Product Development of Chocolate with Quality Function Deployment Approach: A Case Study in SMEs Chocolate Industry in Indonesia

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Abstract. Product development based on customers preference needs to be performed by the manufacturer along with the development of technology and change of consumer needs to a product or service. The aim of this study was to develop the quality of chocolate products of small medium enterprises (SMEs) to be more competitive in the domestic market. Currently, the chocolate market is dominated by imported chocolate products with better product quality and marketing network. The method used was the Quality Function Deployment (QFD) approach, where customer needs are used as the basis for product development. Through the QFD method, it can produce a product development design priority that can be implemented in response to customer need. Results of analysis and calculation using QFD method showed that the top priority for technical response was “skill & knowledge of R&D (research & development) team” with a value of 346.3. The QFD analysis also showed that “chocolate content” is also a priority in product development with a value of 212.8. The quality of chocolate products highly depend on the level of expertise and knowledge of the product development team, as well as the composition of chocolate content. The SME’s chocolate managements may give priority based on the assessment of each technical response in accordance with their own capabilities and resources.

1. Introduction
The geographical origin of a cocoa-producing country shows differences in antioxidant capacity levels depending on the type of solvent extraction used, where the highest antioxidants observed were owned by cocoa beans from Ghana followed by Cote d’Ivoire, Malaysia and Sulawesi [1]. Cocoa beans containing flavonoid are useful to hold free radicals and are beneficial to health because chocolate is rich in antioxidant contents particularly phenol and flavonoid. The beneficial effects of flavonoids are as anti-allergic and anti-tumor agents, stimulates cognitive function, modulation of estrogen activity, as well as anti-virus and antioxidant [2][3][4]. Studies showed that with the presence of antioxidants, it will be able to neutralize free radicals in the body. Processing can have a major impact on the level of polyphenols maintained in cocoa beans and their derivative products. Cocoa derivative products are very diverse as food, beverages, pharmaceuticals, cosmetics and other products. Results of various studies have been reported regarding the contribution of cocoa polyphenols to human health, yet full understanding is still needed in the bioavailability aspects of cocoa polyphenols relating to proper
absorption, distribution, metabolism and excretion of polyphenol itself in the human body [5]. Some health effects of cocoa bean content have been widely considered, including in improving cardiac function, improving stimulation of the nervous system, facilitating the digestion process, and improving kidney and intestine function [6]. The influence of cocoa on health including its effects on heart health and blood vessels should be carefully examined between cocoa beans and chocolate, where the processed chocolate products are no longer pure cocoa beans, yet have been mixed with sugar, milk, and other substances that are sometimes counter-productive and have an adverse effect on health [6].

Each cocoa beans-producing country in the world has a distinct characteristic in terms of flavor and fat content. Flavor is an important quality attribute which determines the acceptability of cocoa beans and cocoa products such as chocolate [7]. Cocoa beans from the African continent such as Ivory Coast, Ghana and Nigeria have high flavor levels with large production volumes. Furthermore, cocoa plants in Southeast Asia such as Indonesia and Malaysia have different characteristics, those are dominant with high fat content, yet flavors are at relatively low levels [8]. The typical taste of cocoa beans depends not only on the varieties of the plant, but also the contours of the soil, the ambient temperature, as well as the amount of sunlight and rain received [3]. On a global scale, the downstream industry of cocoa is divided into three types, namely grinding industry for semi-processed cocoa, cocoa industry for couverture, and chocolate industry for consumption (food, beverage, confectionery, etc.). Global market share for semi-processed cocoa products tends to be highly concentrated and dominated by multinational companies that generally open branch companies in Indonesia [9]. According to [10], the cocoa industry is more complicated because the final product as a chocolate is a combination of various other raw materials such as sugar, milk and other ingredients with various portions as additional ingredients.

World cocoa producers currently come from Ivory Coast, Ghana, Ecuador, Indonesia, Cameroon, Nigeria, Brazil, Papua New Guinea and other countries with respective total production of 2,010,000 tons, 950,000 tons, 270,000 tons, 260,000 tons, 240,000 tons, 225,000 tons, 180,000 tons, 40,000 tons and 525,000 tons by supplying 4.7 million tons of cocoa needs worldwide in 2016/2017 [11]. The availability of a substantial supply of domestic raw materials enables the growth of the chocolate processing industry in particular to meet the needs of the local market. With the relatively low per capita consumption of 0.25 kg/person/year, there is a great opportunity for the development of the national chocolate downstream industry which is in line with the increasing trend of per-capita consumption of chocolate. The development of downstream agroindustries is very strategic, since it provides the creation of large outputs and job opportunities [12]. Cocoa is an important commodity for the global world because its role as the main ingredient of chocolate products, cocoa has a flavor and aroma that cannot be replaced by other commodities [5]. Based on the calculation of international cocoa organization [11], the value of cocoa commodity transactions reached $ US10 billion per year during the period of 2011/2012. The retail value of chocolate sales during 2012 was recorded at $US107 billion with an estimated growth trend of the chocolate industry of 6% annually [11].

Research of [13] explained that during the period of 1997-2006, chocolate consumption worldwide grew by 14% every year. Global consumption of chocolate is dominated by European communities by 49% and North America by 22% with an average consumption of 3.2 kilograms per person by 2015. Consumers in every country generally have their own preferences and special mixes for various chocolate foods and beverages. Swiss is the country with the largest level of chocolate consumption in the world with 9 kg per capita. Japan consumes 2.0 kg per capita. Singapore consumes 0.5 kg per capita, while Indonesia is still relatively small at 0.25 kg per capita that increases from previous year which is only 0.01 kg [11]. Although chocolate per capita consumption of three countries in Asia, namely Indonesia, China and India, are still small, yet the market potential of those three countries has very good market prospect in the future because those countries have very large population. The SMEs
industry has limited resources and capital in developing its business, so SMEs need practical breakthroughs through the development of innovative chocolate products. The approach of quality function deployment (QFD) method is one of practical product development alternative which is relatively rarely implemented in food industry sector.

![Per capita chocolate consumption in several countries by 2015](image)

**Figure 1.** Per capita chocolate consumption in several countries by 2015 (ICCO; Euromonitor; Faostat, edited)

Product development using QFD method in agroindustry is relatively small compared to manufacturing industry or service industry. Until now, not many researches and empirical data can explain it, yet agroindustry has unique characteristics such as seasonal, perishable, and expired date which distinguish it from non-agroindustry in general. Food and beverage industries in Europe invest a very small contribution in the field of research and development compared to other industrial sectors [14]. Food agricultural system is an industry sector with low intensive level of research and development (R&D) category [15],[16]. This research was aimed to develop chocolate products as a foodstuff particularly chocolate bar, bread & chocolate cake, which are based on customer needs. Development of products or services based on consumer preferences will likely be responded when sold in the market. Elements of differentiation for young consumers are more concerned with the image and packaging of products, brands and prices, all of which are regarded as a symbol of quality and social status. These factors are worthy to be considered when designing a product specifically in increasing consumption of the millennial consumer class [17]. Consumers of Generation Y associate new products, especially with the introduction of food without preservatives and pasteurization as well as reduction of unfavorable ingredients for health [18]. Through consumer preferences, products or services will be proportionally developed thus potentially meeting the expectations and needs of consumers. On the other hand, if the producer develops a product or service without involving the customer, it will be less likely responded by the market or even abandoned by its customers. Voice of
the customer can be a valuable input for management in mapping which areas should be prioritized on product development [19].

The development of chocolate products greatly determines the level of acceptance and success of chocolate products in the market. The success of every business is increasingly driven by customers, thus companies should develop the needs and desires of customers to generate high profits and productivity [20]. The QFD method has become the most widely used development tool by manufacturing and service industries to translate customer requirements into engineering specifications. Quality function deployment is an effective quality planning tool with a truly systematic approach and thorough planning method to meet customer demands [20]. Quality function deployment in its practice is used for three basic reasons [21]: (i) to save time designing and developing of new products; (ii) focusing and paying attention to customer satisfaction; and (iii) improving communication at all levels of the organization. The QFD approach is a technique that can be used to translate voices or desires of customers into the technical requirements of a product which will be developed [22]. Technique of quality function deployment (QFD) consists of five activities [23], namely: (i) identifying users and consumers, (ii) formulating and determining customer wants, (iii) prioritizing user wants, (iv) learning competitiveness, (v) defining the users’ wishes into measurable technical requirements.

The QFD method is a way for a company or organization in identifying and meeting the needs and desires of customers. The QFD method may produce product specifications that meet consumer requirements [24]. Quality Function Deployment is a structured method used in the process of designing and developing products to define the needs and desires of customers, and systematically evaluate the capability of the product or service in fulfilling needs and desires of customers [23]. The QFD defined as a method to translate consumer desires and needs into a product design that has certain technical requirements and quality characteristics [25]. The definition given by [25] reinforces the practical reality in the field that consumers only assess the performance of a product or service from customer needs and customer wants while all technical factors affecting the voice of customers are generally not very concerned by consumers. The ability of the product development team to translate any voice of customers into the technical response is absolutely necessary. The application of QFD is a structured approach to integrate customer needs and to describe competitive environment with technical reality as a unique product specification [26].

By using QFD method in the process of designing new products, it will be known several types of matrix stages as shown in Figure 2 [23]: (a) Section. A list of customer needs and customers wants. The list is usually determined on the basis of qualitative market research. The collection of voice of customer data can be done through interviews, questionnaires or other methods, (b) Section B. Commonly there are three main types of information that exist, those are: (i) market qualitative data, indicating the relative importance of the desires and the needs to customers, and (ii) planning of strategic targets for new products or services, (iii) calculations for the ratings of customer wants and needs, (c) Section C. This section contains technical drawings that can be interpreted as a set of process requirements to produce the product according to consumers demand. Generally, this technical drawing is the result of the elaboration of the desires and needs of the customer in Section A, (d) Section D. This section contains the team’s development decisions of relationship strength between each element of Section A (the desires and needs of the customer) and Section C (technical parameters). In this section, the value will be added, the greater the value given, the stronger the relationship between the two elements, (e) Part E. This section is the roof of a house (House of Quality), where in this section contains the team’s development interpretation of interrelationship implementation between the elements of the technical parameters, (f) Section F. In this section usually contains three types of information, namely: (i) the calculation of the demand level of the technical parameters based on the level of desires and needs of the customer from section B and the
relationships occurring in section D, (ii) the degree of comparison of information on technical performance competitions, (iii) technical performance targets. Along with the increasing global competition, rapid technological developments and changes in customer demand, the performance of food and beverage industries are increasingly depending on continuous improvement and introduction of new products and processes [27].

![House of quality diagram](image)

**Figure 2. House of quality [23]**

2. **Methods**

Methodology used in this study refers to QFD implementation classical method, which begins with identifying the "What" area. The first step is determining customer need, determining the planning matrix, determining technical response in the form of parameters of customer development, making the relationship between customer requirements and engineering parameters, determining the relationship between parties in technical parameters, and making technical matrix to prioritize engineering parameters. Sensory quality dimensions used in this research are taste, texture, aroma, product appearance and freshness. Taste refers to the research of [28][29][30][31][32]. Texture refers to research [28][30][31][33][34]. Whereas aroma refers to the research of [28][32][35]. Product appearance refers to [32][36]. Freshness refers to the research of [30][36][37][38][39]. Taste is the most important sensory quality in chocolate products where the flavors of milk, sweet, sour and others are combines to give unique flavor with balanced composition. Aroma of chocolate is very appealing to most people, yet if it is contaminated by a bad smell or chemical stain, the product can be really distasteful [28]. Health is chosen as product quality dimension because healthy nutritious food shows good product quality. Some references to health indicators are [37][38]. Similarly, product packaging refers to product quality dimension because good packaging is able to protect the product well and maintain product quality during storage. Packaging indicator refers to some references such as [30][36]. Product variations included in product quality dimension refer to [37]. Through literature review, pre-survey and questionnaires to customer respondents who routinely consume chocolate food products, the customer need items plotted in the voice of customer area are: (i) taste, (ii) texture, (iii) aroma, (iv) product appearance, (v) variety, (vi) health, (vii) freshness, (viii) packaging. The weight of customer importance was obtained from the results of interviews with customers, field observations, and the results of discussions with practitioners of chocolate industry product development. QFD method requires customer importance of a product or service to be developed specifically to determine
the importance of each sensory quality. The value or weight given was 1-5 where the value 5 indicates the highest weight and 1 is the lowest weight.

The next step was determining the technical response or commonly also referred to as technical requirement that is all elements associated with technical aspects of a product or service in manufacture process. Manufacturing-based industries or services in general have the same grip in determining customer needs and technical responses. However, the development of QFD-based products in the food industry is slightly different in this term. Different food products specifically can result in different customer needs, although it is still in the scope of food product. Research of [14] divides the voice of the customer into two major parts: first: influencing factors including (i) ease of service, (ii) healthy, (iii) tasty, and (iv) no defects, while the second part: packaging and good labeling that consists of: (i) clear information, and (ii) best package. Figure 3 presents the value of customer importance of each customer need.

A research focusing on the implementation of QFD to the food processing industry was conducted by [40] who specified the items of customer needs, such us (i) healthy, (ii) taste, (iii) appearance, (iv) texture, and others. Research of [41] explored the voice of the customer to primary level and secondary level where in this case secondary level is a more detailed explanation of primary level. First primary level: “looks good” is spelled out in secondary level to be (i) good texture, (ii) good color, and (iii) interesting aspect. Furthermore, second primary level: “tasty” is spelled out in secondary level to be (i) pleasant aroma, and interesting aroma (ii). Subsequently, third Primary level: “satisfaction in preparation”, which is described in the secondary level changes to be (i) completely. Fourth primary level: “safe”, which is described in secondary level changes to be (i) safe. Fifth Primary level: “healthy”, which is described in secondary level changes to be (i) healthy. The overall items on the secondary level are also translated very specifically on the tertiary level. Research of [26] determines only four factors become customer needs in his research, those are: appearance, aroma, taste, and texture.

3. Result and Discussion

Interrelationship matrix between customer needs and technical responses consists of values of “1/low”, “3/medium” and “9/high”, it is shown completely in Figure 3. The relationship strength between each customer need and the technical response is identified in three categories, those are 1 for small/low correlation, 3 for medium correlation and 9 for high correlation, and “empty” if there is no correlation. Interrelationship matrix between customer needs and technical responses shows that the aroma, variety, and packaging attributes have the highest importance level value (5). This indicates that consumers consider sensory attributes of aroma, variety, and packaging have the most important role when they decide to buy a chocolate product.

Factors indicated as technical response are: (i) raw materials, (ii) chocolate content, (iii) sugar content, (iv) milk content, (v) processing, (vi) packaging material, (vii) packaging design, (viii) machinery and processing equipments, (ix) skill and ability of research and development (R&D) team, (x) storage system at sale window display. Those technical responses are a determinant of chocolate products quality where every producer and processing industry of chocolate product competes. The next step was creating a planning matrix to define the development direction of chocolate-based food products and compared with competitors, in this case it is indicated as imported chocolate A and imported chocolate B. The factors mentioned in the customer needs are scored with a score of 1 to 5, as previously. In general, the value of local products is still at a low level for the ten customer needs, those are: (i) taste with a value of 2, (ii) texture was 3, (iii) scent was 3, (iv) product appearance was 2, (v) variety was 3, (vi) health was 2, (vii) freshness was 3 and (x) packaging was 2. Meanwhile, product quality of competitors of imported products is as follows (i) taste was 5, (ii) texture was 4, (iv) product appearance was 4, (v) variety was 5, (vi) health was 4, (vii) freshness was 4 and (x) packaging
was 5. Whereas values of competitor product quality imported B are as follow: (i) taste was 4, (ii) texture was 4, (iii) scent was 4, (iv) product appearance was 3, (v) variety was 3, (vi) health was 4, (vii) freshness was 3 and (x) packaging was 4.

Figure 3. Competitive benchmark matrix

The planning matrix also plans values related to the improvement of each customer’s need to be further developed as shown in Figure 4. The values of the product quality plan were: (i) taste was 4, (ii) texture was 4, (iii) scent was 4, (iv) product appearance was 4, (v) variety was 4, (vi) health was 3, (vii) freshness was 3 and (x) packaging was 5. Percentage of total weight is the percentage of improvement that is planned to be developed compared to the current value. These ten items of sensory chocolate food products (taste, texture, aroma, product appearance, variety, health, freshness, and packaging) have different importance levels, in this case consumer gives the biggest weight (point 5) on the three items of customer needs, namely aroma, variety and packaging. A distinctive and strong chocolate aroma is the main attraction for some consumers who routinely consume chocolate food products and become one of the strong reasons they buy chocolate. Variety attribute of chocolate product types has a high value, in this case consumers are very interested when outlet centers selling chocolate product is available. The other items is packaging, a well-packed and attractive product is also very important factor for customers.

Correlation matrix between customer needs and technical responses in general shows that taste is influenced by raw materials, chocolate content, sugar content, milk content, processing, machine & processing equipment, skill & ability of R & D team and transportation as well as storage system before reaching to consumer. Similarly, texture is influenced by raw materials, packaging material, machinery & processing equipment, skill & ability of R&D team and transportation system as well as product storage. Furthermore, product aroma is influenced by raw materials, chocolate content, sugar
content, milk content, processing, machinery & processing equipment, skill & ability of R&D team, transportation and storage system.

Figure 4. House of quality matrix

Product appearance is influenced by packaging material, packaging design, machinery & processing equipment, skill & ability of R&D team, as well as transportation and storage system. Variety is determined by packaging material, packaging design, machinery & processing equipment, skill & ability of R&D team. Health is influenced by chocolate content, sugar content, milk, processing, packaging material, machinery & processing equipment, skill & ability of R&D team, transportation and storage system. Freshness is influenced by packaging material, packaging design, skill & ability of R&D team, as well as transportation and storage system. Final results of the correlation matrix indicates specific technical response factors that need to be increased in sequence are as follows: skill & ability of R&D team of 346.3; chocolate content of 212.8; machinery and processing equipment of 179.9; packaging design of 173.8; packaging material of 159.8; sugar content of 140.8. Results of the planning matrix calculation showed that those ten sensory products need to be improved with different levels from the current values which are taste of 13%, texture of 11%, aroma of 14%, product appearance of 9%, variety of 14%, health of 10%, freshness of 6% and packaging of 19%.

4. Conclusion
Development of chocolate-based food products according to customer preferences is very strategic for the upgrading of the downstream industry of processed chocolate, where the improvement of the industry with all the equipment, machinery, and regulations involved is also determined by the quality
of the products developed. Based on the analysis of QFD method, the priority of product development that can be done by SMEs are as follows: i) improving the skill & ability of R & D team (346.3), ii) improving chocolate content (212.8); iii) improving machinery and processing equipment (179.9); iv) improving packaging design (173.8); v) improving packaging material (159.8); vi) improving sugar content (140.8), vii) improving milk content (140.8), (viii) improving storage system (133.0), (ix) improving raw materials (113.4), and (x) improving processing (90.8). End products sold to the consumers need to be produced according to market trends and consumer needs with efficient processing. The implementation of QFD method in the development of agroindustry and food industry products is still small compared to other industries such as manufacturing and service. The QFD approach is practical to provide a better product development direction (including when implemented in a food industry) because it is based on customer needs and customer wants as the main foundation in product development. Optimum new product development with QFD method, stages of assignment of sensory items that become attributes in customer needs are very important to be considered including in determining correlation between all items of voice of customer with technical response.

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