ICFBE 2020

The 4th International Conference on Family Business and Entrepreneurship

ANALYSIS OF NEW PRODUCT DEVELOPMENT BY USING QUALITY FUNCTION DEPLOYMENT (QFD): A STUDY OF KOMBUCHA

Noel Bentara Immanuel [1], Adi Saptari[1], Dedi Kurniawan[1], Isa bin Halim[2]

[1]*President University, noel_immanuel@yahoo.com, adi.saptari@president.ac.id, dedi.kurniawan@president.ac.id,*

[2]*Universiti Teknikal Malaysia Melaka, isa@utem.edu.my*

ABSTRACT:

Competitiveness of product innovation depends on how the company can answer the customers' needs. To capture the right needs, product designer has to go and ask the customers and summary them into priority and translate the needs into technical requirement in order to produce the competitive product. At this era there are many kinds of drinks available in the market. Tea is one of the popular drinks for quite long. Different types of flavor tea created to find its market. This study is trying to offer a new product of Kombucha tea, a fermented tea. A method of Quality Function Deployment (QFD) was implemented to come out the right design of Kombucha tea which may absorb the customer needs. This was done through the questionaries and interview to the community. Based on this information then provide some technical requirements to produce the right quality Kombucha tea that are wanted by the customer. The results show customer requirement from the questionnaires 59% of respondents agrees that they buy Kombucha due to its taste. While 82% respondent agree on the Fuzzy sensation of kombucha taste. Packaging (Appearance), 58% like the package. And for Health benefit, respondents 83% agree. For easiness to get, respondents only gave 31%. The customer need should be transformed into Functional or technical measures. The study analyzed that there are 13 Functional aspects determined the end quality of Kombucha tea. This study presented on how to translate the customer needs into functional requirements to produce the right product.

Keywords: *QFD, kombucha, product development, customer needs*

Introduction

Human needs intake of water every day, not less than 2000 ml/day for women and 2500 ml/day for men. These values are in total water intake, which might be present in beverages and food (William & Johnson, 2020). Next to water, tea and coffee are in the list of the most consumed drinks admired for its non- alcoholic, caffeine-containing beverage. Various drinks are available in the market, whether packed as ready to drink or brewed by order. Both drinks have recently become popular in Indonesia, innovated into bubble tea, fusion boba drink, brown-sugar coffee, cheese-topped tea and more. These drinks are made for entertainment

purpose and has become a lifestyle in millennials.

Millennials are also known for their strong networks, which may drive word of mouth promotion (Sujansky & Ferri-Reed, 2009). Once they are satisfied, they will tell the others and thus drinks might become viral in social media – a rocketing popularity. These satisfactions are mostly derived from flavor of drinks, considered as the key consideration for customers before buying these drinks beside the store atmosphere (Pangkey, Lapian, & Tumewu, 2016).

Considering this huge market, innovative drinks are often seen in public places, such as shopping malls, parks and even around residential areas. Doing business in this area is tempting, yet challenging since the barrier to entry is rather weak. A big fish is ready to be catch if innovation and persistence both exist in this business. A coffee shop in Bandung successfully obtain a turnover for not less than two million Rupiah per day (Idris, 2017). Joining a boba franchise through small outlet offer up to 18 million Rupiah monthly, reaching break-even point in only a couple month (Utami, 2020).

Besides of its popularity, tea is one of healthy beverages easily found in the market. Bioactive compounds in tea appear to have positive impact towards drinkers' health. It is found that these extracts helped annihilate cancer cells during in vitro tests (Donaldson, 2014). Another research found that tea also help in disease prevention, such as diabetes (Preedy, 2013; Wang, Shi, Bao, Li, & Wang, 2015).

Tea has been innovated from time to time, becoming more entertaining and fun to be drunk. It can be served classically as hot or cold beverage, infused with fruity flavor, added with topping such as boba and jelly and also fermented to become kombucha. Fermentation itself is a common process to preserve food and beverages longer with help of microorganisms, specifically bacteria and yeast. By raising acidity, bad microorganisms' growth is inhibited properly without contaminating finished product (Sreeramulu, Zhu, & Knol, 2000). Cabbages can be fermented into kimchi, peppers can be fermented into tabasco sauce, milk can be fermented into kefir and yogurt, while tea can be fermented into kombucha.

Kombucha has a unique taste and smell, derived from a combination both bacteria and yeast fermentation. This combination often called as SCOBY (Symbiotic Culture of Bacteria and Yeast) or tea fungus, forming layers of biofilm during fermentation which is fully edible. In order to generate a good quality kombucha, it is mandatory to start with good tea and sugar because both of them are the only ingredients for performing fermentation. The better the source of tea, the better the kombucha will be (Villareal-Soto, Beaufort, Bouajila, Souchard, & Taillandier, 2018).

In designing the best taste of Kombucha tea, it is necessary what kinds of taste that people are looking for? In other words, how to catch the customers' requirements so that the products offered can meet or even surpass the customer expectation. Then how the customer requirements can be translated into product or process designed. Many parameters are monitored during kombucha making process, starting for material selection, initial

composition, tea brewing, starter culture composition, incubation duration and bottling condition. A slight difference in any parameters will resulted in taste difference. There will be some quality decrease if fermentation was performed for too long in duration (Chen & Liu, 2000). In order to find and standardize the best formula and process, one of the methods can be applied is Quality Function Deployment (QFD). It is a process which systematically will optimize and enhance final product to increase customers' satisfaction by exceeding their expectations.

Research Questions

1. This research developed based on the problems:
2. What are the customer requirements for this Kombucha tea drink;
3. How to develop product i.e. Kombucha tea that meet or even surpass the customer requirements.

Research Objectives

This research is intended to develop and improve the quality of kombucha that meet customers' requirements, details objectives as follow:

1. To identify customer requirements of kombucha, then prioritize them based on the needs.
2. To transform customer needs into product characteristics in terms of technical improvements and standardization of kombucha production which will exceed customers' expectation.
3. To analysis the competitiveness of kombucha, compared its competitor of other similar drinks.

Literature Review

Currently, tea can be classified into six main types including green tea, white tea, yellow tea, oolong tea, and reprocessed tea. The most common, green tea is a non-fermented tea as the first step in its processing is to inactivate enzymes by dry heating or steaming while black tea is a full-fermented tea. Yellow tea is similar to green tea with extra step by heaping until it turns yellow and white tea is produced with only withering and firing. Reprocessed tea is usually processed with a series of post-processing to add scents or compressing (Zhang & Ruan, 2016).

Tea is believed to be healthy as it contains polyphenols, in particular catechins and epicatechins, the main health-promoting substances in tea. Tea have been reported to possess anti-inflammatory and antioxidant property proven by laboratory and animal studies. Tea also be able to stimulate immune function and able to delay the onset of risk factors associated with disease development (Serafini et al., 2011).

Quality of tea affected by different conditions such as cultivation practices, growing conditions, and processing methods (Hara et al., 1995). Although choice of tea is subjective and based on people's preference, there are some ways to define quality of tea. Good quality tea should not contain woody fragments and must be less crumbled. Tea leaves should have a smooth texture and must feel feather light. The most important of all, a good quality tea have a strong, grassy, fresh fragrance instead of fading smell and the taste is fresh, not be too astringent with sweet aftertaste (Times of India, 2019).

Kombucha and Fermentation

Kombucha is a complex traditional beverage, popular for its uniqueness. Derived from tea, kombucha was made through fermentation process. Sweetened tea, added by sugar as carbon source, will be processed by symbiotic microorganisms of bacteria and yeast resulted in two phases of layers of biofilm and final liquid phase of the sour tea. In short it is a fermented tea, which reported induce health benefits (Vitas et al., 2013).

Kombucha originated in Northeast China around 220 B.C. The name of kombucha was derived from Dr. Kombu, a Korean physician who brought kombucha as curative for Emperor Inkyo in Japan. Kombucha then brought to Europe, especially Russia and Germany, as a result of trade route expansion in the early 20th century. Sugar and tea shortage in World War II did not cause kombucha to 'sink'. Its name regained popularity following a 1960s study in Switzerland comparing its health benefits to those of yogurt. Sandor Katz, a leading fermentation expert, noted that the popularity of kombucha most notably caused by its powerful health aid for serious medical condition (Troitino, 2017).

Kombucha has three main health benefits. Kombucha, just like other fermented foods, is a good source of probiotics. At specific concentrations, probiotic bacteria can help to balance the gut microbiome in humans and improve digestion. Kombucha contains high antioxidants. Antioxidants can protect the body from oxidative damage caused by free radicals. Though free radicals are a normal by-product in the human body, having a diet rich in antioxidants can minimize their impact. Kombucha also contain vitamins and minerals which are produced when the yeast breaks down the sugar, including vitamin C and B (Lewin, 2020).

Product development Techniques

There are many methods or techniques to develop the product based on customer needs or requirements. Among the methods such as Reverse Engineering, Concurrent Engineering and Redesign method. One of the methods that used by practitioners due to its usefulness is QFD (Quality Function Deployment). It was first developed by Yoji Akao in 1966 in Japan, later developed by other researchers among other by Bouchereau & Rowlands (2000). It was designed to help corporation in translating customers' voice into a specific characteristic of a product. By using QFD, manufacturer can define a product which could exceeding customers' expectations. New product development is often related to QFD, which may help corporate designing the most suitable formula for their product. Driven from its function, QFD will be implemented to defined suitable kombucha as finished product that will be consumed.

During product development, it is important to meet customers' expectations. Listed needs are weighed based on the importance, then translated into some technical improvements to achieve the desired final product. In general, there are four phases in product development process as shown below (Figure 1).

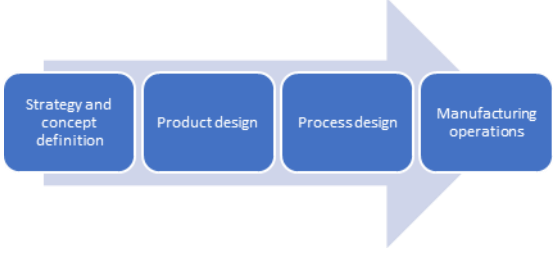

Figure 1. Phases in product development process (Govers, 1996)

In strategy and concept phase, customer requirements will be defined and translated into a product concept in a matrix called House of Quality (HOQ). These requirements – as WHATs matrix – referred as input to in the HOQ basic structure. This list will be rated based on customers' priority, also as a benchmark and competitor analysis. The other part is design requirements or technical measure – as HOWs matrix – referred as component characteristic or process parameters. Both WHATs and HOWs matrix are related in a correlation matrix between. It is also important to set correlation between HOWs, to make sure a process might be related to others (Govers, 1996). The final output will be priorities assigned to design requirements. The complete structure of HOQ can be seen as in Figure 2.

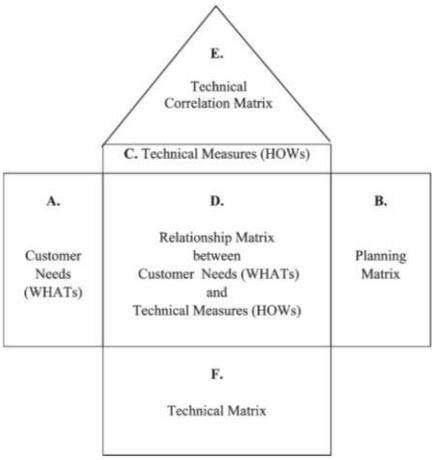

Figure 2. Brief structure of HOQ
(Chan & Wu, Quality Function Deployment: A Comprehensive Review of Its Concepts and Methods, 2002)

Research Method

This study used Quality Function Deployment (QFD) as a mean to answer the customers needs into the product. The reason, this method has a well structure and proven method to capture the customers' needs or requirement translated into processes or technical requirements to produced product. There are six main steps in developing QFD, these represent as HOQ (House of Quality) (see Figure 2), the steps are:

a. *Collecting voice of customers (VOC)*. These are essential information containing customer requirements (WHATs) and competitive analysis of the product. There are a lot of ways to collect this information, such as distributing questionnaires as the most common method. In this study, questionnaires have been distributed to the respondents. Respondents are pick randomly, it captures different ages, different sex and also their occupations. The study also did some interview to the community to capture their opinions. The idea is to get what actually the customer wants. Once the surveys done, then its priorities the needs based on the people most choices.
b. *Functional Requirements, or HOW*s are identified by development team. HOWs consist of unit and goodness direction or improvement that will be standardized in final production process. Customer requirements are then translated into functional requirements that will be applied in this step. HOWs can be formula, steps and

methods, quality and engineering characteristics, and other measures related to customer requirements during kombucha making process.

c. *Relationship matrix*. This matrix is identifying the customer need and answer how to fulfill these needs. Each WHATs should be answered by HOWs. The degree between them are identified in a matrix called relationship matrix. In order to improve satisfaction in WHATs, a parameter in HOWs should be improved. This relationship will be weighed based on the effect as levels.
d. *Competitive Analysis based on customer evaluation*. Each WHATs will be challenged to other competitors in products area, as an input in customer evaluation. This part can be done as competitive benchmark right after WHATs and WHYs analysis.
e. *Functional Correlation matrix*. HOWs could be correlated with each other. Identifying the strength of the bond is important to find the ripple effect when a parameter is going to be adjusted. In other words, if a Functional Requirement is adjusted, the others might be influenced whether positively or negatively.
f. *Functional Matrix*. This is the final area of House of Quality, containing the strategic implications should be applied in business. In this matrix, customer requirements are answered by Functional details which compared to competitors' HOWs. It is important to select which HOW needs to be improved for further analysis.

Results and Discussion

Voice of Customers (VOC)

VOC usually expressed in customers' own words, usually in qualitative forms. However, customers' requirements data should be expressed quantitatively, so it will be easier during decision-making process. These words can be interpreted in a linguistic form, to reduce ambiguity and different perception of meaning (Bouchereau & Rowlands, 2000). From the interview, the study wants to capture what are the need when they buy a Kombucha tea. It was capture there are characteristics of need are: Taste; Affordable Price; Fizzy Sensation; Appearance (the package); Health Benefit; Easy to Get. This information then asked to a larger sample of population through questionaries. The participant was 55 people, mostly are youngster group age 17 -25, 54% and group 26-35, 40% it comprises 94.5% (Table 1).

Table 1. Respondents of study

Age	Frequency	Percent
17 - 25 years	30	54.5
26 - 35 years	22	40.0
36 - 45 years	1	1.8
46 - 55 years	2	3.6
Total	55	100.0

Figure 3 shows what are the needs of Kombucha tea. It was found from the questionnaires that 59% of respondents agrees that they buy Kombucha due to its taste. While 82% respondent agree on the Fuzzy sensation of kombucha taste. For Packaging (Appearance) 58% like the package. And for Health benefit, respondents 83% agree. For easiness to get respondents only gave 31%. Figure 3 shows the Customer requirements of Kombucha.

					Column #
					Direction of Improvement
Row #	Weight Chart	Relative Weight	Customer Importance	Maximum Relationship	Customer Requirements (Explicit and Implicit) \ Functional Requirements
1		17%	3,79	9	Taste
2		17%	3,79	9	Price
3		18%	4,18	9	Fizzy Sensation
4		16%	3,61	9	Appearance
5		19%	4,4	3	Health Benefit
6		13%	2,93	9	Easy to Get

Figure 3 Customer Requirements of Kombucha Tea

Functional Requirements

In answering How to produce the Kombucha that meets the customers' requirements, there are parameters determine the quality of the tea drink. These parameters are based on previous experiments that have been done and also based on the existing standard procedures or recipes that people may refer to. Other than the process also parameters to fulfill the customer requirements, such as the packaging, and the availability. The parameters are: Tea Quality; Quantity of Tea; Number of SCOBY; Sugar Levels-1; Duration of incubation-1; Sugar Levels-2; Duration of incubation-2; Product filtration; Packaging Material; Packaging Quality; Material label; Delivery availability; Stock Readiness.

Relationship matrix

There are four relationship levels indicating between the customer requirements and the Functional Requirements with each own value, starting from no relationship (0), weak relationship (1), moderate relationship (3), and strong relationship (9). Usually each value will be drawn using symbols. Blank is for no relationship, Δ for weak relationship, ○ for moderate relationship and ● for strong relationship.

Figure 4 shows this relationship. For example, the Tea Quality used to produce Kombucha tea will have effect to strong relation with Taste of the tea (●), to the price offered, since it indicates the worth of the taste and the price as well. It also has a strong relation to the Fizzy sensation of the tea. The quality of Tea has weak relation with Health benefit. However, the quality of tea has nothing to do with Appearance and Easy to get parameters. With the same procedure all of the column of Functional Requirements meets with each of the Voice of customer.

Customer Requirements (Explicit and Implicit) \ Functional Requirements	Tea Quality	Tea Quantity	Qty of SCOBY & starter	Sugar Content-1	Duration of incubation-1	Sugar Content-2	Duration of incubation-2	Product filtration	Packaging material	Packaging quality	Label material	Delivery availability	Stock readiness
Taste	●	○	●	●	●	▽	▽						
Price	●	▽		●		●			●	●	▽		
Fizzy Sensation	●	▽				●	●						
Appearance								○	●	●	○		
Health Benefit	▽	▽	▽	○					▽				
Easy to Get												○	●

Figure 4 Relationship Matrix

Competitive Analysis

Each WHATs will be challenged to other competitors in products area, as an input in customer evaluation.

There is still no direct competitor of kombucha, so it is set to other potential competitors. Kombucha will be compared to cold-pressed juice and yogurt drink as healthy drink, and soda drink as similar in taste. Customer will be given a set of questionnaires answered with 1 - 5 Likert Scale on the WHAT parameters: Taste, variants, price, packaging, health benefits, availability in the market and promotions are the challenge point of WHATs. Figure 5 shows the comparison to the competitors.

Ratio of each point calculated by dividing target with current position or value as shown below:

$$Ratio = \frac{target}{our\ current\ value}$$

Each characteristic of the product represents strength of sales point, whether it has strong sales point (weight 9), moderate sales point (weight 3), or considered as not having sales point (weight 1). Therefore, final importance rating of each WHATs calculated by goal and current position

difference in value as this formula.

$$Final\ importance = ratio \times relative\ importance \times sales\ poim$$

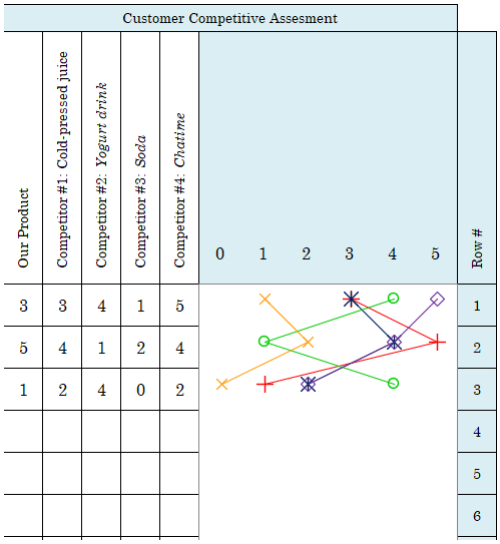

Figure 5. Comparison to Competitors

Functional Correlation Matrix

At this part, all the Functional Requirements were compared to each other. This Functional comparison were judge based on the performance indicator to the end results. There was some technical evaluation which difficult to judge at this point the team simply gave the same. The positive sign means it both parameters mutually reinforcing, while negative shows a opposite relation.

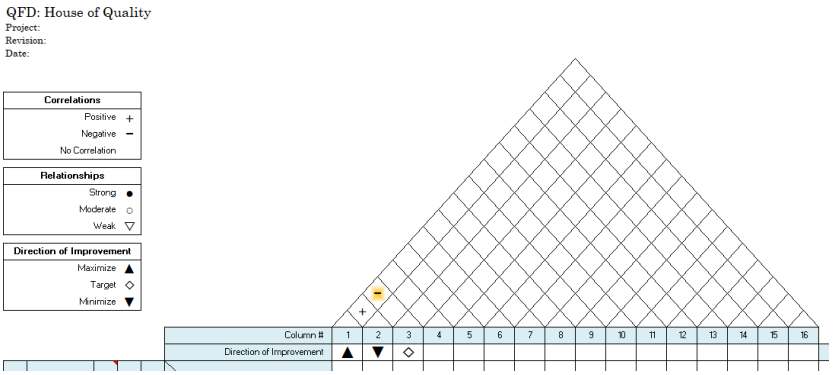

Figure 6 Functional Correlation of the Parameters

Functional Matrix

This is the final area of House of Quality, containing the strategic implications should be applied in business. In this matrix, customer requirements are answered by technical details which compared to competitors' HOWs. It is important to select which HOW needs to be improved for further analysis.

HOWs relative importance rating indicates the degree of Functional requirements are related to all the customer requirements. Calculation of HOWs relative importance rating can be done by this formula:

$$\textit{Relative importance of a HOW} = \Sigma(\textit{final importance rating of WHAT} \times \textit{relationship value between WHAT \& HOW}).$$

The next step is comparing our own product's performance with competitors from marketing point of view as competitive technical assessment. The challenge is that not all process or technical measures can be obtained directly from competitors. Most of them are kept confidential and need more in-house engineering process to be developed. The simplest way is by consuming competitors' product and compare it with our products using various formulas. After information has been acquired, comparative analysis and product improvement can be performed. The team surveyed about the satisfaction level of Functional characteristics of Kombucha products with competitors Kombucha products. Figure 7 shows Functional Matrix.

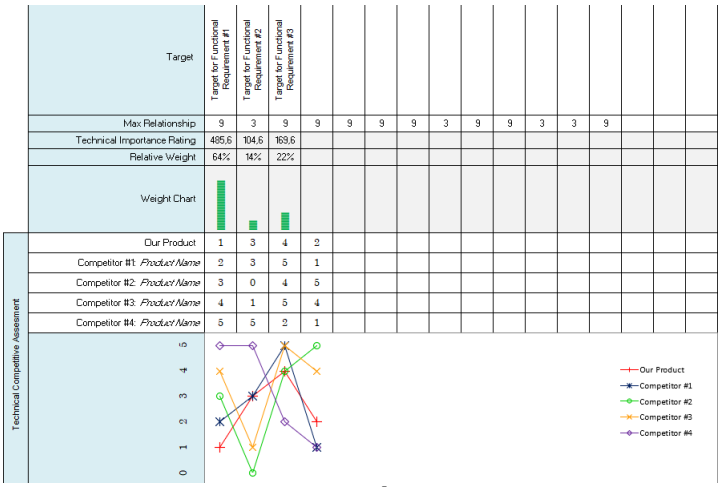

Figure 7. Functional Matrix

Impact in QFD Implementation

Implementation of QFD resulted in significant improvements both for final products and development processes. These improvements include reduction of product development cycle, reduction of problems during production, improved product quality, and increased customer satisfaction because their expectations were met while QFD also act as a benchmark tool (Cristiano, Liker, & White, 2001). The whole process also resulted in increased company competitiveness in the market (Figure 8).

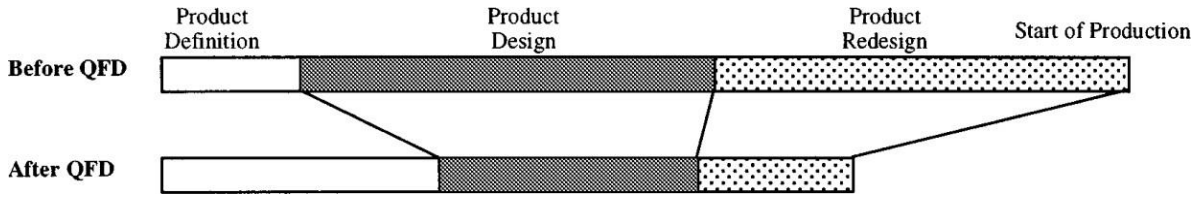

Figure 8. QFD's impact on product development lead time (Cristiano, Liker, & White, 2001)

When QFD is implemented, 30-50% technical changes can be reduced, 30-50% shorter design cycle can be achieved, 0-60% lower start-up costs, and 20-50% fewer complains as warranty claims. Toyota for example has adopted QFD in 1977 and reported a 20% reduction in start-up cost on its van launching in October 1979, a 38% reduction by the end of 1982, and a cumulative 61% reduction in April 1984 (Chan & Wu, Quality Function Deployment: A Comprehensive Review of Its Concepts and Methods, 2002)

Conclusion and Implications

The study has finally identified the customers' need of this Kombucha product. Among others from the highest to the lowest are: Health benefit, Fuzzy sensation of kombucha, Kombucha taste. Packaging (Appearance), Easiness to get.

The customer need should be transformed into Functional or technical measures. The study analyzed that there are 13 Functional aspects: Tea Quality; Quantity of Tea; Number of SCOBY; Sugar Levels-1; Duration of incubation-1; Sugar Levels-2; Duration of incubation-2; Product filtration; Packaging Material; Packaging Quality; Material label; Delivery availability; Stock Readiness.

The competitiveness of kombucha, compared its competitor of other similar drinks currently still below the performance. Some area needs to be improved are: Easiness to get the product.

Analysis particularly on the assessment of competitiveness either in fulfilling Customer needs and Functional or technical measures should be scrutinized further in order to get the right recipes.

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