}\sum_{i=1}^{a}\sum_{j=1}^{b} y_{ij.}^2 - \frac{y_{...}^2}{abn} \quad (4)$$

This sum of square also contains SS_A and SS_B. Therefore, the second step is to compute SS_{AB} as

$SS_{AB} = SS_{Subtotals} – SS_A - SS_B$ (5)

We may compute SS_E by subtraction as

$SS_E = SS_T – SS_{AB} – SS_A - SS_B$ (6)

Or

$SS_E = SS_T - SS_{Subtotals}$ (7)

Data collecting and computing

Data collecting method

In this experiment our group uses three kinds of rice cooker or three brands of rice cooker, such as B, A and C. We use stopwatch to calculate how long every rice cooker are going to switch automatically of in same load of rice. Every rice cooker gave the same load in every experiment. We investigate three load of rice only and assumed the capacity for the water is the same.

Data Processing Steps

1. Open the Minitab 14 program your computer
2. On the menu bar, select stat>DOE>Factorial>Create Factorial Design
3. Select General Full Factorial Design, and then choose Number of factor. Fill in with 2
4. Select design, and then choose number of replicate. Fill in with 2
5. Select factor, write the factor's name and level, and click OK.
6. insert the data in C7 column related with the combination of each level in C1 – C6 column
7. on the menu bar again, select stat>DOE>factorial>analyze factorial design
8. insert the response value that is in C7 column
9. select term, remove the factors value and interactions between factors value to selected terms column, and click OK
10. select stat>DOE>factorial>factorial Plot
11. Elect main effect and interaction. Choose setup then remove the factors value to selected plots column, click OK
12. in interaction menu, choose setup>options>draw file interaction full matrix, and click OK

Table 3. Experiment Result

Brands of Rice Cooker	Load of Cook (liter)					
	0.5		1		1.5	
	1	2	1	2	1	2
B	24	23	50	52	76	76
A	22	24	48	51	74	75
C	25	25	52	53	77	75

Source: Self compiled

Data calculating with Minitab 14

Table 4. Multilevel Factorial Design

Factors:	2	Replicates	2
Base runs	9	Total Runs	18
base bloks	1	Total Bloks	1
number of levels	3,3		

Source: Self compiled

Table 5. General linier model: C7 versus brand of product; load of cook

factor	type	level	value
brand of product	fixed	3	B, A, C
load of cook	fixed	3	0.5 liter. 1.0 liter. 1.5 liter

Source: Self compiled

Table 6. Analysis of Variance for C7, using Adjusted SS for test

source	DF	Seq SS	Adj SS	Adj MS	F	P
brand of product	2	14.10	14.10	7.10	5.29	0.03
load of cook	2	8015.40	8015.40	4007.70	3005.79	0.00
brand of product*load of cook	4	2.20	2.20	0.60	0.42	0.79
Error	9	12.00	12.00	1.30		
Total	17	8043.80				

S= 1.15470 R-Sq =99.85% R - sq(adj) = 99.72%

Source: Self compiled

Table 7. Mean of Run

Least Square Mean	mean	SE Mean
Brand of Product		
B	50.17	0.4714
B	49.00	0.4714
C	51.17	0.4714

Source: Self compiled

Table 8. Load of Cook

0.5 liter	23.83	0.4714
1.0 liter	51.00	0.4714
1.5 liter	75.00	0.4714

Source: Self compiled

Table 9. Brand of product*Load of Product

B	0.5 liter	23.50	0.8165
B	1.0 liter	21.00	0.8165
B	1.5 liter	76.00	0.8165
A	0.5 liter	23.00	0.8165
A	1.0 liter	49.50	0.8165
A	1.5 liter	74.50	0.8165
C	0.5 liter	25.00	0.8165
C	1.0 liter	52.50	0.8165
C	1.5 liter	76.00	0.8165

Source: Self compiled

Table 10. Run Order

	StdOrder	RunOreder	PtType	Bloks	Brand of product	load of product		FITS 1	SRES 1
1	16	1	1	1	C	0.5 lt	25	25	0
2	11	2	1	1	B	1.0 lt	52	51	1.22474
3	15	3	1	1	A	1.5 lt	75	74.5	0.61237
4	6	4	1	1	A	1.5 lt	74	74.5	-0.61237
5	17	5	1	1	C	1 lt	53	52.5	0.61237
6	3	6	1	1	B	1.5 lt	76	76	0
7	10	7	1	1	B	0.5 lt	23	23.5	-0.61237
8	18	8	1	1	C	1.5 lt	75	76	-1.22474
9	13	9	1	1	A	0.5 lt	24	23	1.22474
10	2	10	1	1	B	1 lt	50	51	-1.22474
11	8	11	1	1	C	1 lt	72	52.5	-0.61237
12	1	12	1	1	B	0.5 lt	24	23.5	0.61237
13	12	13	1	1	B	1.5 lt	76	76	0
14	5	14	1	1	A	1 lt	48	49.5	-1.83712
15	4	15	1	1	A	0.5 lt	22	23	-1.22474
16	7	16	1	1	C	0.5 lt	25	25	0
17	14	17	1	1	A	1 lt	51	49.5	1.83712
18	19	18	1	1	C	1.5 lt	77	76	1.22474

Source: Self compiled

Analysis and Conclusion

Experiment and Data Analysis

From the data we got, it seems the brands/type of product has not significant effect for speed of cook for rice cooker, we could see the data, for example, for Type of B, which examined in three load of cook (0.5 liter, 1 liter, and 1.5 liter), the speed for cook in mean time 50.17 minutes, for type of A has used 49 minutes and C has used the time 51.17 minutes. So, the speed of cook for three of this different product almost the same their speed for cook.

If we see the examined for load of cook, the result of analysis of the data is the same with brands of rice cooker. There is not significant effect for the speed of the rice cooker for cook the rice.

Meanwhile, if we see the interaction for brands of product with load of cook for rice cooker, we got different result. The result for calculating of p-value $0.79 > \alpha=0.05$. So we can conclude that there is an interaction for the load of cook and three different product of rice cooker.

Conclusion

The brands/type of product of rice cooker has not a significant effect to the speed of cook for rice cooker.

1. The load of cook has not significant effect to the speed of cook for rice cooker.
2. The interaction between the type of product/brands of product and load for cook has significant effect to the speed of cook for rice cooker.

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