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Biplot Analysis Methods for Selecting the Consumer's Preferences of Primary Needs in Java Island Indonesia

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ABSTRACT

The effect of COVID-19 pandemic in February 2020 changed human consumption pattern. Most people especially for lower and middle communities, they only be able to fulfils the primary needs. The COVID-19 pandemic had been made some companies done a work termination. Therefore, people is required to sort out and choose needs that are on a priority scale. This article used biplot methods to analyze behavior of the consumer's primary needs during the COVID-19 pandemic. Respondents number of this research are 100 respondents from 4 districts in Java Island who filled out the questioner. In some references, biplot analysis methods focus on agriculture field such as determining the best genotypes and habitats of plants. Rarely of them cosider in economic point of view for example in consumers' preferences. As we known that biplot analysis is a valuable technique for identifying environtmental condition. It is superior to other statistical methodologies because of its superior predictive accuracy. This method represent a grapics of multivariate data that plot information between the observation and variables in cartesian coordinates. Therefore, the goal of this study examines the consumers' preferences in Java Island, Indonesia, using biplot analysis to assess preferences of primary needs such rice, cooking oil and margarine in four districts, Bekasi, Madiun, Tasikmalaya, Banyumas, in Java Island were conducted. Regarding to the result of principal component analysis, it shows that consumers have same priority to choose the brand of cooking oil. It was shown from score of PC1 and PC2 values. The result provide helpful information about the consumer preferences of primary needs during COVID-19 from four districts in Java Island.

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A. INTRODUCTION

The largest shock to the global economy since the Second World War occurred in February as a result of the coronavirus outbreak. A labor market implosion caused by lockdowns and decline in consumer spending saw equivalent of over 500 million full-time jobs disappear almost instantly. As factories closed and nations closed their border, world trade trembled. Besides that, unemployment and poverty rates have increased as a result of the COVID-19 epidemic. However, we might be thankful that digital transformation did grow and even upset businesses and the economy when the epidemic stuck Indonesia. The emergence of the digital economy, is pervasive today (Bagchi et al., 2020).

Individuals and families make up the minor components that make up the community consumption patterns. People's consumption habits have changed as a result of the COVID-19 epidemic. On the one hand, the community must classify and select requirements according to importance. On the other hand, people want their demands in life to be met to the utmost extent possible. Numerous statistical techniques have been created during the last three decades to evaluate the stability of the same problem but distinct objects. Several researchers investigated in cultivar across test location (Cooper et al., 1993), (Cooper & DeLacy, 1994), (Cooper et al., 1997) and (Gauch Jr & Zobel, 1997). The additive main effects and multiplicative interaction model (AMMI), one of the most significant analysis techniques, has been widely used to evaluate the stability of variations (Wang et al., 2020) and to assess environments in the case of multi-environment variety trials (Gauch Jr & Zobel, 1997). However, the genotype main effect (G) and genotype by environment interaction (GEI), as in the genotype main effect plus genotype by environment interaction (GGE) biplot approach, must be integrated for test location evaluation (Yan & Hunt, 2001), (Yan et al., 2001) and (Yan & Rajcan, 2002). The GGE biplot was the most suitable type of biplot for mega-environment inquiry, genotype evaluation, and test location evaluation, according to (Yan & Rajcan, 2002).

In this paper we consider the consumer's Preferences of primary needs especially in Java Island, Indonesia by using the biplot analysis methods. Several researchers consider not only biplot but also GGE. The GGE-biplot focuses on two ideas. First, only G and GEI are pertinent to and need to be taken into account at the same time, even if the measured yield is the combined effect of G, E, and GEI. Second, to approximate and display the GGE of a MEYT, the biplot approach is used, hence the name GGE biplot (Gabriel, 1971). The first two principal components (PC1 and PC2, also known as primary and secondary effects, respectively) that result from subjecting environment-centered yield data, or the yield variance owing to GGE, to singular value decomposition are what make up this GGE-biplot. It is demonstrated that this GGE-biplot efficiently reveals the data's GEI pattern. It facilitates ME identification by demonstrating with clarity which genotype prevailed in certain conditions (Yan et al., 2000). In GGE-biplot analysis, test location evaluation is conducted graphically (Yan et al., 2000). A representative location implies that varieties selected in that location would have high probability of performing well in other locations of the same region.

There are many researchers who are considering using this method. In 2021, (Mahmud et al., 2021) investigated the farmers' preference, Yield for four types of sweet potato in multiple environments. A technique, called GGE-biplot, that enables visual inspection of the GEI pattern of MEYT (Multi environment yield trials) was investigated by (Yan et al., 2000) in 2000. (Kaya et al., 2006) has been investigated the GGE-biplot analysis for multi-environment yield trials in bread wheat. GGE-biplot analysis also investigated by in 2014 (XU et al., 2014). They considered investigating the cotton regional by using GGE-biplot in YaRV China. However, rarely researchers who consider biplot analysis method. Therefore, this is the main reason that we consider of it.

Furthermore, GGE biplot analysis is use as a useful tool for some researchers. For example, GGEBiplotGUI Package can be used to analyze a visual data analysis of multi-invirontment trials (Frutos et al., 2014). In 2022, Omrani et al. (2022) studied that for wheat Triticum aestivum L genotypes for two crop years in five regions. The result got that the genotypes G2 and G21 are

the highest yielding. Meanwhile, biplot analysis is a useful technique in scientometrics for multivariate data (TorresSL_CITATION {"citation. GT biplots combined with other statistical techniques are excellent tool for visual evaluation of superior genotypes (Gholizadeh & Dehghani, 2016) and (Gholizadeh et al., 2018). Biplot analysis is a valuable tool for making decisions and visualization of interrelationships between variables and genotypes for mango (*Mangifera indica L.*) (Maia et al., 2016). The GGE biplot is an efficient approach for identifying three mega-environments in grain sorghum in Brazil (da Silva et al., 2021). In contrast, GYT biplot used to definite the best Barley genotypes in multi traits (Kendal, 2020) and (Kendal, 2019). In 2019, Yan (2019) investigated location-grouping (LG) biplot method for mega-environment delineation that does not require common genotypes across years so that data from routinely conducted variety trials can be utilized to understand the mega-environments and test locations for any crop and region.

Moreover, in Amhara region, Ethiopia, GGE biplot view identified that Serinka and CIP-396004.337 are an ideal testing location and ideal genotype, respectively for this region (Gedif & Yigzaw, 2014). On the other hand, Hj-biplot methodology is the best tool to analyse a low-dimensional Euclidean space of multivariate data matrix (Gallego-Álvarez et al., 2015). Biplot can be used as tools to draw a single graphic between the predictor variables and response variables (Oyedele, 2021). GGE biplot technique is one of the appropriate methods for investigating the genotype-environment interaction (Ansarifard et al., 2020)(Yan, 2013). GGE biplot graph reflected the superior genotype of cotton (Sadabadi et al., 2018). GGE biplot method is used to explore the G and GEI for chickpea genotypes (Farshadfar et al., 2013).

Using biplot analysis techniques, we examine consumer preferences for primary needs in this paper, with focus on Java Island, Indonesia. Although there is little research on consumer preferences using biplot analoysis, the current study's objectives including determining the highest consumer preferences. This is acchieved by using the biplot method to investigate the effect of COVID-19 for primary needs was shown in every attributes. Plotting information between variables and observations in cartesian coordinates is what the biplot analysis method does for multivariate data.

B. MATERIALS AND METHODS

1. Primary Needs

The type of research for the consumer data are both descriptive and quantitative. In this paper, we consider three basic needs: rice, cooking oil and margarine. All product were evaluated. One hundred respondents were filled out the questionnaire when we had a focus group discussion in 4 districts in Java Island (Madiun, Tasikmalaya, Bekasi and Banyumas). The primary needs that were ranked next most important (rice, cooking oil and margarine). The attributes of each primary need are price, brand, promotion, availability, and quality. Information of rice brand, cooking oil brands and margarine brand can be seen in Table 1.

Table 1. Primary Needs Brand

Rice	Cooking Oil	Margarine
Campur	Barco	Amanda
IR	Curah	Blue Band
Local	Filma	Curah
Pandan wangi	Fortune	Filma
Ramos	Minyak Kiita	Forvita
Rojolele	Mitra	Palma
Sania	Resto	Palmia Royal
	Rose Brand	Simas
	Sabrina	
	Sania	
	Sovia	
	Sunco	
	Tawon	
	Tropical	

2. Statistical Analysis

Results were analyzed utilizing both univariate and multivariate statistical techniques. Consumer data that was both descriptive and quantitative were first examined separately, and then jointly. All statistical analysis is using R Studio and Lisrel for Windows ver. 12.0.1.2. Firstly, the descriptive data were analyzed using an R studio with means separation and principal components analysis. To identify linear correlations, correlation analysis was done separately and together on descriptive and consumer data. Scatterplots were used to visually evaluate any potential nonlinear correlations between consumer attributes and daily needs attribute intensities.

Using R studio, internal preference mapping was carried out on consumer means, and the treatment mean scores were shown on the resulting principal component eigenvectors. Using landscape segmentation analysis, external preference mapping was created (LSA). The LSA was performed using same software R studio on customer acceptability scores, and consumer segmentation was performed using agglomerative hierarchical clustering on consumer LSA coordinates (AHC). The Euclidian distance matrices and Ward's approach were applied. Discriminant analysis was used to the generated clusters until a cross-validation correct identification rate of 95% or higher was achieved. Using R studio, the AHC and discriminant analysis were carried out. The clustering variables also use similar software. However, for PCA applied Lisrel for Windows ver. 12.0.1.2.

3. Singular Value Decomposition (SVD)

Biplot analysis introduced for the first time by Gabriel (Gabriel, 1971). This analysis was done using determined matrices from the singular value decomposition (SVD). A matrix's factorization into three matrices is known as its singular value decomposition (SVD). It provides a significant geometrical and theoretical understanding about linear transformation and has some intriguing algebraic characteristics. It has some significant data science applications as well. The SVD of mxn matrix A is given by the formula:

$$A = U\sum V^T \tag{1}$$

with

U: $m \times m$ matrix of the orthonormal eigenvectors of AA^T

V^T: transpose of a $n \times n$ matrix containing the orthonormal eigenvectors of A^TA

$\sum$: diagonal matrix with r elements equal to the root of the positive eigenvalues of AA^T or A^TA.

Equation (1) can be written in the following (Jolliffe, 1990)

$$A = UL^{\alpha}L^{1-\alpha}V^T \tag{2}$$

4. α Parameter

There are two α values which are used to define $UL^{\alpha} = G$ and $L^{1-\alpha}V^T = H'$ that are $\alpha = 0$ and $\alpha = 1$. If $\alpha = 0$ so that we have following equation

$$U = G \text{ and } LV^T = H' . \tag{3}$$

in general, for $\alpha = 0$, it will be given biplot graph that describing not only multivariate data but also relationship between variables and trend of the object. For $\alpha = 0$ the factorization result namely *CPM biplot.* On the other hand, for $\alpha = 1$, we have following equation

$$UL = G \text{ and } V^T = H' . \tag{4}$$

meanwhile, biplot described distance between a pair of series. Result of factorization called *RMP* biplot (*Row Metric Preserving*).

5. Biplot feasibility measure

Biplot analysis is a useful technique for multivariate data. The data information represented by biplot is determined based on ρ^2 values. The ρ^2 defined as a biplot feasibility measure. Formula of ρ^2 is wiritten in the following:

$$\rho^2 = \frac{\lambda_1 + \lambda_2}{\sum_{k=1}^{r} \lambda_k}$$

C. RESULT AND DISCUSSION

1. Descriptive Analysis

In this section, we explained the data analysis of PC1 and PC2 values for each district which is obtained by using Lisrel for Windows ver. 12.0.1.2. The value of PC1 and PC2 can be seen in Table 2, Tabel 3, and Table 4 for rice, cooking oil and margarine, respectively.

Table 2. PC1 and PC2 score for rice in four Districts

	Bekasi		Madiun		Tasikmalaya		Banyumas	
	PC1	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**
Price	0.901	-0.113	0.925	-0.140	0.877	0.231	0.845	0.368
Promotion	0.793	0.583	0.748	0.658	0.503	0.747	0.444	0.858
Availability	0.935	-0.059	0.904	-0.191	0.909	0.174	0.852	-0.440
Brand	0.867	0.074	0.853	-0.033	0.684	0.533	0.521	-0.237
Quality	0.862	-0.428	0.958	-0.169	0.847	0.283	0.918	-0.211

Table 3. PC1 and PC2 score for cooking oil in four Districts

	Bekasi		Madiun		Tasikmalaya		Banyumas	
	PC1	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**
Price	0.912	-0.303	0.9661	0.141	0.842	-0.455	0.691	-0.344
Promotion	0.914	0.142	0.838	0.525	0.789	0.497	0.272	0.845
Availability	0.928	-0.298	0.953	-0.191	0.921	-0.250	0.903	-0.151
Brand	0.881	0.373	0.859	-0.291	0.796	0.511	0.667	0.441
Quality	0.922	0.102	0.959	-0.147	0.950	-0.195	0.899	-0.167

Table 4. PC1 and PC2 score for margarine in four Districts

	Bekasi		Madiun		Tasikmalaya		Banyumas	
	PC1	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**	**PC1**	**PC2**
Price	0.871	-0.360	0.901	0.347	0.837	-0.455	0.842	-0.299
Promotion	0.868	-0.349	0.900	0.371	0.866	0.416	0.554	0.820
Availability	0.934	0.052	0.972	-0.165	0.903	-0.345	0.911	-0.239
Brand	0.843	0.462	0.916	-0.331	0.866	0.458	0.855	-0.036
Quality	0.963	0.186	0.972	-0.188	0.911	-0.071	0.951	0.047

The findings of the descriptive analysis showed that there are attributes preference of the consumers to buy rice in Bekasi district Figure 1. Three **PC**s are explained in Table 2. Figure 1 explains that the communities of Bekasi district have same priority for selecting of rice. This can be seen from the priority vector of promotion, brand, availability, price and quality. Regarding to the biplot result, the variation of rice types which chosen are varied and everyone gave different responses for same product. However, for some people in Bekasi, they did not choose brand of the rice to consume. It can be seen from the vector priority direction.

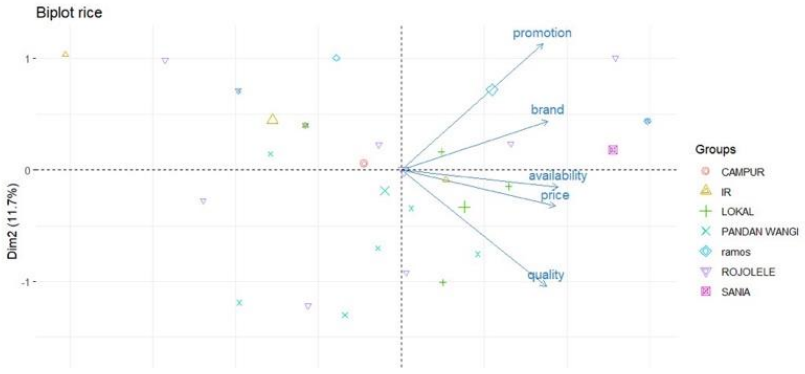

Figure 1. Atributes preference of rice in Bekasi District

The communities in the Madiun area have equal priority when choosing their rice, as shown in Figure 2. This is evident from the promotion, brand, availability, price, and quality priority

vectors. in relation to the biplot result, different rice varieties selected, and everyone's answers were diverse for the same item. However, several residents of Madiun did not select the brand of the rice they ate. The vector priority direction reveals it.

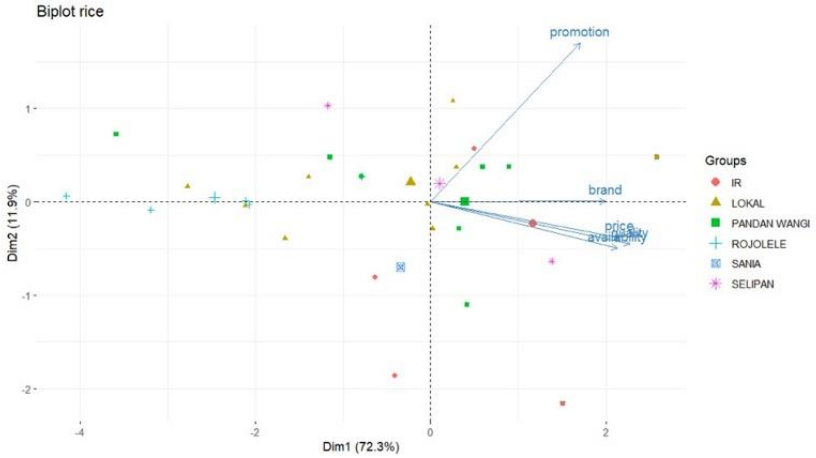

Figure 2. Atributes preference of rice in Madiun District

As seen in Figure 3, the communities in the Tasikmalaya region prioritize rice equally. The priority vectors for promotion, brand, availability, price, and quality make this clear. Different rice kinds were chosen, and everyone's responses varied for the same item in relation to the biplot result. However, a number of Tasikmalaya locals didn't choose the brand of the rice they consumed. It can be seen from the vector priority direction. The Banyumas region's communities prioritize rice equally, as shown in Table 3. This is made evident by the promotion, brand, availability, price, and quality priority vectors. Everyone's reactions differed for the same item in respect to the biplot result, and different varieties of rice were used. However, several residents of Banyumas didn't pick the brand of the rice they ate. The vector priority direction reveals it. The following is the attributes preference of rice in Tasikmalaya District and attributes preference for rice in Banyumas District, as shown in Figure 3 and Figure 4.

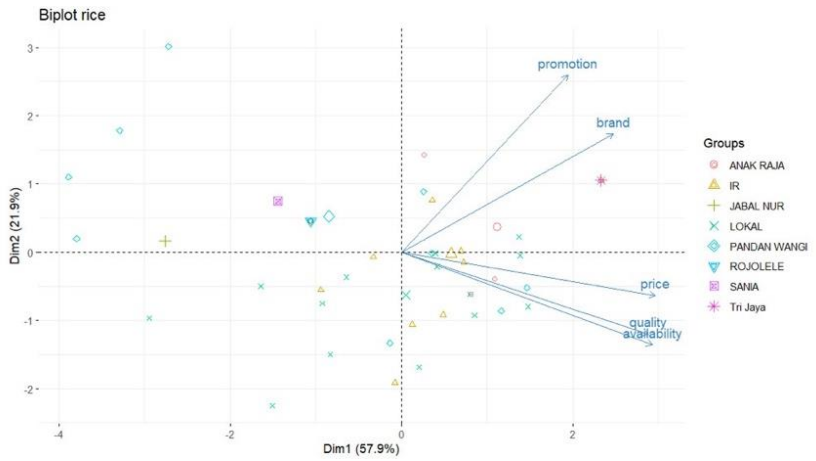

Figure 3. Attributes preference of rice in Tasikmalaya District

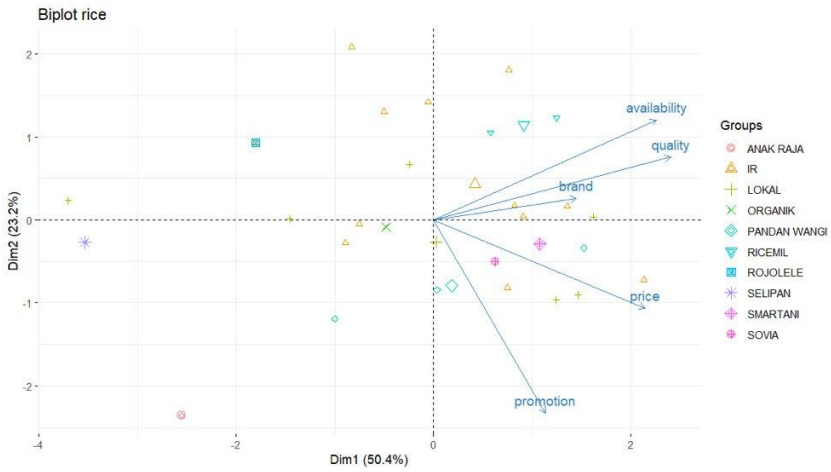

Figure 4. Attributes preference for rice in Banyumas District

It was seen that curah brand, rose brand and filma brand close to availability. Variables and correlations between variables are shown by length and angle between vectors. The biggest priority variations are in brand and availability. This is indicated by the large vector length, and at the same time these two variables have a very small correlation. This is indicated by the very large angle formed. While, the brand has a large correlation, this is indicated by the very small angle between the two vectors. In contrast, availability and price have a big correlation. Regarding to principal component analysis (PCA), consumers priority of cooking oil with several brand have same priority. It can be seen from the PC1 values for Bekasi district in Table 3 has values around 0.881 until 0.922, while for PC2 values, the communities in Bekasi bought cooking oil based on the brands. The following are atributes preference of cooking oil in Bekasi District and atributes preference of cooking oil in Madiun District, as shown in Figure 5 and Figure 6.

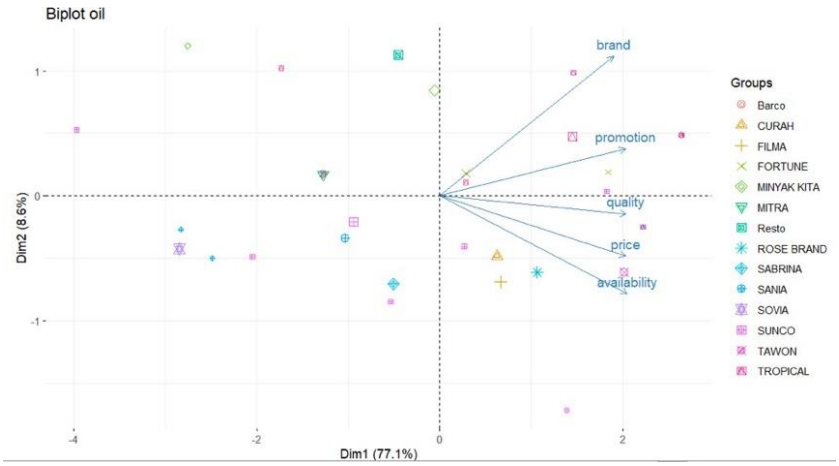

Figure 5. Atributes preference of cooking oil in Bekasi District

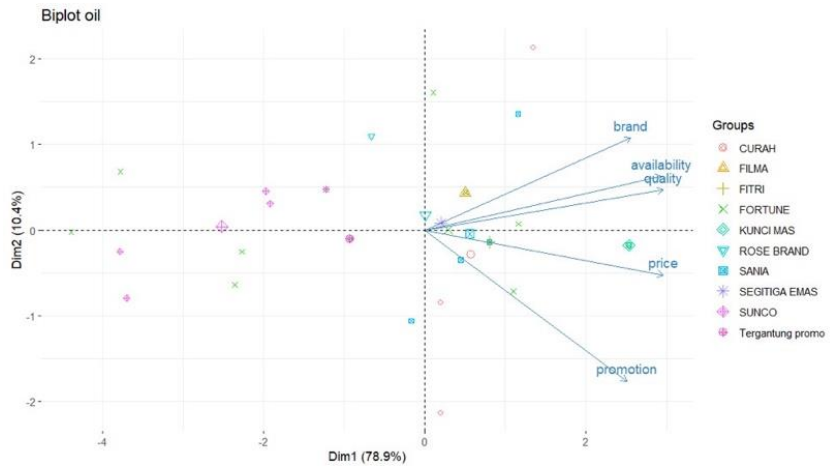

Figure 6. Atributes preference of cooking oil in Madiun District

The same situation also happened in Tasikmalaya. Attributes price and availability are become priority of the communities. It can be seen in the Figure 7. Based on the PC1 value, it was seen that the quality has high score at 0.950 point, while for PC2 value, it was seen that promotion and brands become priorities for people in Tasikmalaya.

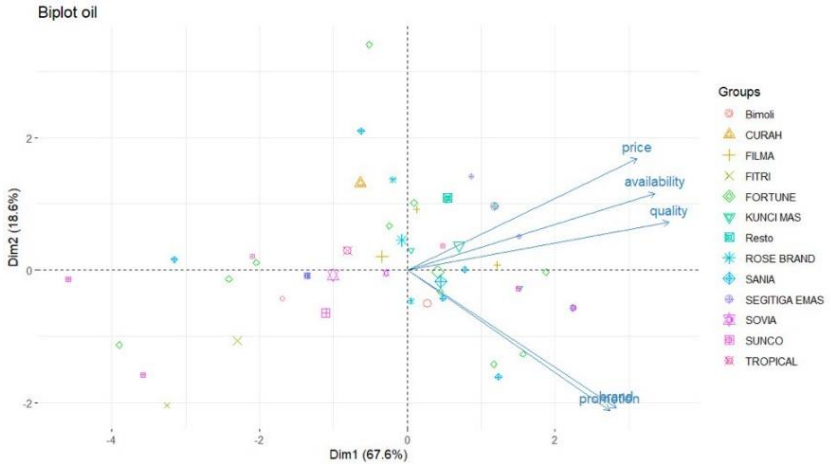

Figure 7. Atributes preference of cooking oil in Tasikmalaya District

The communities of Banyumas district have different with others three district in priority for the primary needs. Regarding to Figure 4, Figure 8 and Figure 12, communities of Banyumas district did not make five attributes (price, promotion, availability, brands and quality) as priority when they buy some primary needs.

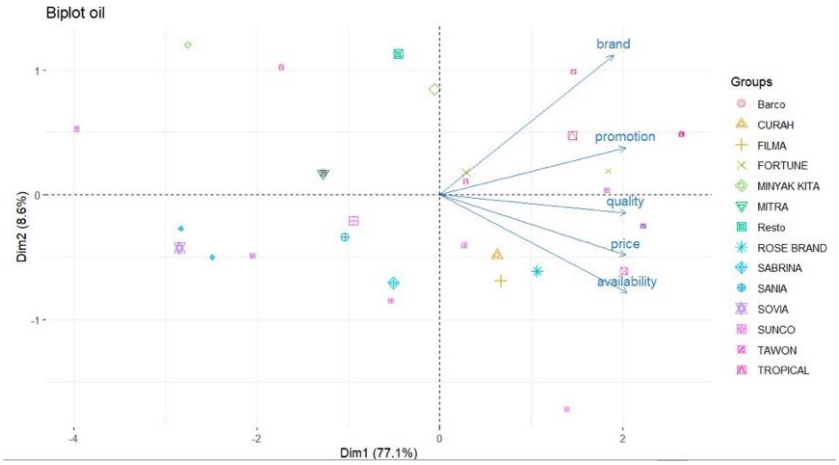

Figure 8. Atributes preference of cooking oil in Banyumas District

Margarine for some communities in Indonesia can be primary needs. Since, they can replace the use of cooking oil when it rarely in the market. Regarding to biplot graph, it was seen in Figure 9 that for all attribute, it has equally values. However, from PC2 score and variables, it can be seen that the attribute of quality and availability not a priority to buy margarine. The communities in Bekasi, they choose the promotion dan price as priority. It can be seen from the vector in Figure 9 close to each other's. Besides that, brands for margarine at the bottom right position in Cartesian's coordinate. It means that margarine for majority of the community in Bekasi district not a primary needs priority.

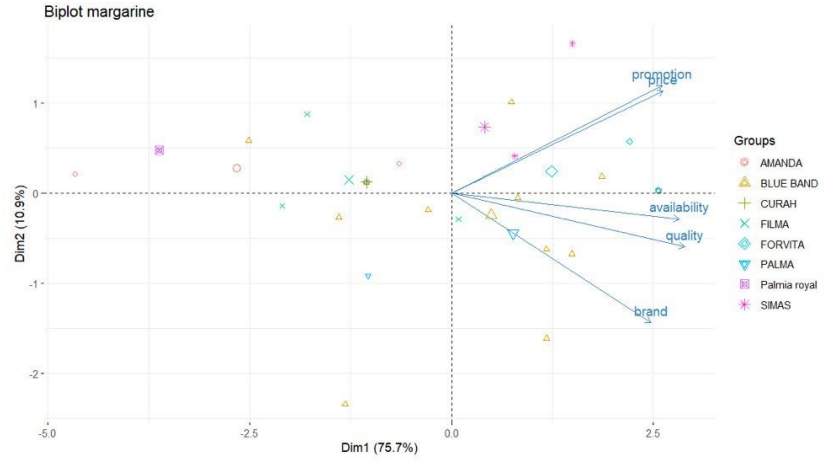

Figure 9. Atributes preference of Margarine in Bekasi District

Figure 10 and 11 describe the society's tendencies of Madiun and Tasikmalaya district when they buy margarine. It was seen that promotion and brands not to be priority. Majority of communities in Madiun and Tasikmalaya choose price and availability for margarine. Margarine for some communities in Indonesia can be primary needs. Since, they can replace the using of cooking oil when it is rarely seen in the market.

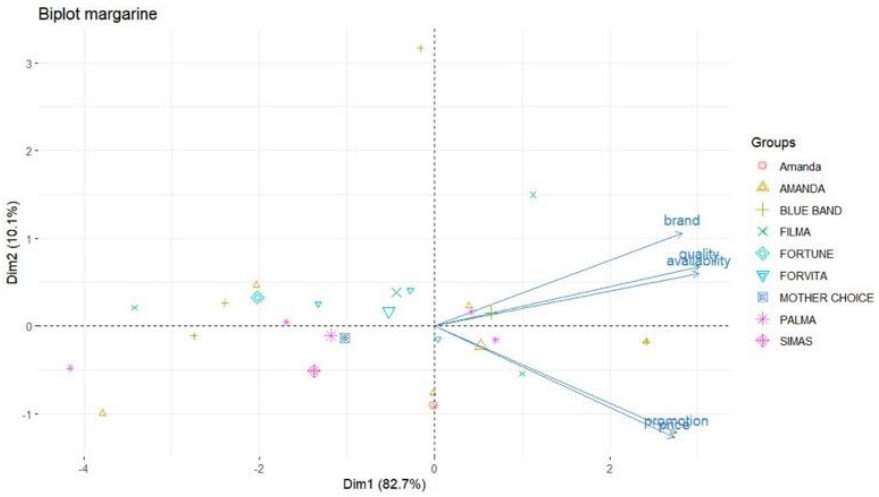

Figure 10. Atributes preference of Margarine in Madiun District

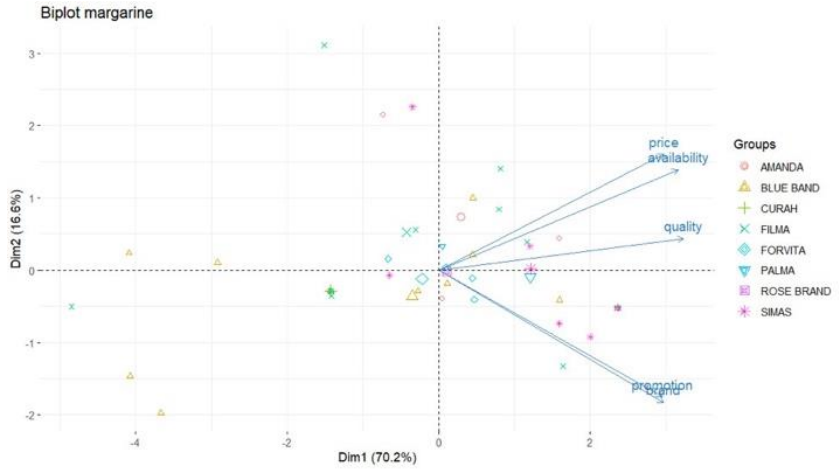

Figure 11. Atributes preference of Margarine in Tasikmalaya District

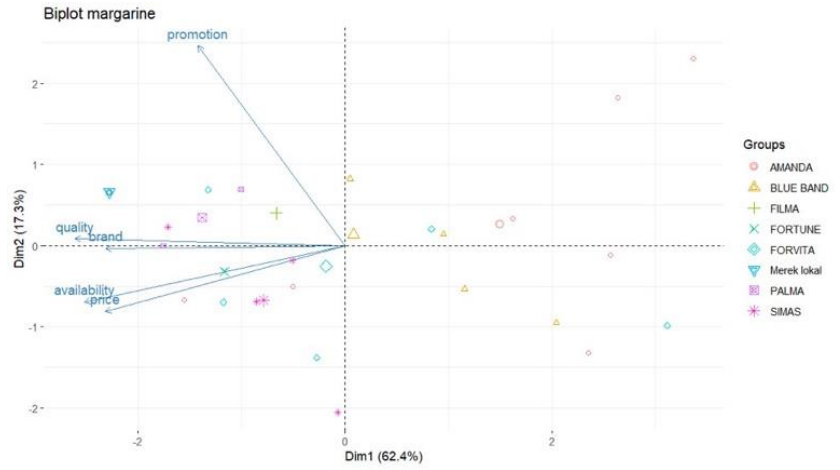

Figure 12. Atributes preference of Margarine in Banyumas District

D. CONCLUSION AND SUGGESTIONS

Because customers could utilize the product in its true context, qualitative multivariate analysis was highly helpful in determining consumers' preference of the primary needs (i.e., the results are more ecologically relevant). As a result of customers using the product in various contexts, product applications and product preferences could be better understood. The attributes of the primary needs are price, promotion, availability, brand and quality. Statistical analysis for consumers' preference of basic needs in four districts in Indonesia has result that in every district, the communities have different priority for choosing attributes of the primary needs. It can be seen not only from figures but also from values of PC1 and PC2 in the tables.

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