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Multiple Correspondence Analysis on Public Service in Sabang Tourism Area

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Abstract. Sabang area is being developed to be e tourism destination in Indonesia. There are several tourism spots in Sabang. The research purposes are to identify the most interesting tourism location, similarly of the tourism spots, and correlation of public service variables. Data were gathered with using questioners. Respondents were domestic tourists, trader, and hotel manager. A number of tourism sites included 20 sites. Both Multiple Correspondence Analysis and Spearman Correlation are used to analyze the data. The research results show that each site clusters on one or great than one variable. Hospitally, cleanness, publication, and beauty gather with gender variable. The results are strengthened by Spearman correlation which is approximate one.

Keywords : Multiple Correspondence Analysis, Spearman Correlation.

1 INTRODUCTION

Background

In everyday life, often we find relation between one variable and another variable. This relation can be studied by various statistical methods both parametric and non parametric. In practice, assumptions related to parametric statistic are difficult to satisfy, therefore non parametric statistic are appropriate to be used to solve the problems mentioned above. For instance, correspondence analysis can be used to solve the problem, if data are found in the form of contingency table and qualitative variables.

Correspondent analysis is a plot between rows and columns of matrix in the form of data categories and the accuracy rates are not lost either by statistical analysis using the assumption (Irelandia, 2006). This analysis is used for public service resort in Kota Sabang since the data consists of rows and columns, so it can be simplified from n-dimension into simple dimension that can describe any information from this data.

Kota Sabang which familiar call of Weh Island, as objects of maritime tourism in Aceh Province is famous for its beautiful natural panoramas to overseas. Many tourists come to this island to enjoy its beauty. These conditions create separate duties for the City Government of Sabang as

implementers of public services in order to fulfil their needs. Therefore, the public service in tourism sector needs to be reviewed further.

Research Objective

This study aimed to determine whether there is any relation between variables, the similarity between variables and to find out the association between one variable and another variable by presenting each variable of tourist attraction, gender and public service together in an optima small dimensional vector space.

Research Benefit

Benefit of this paper is to obtain mapping using correspondence analysis and to obtain information from the mapping so they can be used as inputs in formulating policies and actions by the government of Sabang.

2 Research Method

Data

In this research uses secondary data taken from previous research, funded by a research institute in Aceh Institute. In such research, the data used are generally quantitative. Source of data is taken from primary data sources and secondary data sources. The primary data source was obtained directly from the field through interviews and questionnaires, while secondary data sources obtained from government agencies, media, and also the results of research.

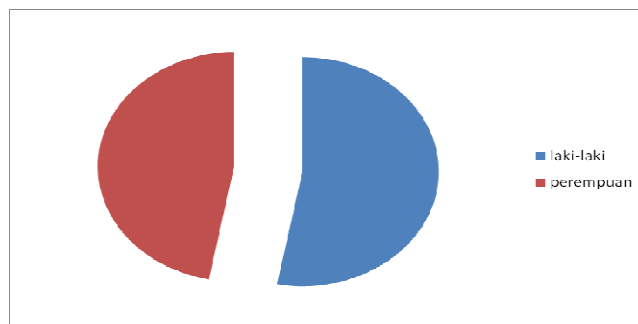
Data collection technique used was quota sampling, where five respondents were selected for each tourist attraction which frequently visited. The research was conducted in the city of Sabang, precisely at 20 locations of Sabang attractions, namely; Pasir Putih, Teupin Sirkui, Danau Aneuk Laot, Pantai Kasih, Teluk Sabang, Air Terjun, Air Panas Keuneukai, Tugu Kilometer Nol, Balohan, Pantai Reuteuk, Pantai Arun, Pantai Anoi Itam, Pantai Paradiso, Pantai Sumur Tiga, Pulau Rubiah, Lueng Angina, Pantai Iboih, Teupin Layee, Pantai Pria Laot Dan Pantai Gapang. Total respondents were 100 visitors and the variables are as follows:

1. Tourist attraction: Pasir Putih, Teupin Sirkui, Danau Aneuk Laot, Pantai Kasih, Teluk Sabang, Air Terjun, Air Panas, Keunuekai, Tugu Km Nol, Balohan, Pantai Reuteuk, Pantai Aroun, Pantai Anoi Itam, Pantai Paradiso, Pantai Sumur Tiga, Pantai Rubiah, Lueng Angin, Pantai Iboih, Teupin Layee, Pantai Pria laot dan Pantai Gapang (20 categories).
2. Gender: Male and Female (2 categories).
3. Public Service: (7 categories). Cleanliness, friendliness, beauty, transportation, publications, facilities, and prices.

3 Result And Discussion

Result

For multiple correspondence analysis, the variables used are tourist attractions, gender and public service. Visitor attractions divided into 20 different locations with the total of respondent is 100 visitors. Therefore, there are five respondents for each tourist attractions. Furthermore, the second variable is gender that divided into male and female categories (male: 53 respondents, female: 47 respondents). The following pie chart display respondent categories.



Picture 1. Pie Chart for Gender category

Pie chart above shows that the number of male respondents is more than female. Nevertheless, this difference is significantly small, so that multiple correspondence analysis method can be used.

The third variable is public service that consists of 7 categories; cleanliness, friendliness, beauty, transportation, publication, facility, and price. Scale used is 1 = Disagree, 2 = doubtful, 3 = Agree, 4 = Strongly Agree.

Table 1. Singular Value, Main inertia, Chi Square, Proportion of Explained, and Proportion Cumulative

No.	Category	Total	Mean
1	Cleanliness	226.3	2.3
2	Friendliness	305.5	3.1
3	Beauty	297.0	3.0
4	Transportation	213.5	2.1
5	Publication	233.5	2.3
6	Facility	189.0	1.9
7	Price	261.0	2.6

According to table above, friendliness and beauty categories were 3.1 and 3.0 in value means the level of friendliness and the beauty is relatively good for the 20 major tourist attractions in Sabang. Followed by cleanliness, transportation, and publication that were ranked at number-two means that tourists were hesitate to the public service for this category. Likewise facility which figures was approaching at 1.9. Base on this result, we suggest that the improvement of public services in this category should be increased to satisfy the tourists. The analysis of three variables above will be continued with multiple correspondences. Below is the output using SPSS.

Table 2. Singular Value, Main Inertia, Proportion of Explained, and Proportion Cumulative

Dimension	Singular Value	Main Inertia	Proportion of Explained	Proportion Cumulative
1	0.64704	0.41867	4.83	4.83
2	0.60341	0.36410	4.20	9.03
3	0.60110	0.36132	4.17	13.20
4	0.59345	0.35218	4.06	17.26
...
...
Total		8.66667	100.00	-

The table above shows that the percentage of the cumulative proportion of the first two characteristic roots is 9.03%, which means that two vector rows and columns can explain the variability origin data for 9.03% of total inertia. Means that the output picture only explain 9.03% of actual data. Each dimension can be described as the following proportions:
 1. Dimension 1 explained the data variability of 4.83%
 2. Dimension 2 explains the data variability of 4:20%

Discussion

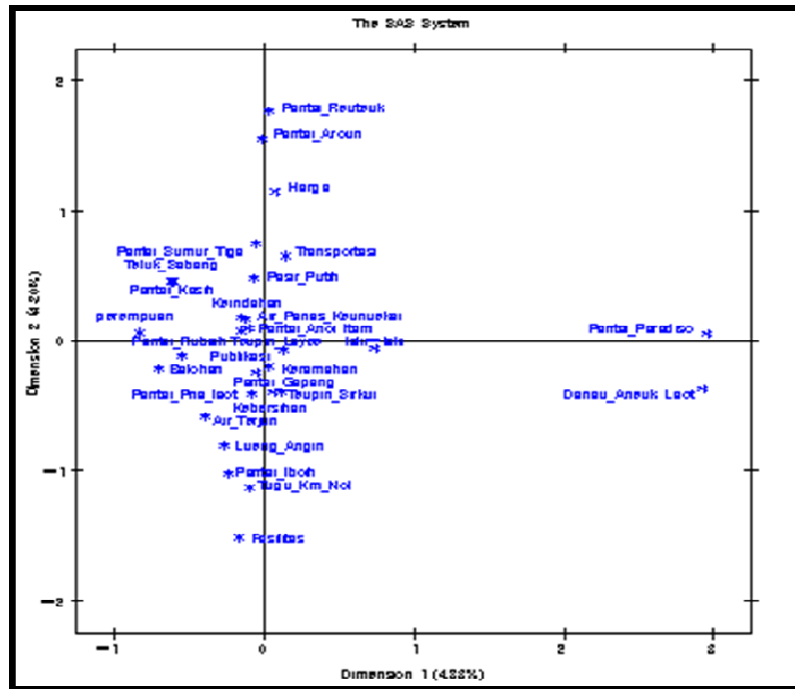
Multiple Correspondence Analysis

In multiple correspondence analysis, the output will be displayed in the form of one-dimensional and two dimensional. In this case, both dimensions will be drawn into a Cartesian graph. To illustrate the Cartesians in the chart, locations of the dots is required. The Dots can be obtained using SAS software. Here are the results obtained by SAS:

Table 3. Coordinate for each categories for 1- dimensional and 2- dimensional

Variable	Category	1-dimentional	2-dimentional	
Tourist Attraction	Air Panas Keuneukai	-0.1542	0.1793	
	Air Terjun	-0.3881	-0.5781	
	Balohan	-0.7021	-0.2168	
	Danau Aneuk Laot	2.9323	-0.3660	
	Lueng Angin	-0.2665	-0.8041	
	Pantai Anoi Itam	-0.0999	0.1026	
	Pantai Aroun	-0.0056	1.5508	
	Pantai Gapang	0.1266	-0.0658	
	Pantai Iboih	-0.2311	-1.0196	
	Pantai Kasih	-0.6123	0.4586	
	Pantai Paradiso	2.9625	0.0521	
	Pantai Pria laot	-0.0821	-0.4134	
	Pantai Reuteuk	0.0343	1.7677	
	Pantai Rubiah	-0.5510	-0.1118	
	Pantai Sumur Tiga	-0.0568	0.7476	
	Public Service	Pasir Putih	-0.0612	0.4768
		Teluk Sabang	-0.6123	0.4586
Teupin Layee		-0.1554	0.0785	
Teupin Sirkui		0.1165	-0.3916	
Tugu Km Nol		-0.0958	-1.1244	
Facility		-0.1645	-1.5065	
Price		0.0818	1.1513	
Gender	Cleanliness	0.0679	-0.3979	
	Beauty	-0.1226	0.1663	
	Friendliness	0.0350	-0.1914	
	Publication	-0.0464	-0.2439	
Transportation	Transportation	0.1484	0.6572	
	Male	0.7459	-0.0585	
	Female	-0.8325	0.0653	

According to the table above, the coordinate dots of both dimensions are depicted in a picture resulting from SAS. Below is the multiple correspondence analysis appearance from SAS



Picture 2. Multiple Correspondence Analysis Output

Base on the result display:

1. The majority of tourist attractions are clustered in publication, cleanliness, friendliness and beauty attributes.
2. Pantai Reuteuk and Pantai Aroun are clustered in price attribute. Means that the prices at these locations are relatively cheap and achievable.
3. Pasir Putih and Pantai Sumur Tiga are clustered in transportation attribute. In these locations have good road facilities for vehicles. Thereby, we can conclude that in transportation facilities in these places are better than the others.
4. Tugu Km Nol is clustered in facility attribute that serves variety food and beverage, rental and toilet that relatively good that others places.
5. Pantai Iboh is clustered in cleanliness attribute which means the hygiene standard in this place is high compare to other attractive places.

6. Pantai Anoi Itam and Teupin Layee are clustered in transportation attribute. It Means that at these places transportation facilities are relatively good that other locations.
7. Both male and female are clustered in publication, cleanliness, friendliness, and beauty. It means that they expect better public service at these attributes.

Spearman Correlation

Spearman correlation is used to support the multiple correlation analysis outcomes to investigate the strength and relation among variables. The latter to observe closeness among 7 public service variables: cleanliness, friendliness, beauty, transportation, publication, facility, and price.

Table 4.4 Spearman Correlation Output

-	Cleanliness	Friendliness	Beauty	Transportation	Publication	Facility	Price
Cleanliness	1.00000	0.81949	0.72357	0.12420	0.82031	1.70147	0.43385
P value		< 0.0001	0.00030	0.60190	<0.0001	0.00060	0.05600
Friendliness		1.00000	0.72336	0.03967	0.75482	0.75255	0.47378
P value			0.00030	0.86810	0.00010	0.00010	0.03480
Beauty			1.00000	0.30185	0.77748	0.49189	0.43946
P value				0.19590	<0.00010	0.02760	0.05250
Transportation				1.00000	0.46790	0.20928	-0.00339
P value					0.03570	0.37590	0.98870
Publication					1.00000	0.66516	0.21078
P value						0.00140	0.37240
Facility						1.00000	0.23645
P value							0.31550
Price							1.00000
P value							

Base on the table above, we can conclude:

1. Cleanliness is significantly associates with friendliness, beauty, publication, and facility. Means that is cleanliness increases, it affects friendliness attribute, beauty, publication and facility. On the contrast, cleanliness does not relate to transportation and price since p value is more than 0.05.
 2. Friendliness is significantly associates with beauty, publication, facility and price but not with transportation.
 3. Beauty does not correlate with price because p value is more than 0.05.
- According to the result of spearman correlation above, it can be concluded that the result has support the output accuracy of correspondent analysis (Picture 2).

4 Conclusion and Suggestion

Conclusion

Regarding to research outcome and discussion , we can conclude that:

1. The majority of tourist attractions are clustered in publication, cleanliness, friendliness and beauty attributes.
2. Pantai Reuteuk and Pantai Aroun are clustered in price attribute. This explains that the price offered in this area is relatively cheap and very affordable for tourists.
3. Pasir Putih and Pantai Sumur Tiga clustered in the transport attribute. Thus, the conclusion of transport in both places is better than other places.
4. Tugu Km Nol clustered in attribute Facility.
5. Pantai Iboih clustered with cleanliness attribute that indicates where this tour has a high level of cleanliness of the other attractions.
6. Transportation attributes clustered with beach resorts and Teupin Layee Anoi Itam. This is the best means of transport from other regions.
7. Spearman correlation test results confirming the accuracy of the results of correspondence analysis display.

Suggestion

City Government of Sabang should level the public service in every area of tourism in order to further enhance the development of tourism revenue in Sabang.

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Linear Programming and Sensitivity Analysis for Optimizing Nutrient Sufficiency

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Abstract. The application of Linear Programming and Sensitivity Analysis in this research is to optimize the nutrition sufficiency of adult female in Aceh Besar regency. The objectives of this research are to identify the amount of money to fulfill the food needed and food quantity combination that must be prepared in a week, so that the nutrition can be satisfied. Data consist of 43 decision variables as well as 248 females as the object. Data Analysis results count of money that should be prepared by the community in Aceh Besar for food consumption is Rp. 3,398.21 per kilogram body weight per week, also food consumption combination in the unit of gram and URT per week. The research also results output of Sensitivity Analysis.

Keywords : *Linear Programming, Sensitivity Analysis, Nutrient Sufficiency.*

1 Introduction

1.1 Background

In developing or disaster area like Aceh Besar regency, people or families are often difficult or they do not notice nutrient of themselves. These happenings because knowledge about nutrient is little, purchasing power which is thought is not able to buy foods which have high nutrient, or knowledge about nutrient is not suitable with community habit.

Foods which will be consumed ought to satisfy 100% of nutrient elements in the body, their prices can be reached with purchasing power of the community, and food kinds are suitable with consumption habit. Therefore, optimalization of person or family nutrient sufficiency with notice purchasing power and consumption habit is important for community, and the other people or institution which has interest.

This research is held to apply linear programming model and sensitivity analysis for optimizing of nutrient sufficiency in Aceh Besar regency, Aceh province.

1.2 Objectives

Purpose of the research is :

1. To apply linear programming model in identifying the amount of expenditure budget for foods which should be prepared per week so that necessity of nutrient elements can be satisfied.
2. To apply sensitivity analysis in identifying change of objective function score which is caused by food price change or nutrient element necessity change in body.

2 Materials And Methods

2.1 Sampling Method

Data used in the research are both primer and secondary data. The former data are family food consumption data with factors which their influence. Respondents were housewives in Aceh Besar regency, Aceh Province, Indonesia. The number of samples taken was 250 households held with two steps, they were :

1. The first step

The first step was applied stratified random sampling, stratification was based on region locations in Aceh Besar regency. There were five regions which become layers.

2. The Second Step

Cluster sampling was used after the first step, the cluster was subdistrict. 2 subdistricts were chosen from every regions randomly, the subdistricts can be seen in Table 1, then households were taken from the subdistricts. Respondents in the households were housewives who have obtained cash direct aid (Bantuan Langsung Tunai [BLT]) from central government. Households receiver BLT have low economics or poor families.

Table 1. Subdistricts which selected as location of sampling in every region

Region 1	Region 2	Region 3	Region 4	Region 5
Montasik Indrapuri	Peukan Bada Lhoknga	Mesjid Raya Baitussalam	Kutabaru Krueng Barona Jaya	Darul Imarah Darul Kamal

Housewives are chosen as respondents because they know about food consumed in family. 50 households were chosen from every regions, where each subdistricts were represented by 25 households. Respondents were taken from all villages in the subdistricts, each of villages consists of 1 or 2 households.

Respondens were interviewed with using questionnaire. Data taken from questionnaire included the number of family expenditure budgets for non food, frequency and the number of foods which is usually consumed by family member. Respondens were interviewed not only about their consumed food habit but also about their family consumed food habit. Respondens and their families are also counted their body weight and height.

Secondary data source is nutrition sufficiency rate table (Tabel Angka Kecukupan Gizi [AKG]) and Indonesian Food Composition Table (Daftar Komposisi Bahan Makanan [DKBM]). AKG table is needed to identify requirement nutrient elements of family members daily and DKBM is required to identify nutrient element of every foods which are usually eaten in 100 gram foods.

2.2 Research Steps

Research steps of this research are :

- Gather data with using food frequency questionnaire
- Build linear programming model.
- Find values of decision variables and objective function
- Apply sensitifity analysis
- Make conclusion.

3 Results And Discussions

3.1 Data Characteristics

Survey was held to 250 households. 968 people from 250 households had been gathered, or 1 family was around 4 people. The number of males was 483 whereas females was 485, see Figure 1. 237 people of 483 male people which were obtained have age between 20 and 59 years old. 279 people of 485 female people which were got have age between 20 and 59 year and 31 people were giving suck. Object of this linear programming research was female which have age between 20 and 59 years old without both fregnant and giving suck. The number of them was 248 people, see Figure 2.

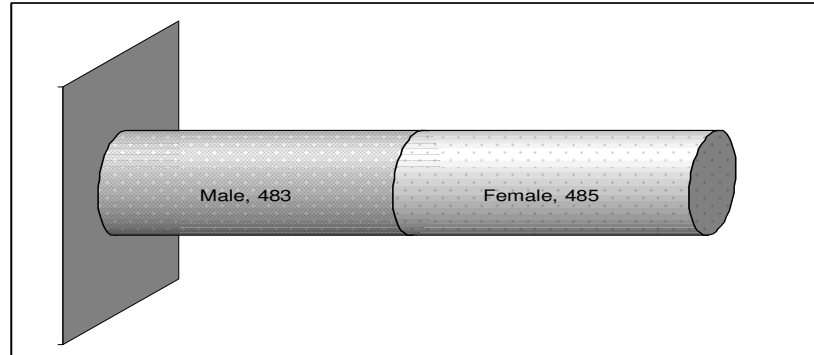


Figure 1. Distribution of data according to gender

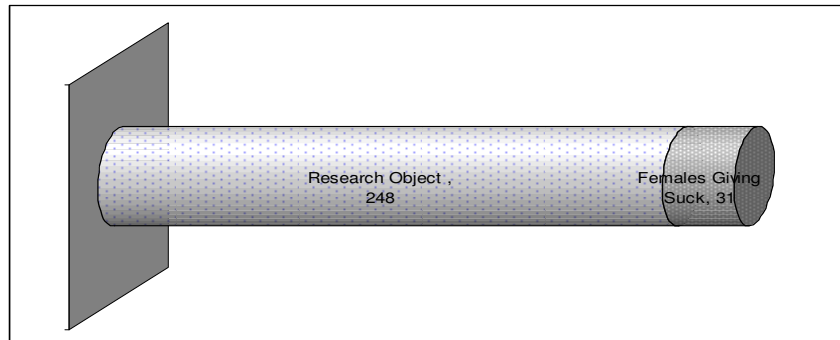


Figure 2. Distribution females age between 19 and 59 years old

Foods which are consumed by family members in Aceh Besar in the research have many kinds, let rice, nasi gurih, nasi goreng, roti, to tahu goreng. Each of foods has measurement unit (satuan ukuran rumah tangga [URT]) which is different, such as rice its URT is plate, noodle its URT is pack, bread its URT is piece, etc. URT of each food is converted to gram unit with measure directly foods which are usually consumed.

Food prices are obtained from interview directly with respondents. URT of food was converted to gram, then it was converted to food prices, for instance one plate of rice is 250 gram and its price Rp 3000 (see Table 2). The food prices are used in linear programming objective function as decision variable coefficients, so purpose of minimize expenditure budget can be reached. The amount of food nutrient usually consumed is taken from DKBM. The data is used as constraints in linear programming model.

Table 2. Conversion of food URT usually consumed by Aceh Besar society to gram unit and food prices

No.	Name of Foods	Food Codes	URT	Convert result from URT to Gram	Food Prices per URT (Rp)
I. Cereals					
1	Rice	X1	Plate	250	3000
2	Nasi gurih	X2	Plate	350	3500
3	Fried Rice	X3	Plate	350	3500
4	Instant noodle	X4	Pack	100	1000
5	Bread	X5	Piece	50	500
II. Meats, Fishes, Eggs					
6	Chicken	X6	Piece	50	4000
7	Beef/ mutton	X7	Piece	60	4000
8	Sea Fish	X8	Piece	50	3000
9	Freshwater fish	X9	Piece	60	4000
10	Salted fish	X10	Piece	10	600
11	Crab	X11	Piece	200	5000
12	Egg	X12	Unit	45	600
13	Salted egg	X13	Unit	60	1200
14	Milk	X14	Glass	230	4000
15	Shrimp	X15	Piece	10	250
16	Clam	X16	Tablespoon	10	1000
III. Beans					
17	Tempe	X17	Piece	38	250
18	Tahu	X18	Piece	100	350
19	Long bean	X19	Tablespoon	4	16
20	Green bean	X20	Tablespoon	1,5	22
IV. Leaves					
21	Spinach	X21	Tablespoon	20	150
21	Water spinach	X22	Tablespoon	20	100
23	Mustard Green	X23	Tablespoon	20	200
24	Sup (Carrot, Cabbage)	X24	Tablespoon	40	400
V. Fruit Vegetables					
25	Squash	X25	Tablespoon	20	150
26	Tomato	X26	Unit	100	300
27	Cucumber	X27	Unit	340	1000
28	Jackfruit	X28	Tablespoon	25	300
29	Eggplant	X29	Piece	30	100
VI. Fruits					
30	Papaya	X30	Piece	125	500
31	Pineapple	X31	Piece	100	500
32	Banana	X32	Unit	150	400
33	Orange	X33	Un	100	800

34	Apple	X34	Unit	200	4000
35	Bark	X35	Unit	75	600
36	Melon	X36	Piece	100	1000
37	Watermelon	X37	Piece	150	500
VII. Others					
38	Meatball	X38	Bowl	750	5000
39	Siomay	X39	Plate	500	5000
40	Fried banana	X40	Piece	100	500
41	Chicken noodle	X41	Plate	500	5000
42	Bakwan	X42	Piece	50	500
43	Fried Tahu	X43	Piece	50	500

3.2 Build Linear Programming Model

Values which want to be resulted are the number of foods which should be consumed per week in Aceh Besar area. Each of foods is coded, let X_1 is rice code, X_2 is nasi gurih, to X_{43} is fried tahu. Decision variables, X_j ($j=1,2,3,\dots,43$) represent 43 of food kinds (see Table 2).

Objective of the linear programming model is minimization of total cost which should be prepared for food expenditure per person per week. Model of linear programming for this problem becomes :

$$\text{Minimum } Z = 12 X_1 + 10 X_2 + 10 X_3 + \dots + 10 X_{43}$$

For each food price (C_j) can be counted from data in Table 2 . Let $C_1 = 3000/250 = 12$.

Constraints of this model are :

a. The first constraint (energy)

Constraints of the models need both AKG and DKBM data. Coefficients of decision variables use DKBM data. Values of right hand sides (rhs) are taken from AKG. Rhs values for energy constraint for 1 kilogram body weight per week are

$$\frac{\text{Necessity of energy per person per day (from AKG table)}}{\text{Body Weight (from AKG table)}} \times \text{many days per week} =$$

$$\frac{2250}{54} \times 7 = 291.67$$

Coefficients of decision variables in constraints use DKBM data. Let coefficient of X_1 is energy in 1 gram rice is

$$\frac{\text{energy in 100 gram rice (from DKBM table)}}{100} = \frac{178}{100} = 1.78$$

Coefficient of X_2 is energy nasi gurih in 1 gram nasi gurih is

$$\frac{\text{energy in 100 gram nasi gurih (from DKBM table)}}{100} = \frac{253}{100} = 2.53$$

Hence, model of energy constraint is

$$1.78X_1 + 2.53X_2 + 2.76X_3 + \dots + 3.28X_{43} = 291.67$$

b. The second constraint (protein)

Rhs of the protein constraint is 6.22 gram for 1 kilogram body weight per week. Coefficient of X_1 which is protein of rice in 1 gram is 0.021, coefficient of X_2 which is protein of nasi gurih in 1 gram is 0.043.

Hence, model of the protein constraint is

$$0.021X_1 + 0.043X_2 + 0.032X_3 + \dots + 1.84X_{43} = 6.22$$

c. The third constraint (calcium), the forth constraint (phosfor), the fifth constraint (iron), the sixth constraint (vitamine A), the seventh constraint (vitamine C) are each

$$0.05X_1 + 0X_2 + 0X_3 + \dots + 0X_{43} = 64.81$$

$$0.22X_1 + 0X_2 + 0.028X_3 + \dots + 1.496X_{43} = 58.33$$

$$0.005X_1 + 0.0035X_2 + 0.0066X_3 + \dots + 0.1048X_{43} = 3.37$$

$$0X_1 + 0X_2 + 0X_3 + \dots + 0X_{43} = 64.81$$

$$0X_1 + 0X_2 + 0X_3 + \dots + 0X_{43} = 7.78$$

with limits of each food are:

$$X_1 = 97.22; 0 \leq X_2 \leq 6.48; \dots; 0 \leq X_{43} \leq 1.85$$

Lower bound and upper bound of foods are determined from the twentieth percentile and the eightieth percentile of respondent food consumption data. Lower bound means respondent usually consumes foods great than the lower bound, whereas upper bound means that respondent generally consumes foods less than the upper bound. Let percentile 20 (lower bound) of instant noodle is 0.92 gram per kilogram body weight per week and

percentile 80 (upper bound) is 5.56 gram per kilogram body weight per week (Table 3), it is the mean that adult women in Aceh Besar regency generally consumed great than 0.92 gram per kilogram body weight per week and less than 5.56 gram per kilogram body weight per week. Both of the limits are used so that result of the research can be accepted highly because consumption suitable with habit of society in the place.

Table 3. Lower bound and upper bound of foods (gram per kilogram body weight per week)

No	Names of foods	Codes of foods	Lower bound	Upper bound
I. Cereals				
1	Rice	X1	97,22	97,22
2	Nasi gurih	X2	0	6,48
3	Fried Rice	X3	1,62	12,96
4	Instant noodle	X4	0,92	5,56
5	Bread	X5	0,46	2,77
II. Meats, Fishes, Eggs				
6	Chicken	X6	0,04	0,46
7	Beef/ mutton	X7	0,05	0,14
8	Sea Fish	X8	6,48	19,44
9	Freshwater fish	X9	0,005	1,11
10	Salted fish	X10	0,09	0,74
11	Crab	X11	0,06	1,85
12	Egg	X12	1,25	5,83
13	Salted egg	X13	0,14	1,11
14	Milk	X14	0,08	1,06
15	Shrimp	X15	0,1	0,74
16	Clam	X16	0,004	infinity
III. Beans				
17	Tempe	X17	1,41	5,63
18	Tahu	X18	1,85	11,11
19	Long bean	X19	0,07	0,44
20	Green bean	X20	0,02	0,11
IV. Leaves				
21	Spinach	X21	0,37	2,22
22	Water spinach	X22	0,55	2,22
23	Mustard Green	X23	0,007	0,74
24	Sup (Carrot, Cabbage)	X24	0,15	2,22
V. Fruit Vegetables				
25	Squash	X25	0,01	0,37
26	Tomato	X26	1,85	6,48
27	Cucumber	X27	0,79	6,3
28	Jackfruit	X28	0,12	0,58

29	Eggplant	X29	0,14	1,11
VI. Fruits				
30	Papaya	X30	1,16	4,63
31	Pineapple	X31	0,04	0,93
32	Banana	X32	2,08	11,11
33	Orange	X33	0,46	3,7
34	Apple	X34	0,08	0,93
35	Bark	X35	0,35	2,78
36	Melon	X36	0,02	0,04
37	Watermelon	X37	0,23	2,78
VII. Others				
38	Meatball	X38	0,58	10,42
39	Siomay	X39	0,1	2,32
40	Fried banana	X40	1,85	7,41
41	Chicken noodle	X41	0,19	infinity
42	Bakwan	X42	0,46	1,85
43	Fried Tahu	X43	0	1,85

3.3 Results of Linear Programming

Output of the linear programming model is

The LP Procedure

Problem Summary

Objective Function	Min Biaya
Rhs Variable	_RHS_
Type Variable	_TYPE_
Problem Density (%)	80.52

Variables	Number
-----------	--------

Lower Bounded	2
Upper and Lower Bounded	40
Fixed	1
Slack	1
Total	44

Constraints	Number
-------------	--------

LE	1
EQ	6
Objective	1
Total	8

Solution Summary

Terminated Successfully

Objective Value	3398.2139624
Phase 1 Iterations	20
Phase 2 Iterations	21
Phase 3 Iterations	0
Integer Iterations	0
Integer Solutions	0
Initial Basic Feasible Variables	8
Time Used (seconds)	0
Number of Inversions	3
Epsilon	1E-8
Infinity	1.797693E308
Maximum Phase 1 Iterations	100
Maximum Phase 2 Iterations	100
Maximum Phase 3 Iterations	99999999
Maximum Integer Iterations	100
Time Limit (seconds)	120

Variable Summary

Variable					Reduced
Col Name	Status	Type	Price	Activity	Cost
1 x1		FIXED	12	97.22	13.136867
2 x2	LOWBD	UPLOWBD	10	0	20.617881
3 x3	LOWBD	UPLOWBD	10	1.62	13.576142
4 x4	LOWBD	UPLOWBD	10	0.92	0
5 x5	UPPBD	UPLOWBD	10	2.77	-6.367372
6 x6	LOWBD	UPLOWBD	80	0.04	76.040831
7 x7	LOWBD	UPLOWBD	66.67	0.05	15.327515
8 x8	LOWBD	UPLOWBD	60	6.48	78.556453
9 x9	UPPBD	UPLOWBD	66.67	1.11	-135.7448
10 x10	UPPBD	UPLOWBD	60	0.74	-8.928443
11 x11	UPPBD	UPLOWBD	25	1.85	-13.84044
12 x12	UPPBD	UPLOWBD	13.33	5.83	-28.47958
13 x13	UPPBD	UPLOWBD	20	1.11	-48.92844
14 x14	BASIC	UPLOWBD	17.39	0.7717433	0
15 x15	UPPBD	UPLOWBD	25	0.74	-216.5969
16 x16	BASIC	LOWERBD	100	23.674607	0
17 x17	UPPBD	UPLOWBD	6.58	5.63	-263.2249
18 x18	LOWBD	UPLOWBD	3.5	1.85	7.3871856
19 x19	UPPBD	UPLOWBD	4	0.44	-16.49369
20 x20	UPPBD	UPLOWBD	14.67	0.11	-6.983705
21 x21	UPPBD	UPLOWBD	7.5	2.22	-33.26171
22 x22	UPPBD	UPLOWBD	5	2.22	-37.51481
23 x23	UPPBD	UPLOWBD	10	0.74	-79.488
24 x24	BASIC	UPLOWBD	10	1.8702092	0
25 x25	LOWBD	UPLOWBD	7.5	0.01	5.4046496
26 x26	LOWBD	UPLOWBD	3	1.85	10.051054
27 x27	BASIC	UPLOWBD	2.94	5.121166	0
28 x28	LOWBD	UPLOWBD	12	0.12	0.461313
29 x29	UPPBD	UPLOWBD	3.33	1.11	-2.926571
30 x30	BASIC	UPLOWBD	4	3.4691777	0
31 x31	LOWBD	UPLOWBD	5	0.04	12.405158
32 x32	UPPBD	UPLOWBD	2.67	11.11	-1.488667
33 x33	LOWBD	UPLOWBD	8	0.46	24.668219
34 x34	LOWBD	UPLOWBD	20	0.08	18.419547

35 x35	UPPBD	UPLOWBD	8	2.78	-113.5474
36 x36	LOWBD	UPLOWBD	10	0.02	10.45073
37 x37	LOWBD	UPLOWBD	3.33	0.23	0.7390287
38 x38	UPPBD	UPLOWBD	6.67	10.42	-64.97344
39 x39	UPPBD	UPLOWBD	10	2.32	-18.85536
40 x40	LOWBD	UPLOWBD	50	1.85	68.05485
41 x41	BASIC	LOWERBD	10	63.670007	0
42 x42	UPPBD	UPLOWBD	10	1.85	-182.0639
43 x43	LOWBD	UPLOWBD	10	0	13.887186
44 Protein	BASIC	SLACK	0	1.8288826	0

Constraint Summary

Constraint Row Name	Type	S/S Col	Rhs	Activity	Dual Activity
1 Cost	OBJECTIVE	.	0	3398.214	.
2 Energy	EQ	.	291.67	291.67	-8.322215
3 Protein	LE	44	6.22	4.3911174	0
4 Calcium	EQ	.	64.81	64.81	20.681794
5 Phosfor	EQ	.	58.33	58.33	-10.30853
6 Fe	EQ	.	3.37	3.37	2982.0924
7 Vit.A	EQ	.	64.81	64.81	2.6698401
8 Vit.C	EQ	.	7.78	7.78	-61.3875

Result of the model is Z value Rp.3398,21 per kg body weight per week and X_j value is quantity of foods with unit gram per kilogram body weight per week.

Food combination is determined according to ideal body height and weight. Each of the body heights can be looked for ideal body weight, the number of foods which should be consumed 1 week in gram and URT, and the number of costs which should be prepared in 1 week for the foods. For instance, necessity of rice to adult female which has body height 1.5 metres.

Ideal body weight can be conted with formula :

$$\text{Body Weight (BW)} = \text{Body Mass Index (BMI)} \times (\text{Body Hight (BH)})^2$$

In this formula, body weight in kilogram, body height in metre, and IMT is taken from normal BMI median (22), so the formula becomes :

$$\text{Ideal BW} = 22 \times (\text{BH})^2$$

After each of ideal body hights is obtained, then food consumption with gram per week for every body hight can be counted with :

$$\text{Food Consumption } jth = X_j \times \text{ideal BW}$$

Therefore, quantity of rice consumption for 1.5 metre can be counted with:

$$BW = 22 \times (BH)^2 = 22 \times (1.5)^2 = 49.5$$

Consumption of rice (gram per week) = $97,22 \times 49,5 = 4812,390$ gram

Quantity of every foods can be converted to URT unit, the formula can be used :

$$\text{Food consumption (URT)} = \frac{\text{Food consumption } j \text{ (gram)}}{\text{Food weight URT (gram)}}$$

Hence, quantity of rice consumption for females which have body height 1.5 metre is:

$$\text{Rice (plate)} = \frac{4812.390 \text{ (gram per week)}}{250 \text{ (gram)}} = 19.250 \approx 19 \text{ plate per week}$$

Cost of every food consumption for every body height can be counted with formula :

$$\text{Food consumption cost} = \text{Food consumption (URT)} \times \text{Food prices (Rp/URT)}$$

Cost of rice for a body height is :

$$\text{Rice consumption cost} = \text{Rice consumption (Plate)} \times \text{Price of nasi (Rp/plate)}$$

Price of every food can be seen in Table 2. Hence, cost of rice consumption for females which have body height 1.5 metre is:

$$\text{Rice consumption cost} = 19 \times \text{Rp. } 3,000,- = \text{Rp. } 57,000,- \text{ per week}$$

Total cost of foods which should be prepared for every person in one week is multiply Rp. 3398,214 (result of linear programing) with ideal body weight, mathematically it can be written:

$$\text{Cost per week} = \text{Rp. } 3398.214 \times \text{Ideal body weight (kilogram)}$$

Therefore, cost which should be prepared per week for body height 1.5 metres can be counted :

$$\text{Cost per week} = \text{Rp. } 3398.214 \times 49.5 \text{ kg} = \text{Rp. } 168211.159$$

3.4 Result of Sensitivity Analysis

a. Sensitivity Analysis for change of cost (C_{ij})

Result which is obtained from the model is minimum score Z Rp.3398.21 per kg body weight per week. According to sensitivity result, if cost of chicken meat (X6) change from Rp 80 per gram becomes between 3.959 and infinity with the other cost is fixed, then total cost (Z) will change from Rp. 3398.21 becomes between Rp. 3395.17 and *infinity*. The less cost of foods changes, the less total cost is gotten. Changes the other foods can be noticed in the Output.

The LP Procedure

Price Range Analysis

Variable Col Name	-----Minimum Phi----- Price Entering Objective	-----Maximum Phi----- Price Entering Objective
1 x1	-1.136867 x1	2121.0478 INFINITY .
2 x2	-10.61788 x2	4305.4007 INFINITY .
3 x3	-3.576142 x3	3376.2206 INFINITY .
4 x4	10 x4	3398.214 INFINITY .
5 x5	-INFINITY .	-INFINITY 16.367372 x5
6 x6	3.9591693 x6	3395.1723 INFINITY .
7 x7	51.342485 x7	3397.4476 INFINITY .
8 x8	-18.55645 x8	2889.1681 INFINITY .
9 x9	-INFINITY .	-INFINITY 202.41484 x9
10 x10	-INFINITY .	-INFINITY 68.928443 x10
11 x11	-INFINITY .	-INFINITY 38.840444 x11
12 x12	-INFINITY .	-INFINITY 41.80958 x12
13 x13	-INFINITY .	-INFINITY 68.928443 x13
14 x14	-9.44497 x11	3377.5043 21.205305 x28
15 x15	-INFINITY .	-INFINITY 241.59692 x15
16 x16	85.097651 x37	3045.4067 103.35871 x28
17 x17	-INFINITY .	-INFINITY 269.80486 x17
18 x18	-3.887186 x18	3384.5477 INFINITY .
19 x19	-INFINITY .	-INFINITY 20.493685 x19
20 x20	-INFINITY .	-INFINITY 21.653705 x20
21 x21	-INFINITY .	-INFINITY 40.761714 x21
22 x22	-INFINITY .	-INFINITY 42.514811 x22
23 x23	-INFINITY .	-INFINITY 89.487997 x23
24 x24	8.3727058 x28	3395.1706 11.210056 x37
25 x25	2.0953504 x25	3398.1599 INFINITY .
26 x26	-7.051054 x26	3379.6195 INFINITY .
27 x27	2.4199419 x28	3395.5507 4.0336905 x18
28 x28	11.538687 x28	3398.1586 INFINITY .
29 x29	-INFINITY .	-INFINITY 6.2565707 x29
30 x30	-5.267114 x37	3366.0647 5.7909212 x28
31 x31	-7.405158 x31	3397.7178 INFINITY .
32 x32	-INFINITY .	-INFINITY 4.1586665 x32
33 x33	-16.66822 x33	3386.8666 INFINITY .
34 x34	1.5804532 x34	3396.7404 INFINITY .
35 x35	-INFINITY .	-INFINITY 121.54739 x35
36 x36	-0.45073 x36	3398.0049 INFINITY .
37 x37	2.5909713 x37	3398.044 INFINITY .
38 x38	-INFINITY .	-INFINITY 71.643443 x38

39 x39	-INFINITY .	-INFINITY 28.855363 x39	3441.9584
40 x40	-18.05485 x40	3272.3125 INFINITY .	INFINITY
41 x41	2.1663635 x32	2899.4463 10 x4	3398.214
42 x42	-INFINITY .	-INFINITY 192.06392 x42	3735.0322
43 x43	-3.887186 x43	5453.5174 INFINITY .	-INFINITY
44 Protein	-29.23559 x10	3344.7455 94.997241 x28	3571.9528

b. Sensitivity Analysis for change nutrient elements (g_i)

Sensitifity Analysis for change right hand side (RHS) in constraints can be seen in Output. Result which is gotten from the model is minimum score (Z) Rp.3398.21 per kilogram body weight per week. According to Output, if necessity of energy changes becomes between 277.86 and 295.965 with the other necessity is fixed, then total cost (Z) change between 3362.47 and 3513.13. Change of the other nutrient element can be seen in the Output.

The LP Procedure
RHS Range Analysis

Row	-----Minimum Phi-----		-----Maximum Phi-----	
	Rhs Leaving	Objective	Rhs Leaving	Objective
Energy	277.86107 x14	3513.1348	295.96548 x27	3362.4661
Protein	4.3911174 Protein	3398.214	INFINITY .	.
Calcium	64.634782 x27	3394.5901	65.453771 x27	3411.5283
Phosfor	57.832799 x27	3403.3394	58.465326 x27	3396.819
Fe	3.3637699 x27	3379.6352	3.3928902 x27	3466.4746
Vit.A	62.290275 x24	3391.4867	65.322366 x24	3399.5819
Vit.C	6.8637479 x27	3454.4604	8.0293807 x27	3382.9051

Change of X_j food nutrient element content (a_{ij}) in this cases is not learned because a_{ij} value is fixed.

4 Conclusions

Conclusions from the research are:

1. Adult females in Aceh Besar regency which have 19 to 59 old should prepare cost for food minimum Rp. 3398.21 per kilogram body weight per week, and combination of food consumption in URT which have been counted can be become as guidance.
2. Sensitifity analysis in this research can be applied to see change minimum cost (Z) which is caused by either food cost or nutrient necessity in body change.

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