

Development of Durian Chips Product by Apply of Quality Function Deployment

Watchanachai Joompha^{1,*}, Nalin Pianthong²

¹Ph.D Student, Department of Industrial Engineering, Faculty of Engineering,

²Lecturer, Department of Industrial Engineering, Faculty of Engineering,

Ubon Ratchathani University, Ubon Ratchathani, 34190, Thailand

*E-Mail: watchanachai_joompha@hotmail.com

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาผลิตภัณฑ์ทุเรียนทอดกรอบโดยใช้เทคนิคการแปลงหน้าที่ทางคุณภาพ ระเบียบวิธีในการวิจัยครั้งนี้เป็นการวิจัยเชิงปริมาณ โดยได้ดำเนินการวิจัยเชิงปริมาณกับลูกค้าที่ซื้อทุเรียนทอดจำนวนทั้งสิ้น 384 คน ด้วยวิธีการสุ่มตัวอย่างแบบง่ายระหว่างเดือนพฤษภาคม – สิงหาคม 2559 เพื่อนำข้อมูลที่ได้มาใช้เป็นข้อกำหนดรายละเอียดความต้องการของลูกค้า เพื่อแปลงเป็นข้อกำหนดทางเทคนิคในการปรับปรุงและพัฒนาคุณภาพทุเรียนทอดกรอบ กรอบแนวคิดที่ใช้ในการวิจัยครั้งนี้เป็นการรวบรวมความคิดของผู้บริโภคในการแปลงเป็นข้อกำหนดรายละเอียดทางเทคนิค โดยข้อมูลที่ได้จากการประยุกต์ใช้เทคนิค QFD ในเฟสที่ 1 การวางแผนผลิตภัณฑ์ในรูปแบบบ้านคุณภาพ (HOQ) พบว่า 5 คุณลักษณะทางคุณภาพของทุเรียนทอดที่สำคัญ ซึ่งเป็นความต้องการของลูกค้า ได้แก่ มีกลิ่นแบบธรรมชาติ มีความกรอบ มีลักษณะเป็นแผ่นบาง ไม่มีกลิ่นเหม็นหืน และมีรสชาติแบบธรรมชาติ และเมื่อทำการแปลงเป็นข้อกำหนดทางเชิงเทคนิคที่ต้องปรับปรุง พบว่า ข้อกำหนดทางเทคนิคที่สำคัญ 5 อันดับแรก ได้แก่ การอบหลังจากการทอดและการอบก่อนส่งมอบลูกค้าหรือขายปลีก การพัฒนาและปรับปรุงบรรจุภัณฑ์ การปรับปรุงรสชาติให้มีความหลากหลาย และ ระยะเวลาเก็บรักษาที่มีความเหมาะสม และการคัดเกรดทุเรียน นอกจากนี้ข้อค้นพบที่สำคัญ ประกอบด้วย ความตระหนักในการออกแบบผลิตภัณฑ์ตามข้อกำหนดรายละเอียดทางเทคนิค ประโยชน์ของงานวิจัยนี้สามารถใช้เป็นข้อมูลรองรับการวิจัยผลิตภัณฑ์ และออกแบบเครื่องมือสำหรับการออกแบบกระบวนการผลิตอาหาร การควบคุมคุณภาพ การบริหารจัดการต้นทุนการผลิต และการกำหนดความต้องการของลูกค้าในการพัฒนาผลิตภัณฑ์ทุเรียนทอดกรอบได้อย่างมีประสิทธิภาพ

คำสำคัญ : เทคนิคการแปลงหน้าที่คุณภาพ รูปแบบบ้านคุณภาพ ข้อกำหนดรายละเอียดความต้องการของลูกค้า ทุเรียนทอดกรอบ

Abstract

The objective of this research was to develop durian chips product through applications of Quality Function Deployment (QFD) technique. The research methodology was a quantitative method. A customer requirements survey was conducted for Chanthaburi Province. The 384 customers were selected by simple random sampling and were collected through a questionnaire surveying during May – August 2016. Furthermore, the application of QFD method to develop durian chips has been reported the customer requirements to translate the technical requirements. In this research, a QFD technique conducted to translate Voice of Customers (VOCs) into the technical requirements for product planning. The top five customer requirements to develop durian chips were identified as natural color shade, crispness, thin sheet, non rancid and natural taste. The research results revealed that the calculation of relative important to translate the technical requirements (TRs) identified that the “drying, vacuum packaging, seasoning, storage time and grading” were the highest requirements to the overall improvement of durian chips. Moreover, the findings strongly support the improvement method is essential for applications of QFD technique for design and development. It considered the importance of product design in technical requirements. This research supported an efficiency method for product research and design tool that considers the food production process, quality control, cost revenue and customer demands.

Keywords: Quality function deployment; House of quality model; Customer requirements; Durian chips

Introduction

Thailand is one of the most Durian producers in the world. Durian production in Thailand is about 550,000 to 650,000 tones [1]. The annual main durian crop period is from May to August. Processing agricultural products will help prevent the overproduction of fresh durian. Durian chip is the product to increase the value of agricultural produce to processed food. Durian chips are produced by the small enterprise foundation or Thailand's OTOP (One Tamboon One Product). OTOP is local wisdom for making community products [2]. Durian Chip is popular product of OTOP Entrepreneur in Chantaburi and Rayong Province, because have many local material. In 2016, we found that more 30 Durian Chip OTOP Enterprise in Chantaburi and Rayong Province [3]. The integration of Free Trade Area (FTA) and ASEAN Economic Community (AEC) will affect the adaptation of OTOP [4].

Recently, Thai populations are engaged in agriculture for a long period of time. Most of them grow single crops such as rice, longans, cone, tapioca, sugar cane, rubber tree and durian etc. Although farmer is the main occupation but there are a lot of problem about agriculture such as low yield, high cost, soil degradation and insufficient water. Many governments used to solve the problem by cultivation zone, value-added agriculture and cost reduction. The mass agricultural products such as rice, rubber tree and longans face low price problems. Many governments used to solve the problem by purchasing surplus crops, providing subsidies or low-interest loans to farmers. Design and development of the agricultural product to meet customer needs is another way to add value to agricultural products. The product is processed based on

Customer needs. It will help to solve the problem of agricultural sustainability.

Quality function deployment (QFD) technique is a customer-oriented approach to design and develop product and is data specifically of a system for translating customer requirements into appropriate company requirements at each stage, from research and product development through engineering and manufacturing to marketing/sales and distribution [5], [6]. In Thailand, the numerous research have been reported that QFD technique is considered the most complete and comprehensive method for analyzing the product processes and aligning them to the customer's requirements [7]. As such, QFD has been subsequently adopted as a product development and quality improvement tool worldwide [8]. Therefore, QFD is a structured approach to develop product that can be applied to the creation of many food products [9].

QFD has been applied to the development of various food products. Furthermore, several researchers have proposed the new QFD models to apply them to the development of new food products. Benner et al. [10] proposed the QFD Food Industry Roadmap, in which two alternative roads are defined to deploy 'Voice of Customer' throughout the New Product Development (NPD) process: the packaging deployment road and the food deployment road [11].

Durian chips product is known as one of the most popular Chanthaburi Province foods to Thai consumers. To increase the consumption rate of durian chips product in the current market, this study determined customer requirements technique by applying QFD and

HOQ technique with an objective to develop a product for the requirement. The survey for customers was conducted.

Literature Review

Quality Function Deployment

Quality Function Deployment (QFD) is an approach to develop product based-on customer-oriented, and was first proposed in Japan in 1966 by Yoji Akao [5]. QFD is conceptualized as “a method for developing a design quality aimed at satisfying the customer and then translating the customer’s demands into design targets and major quality assurance points to be used throughout the production phase” [12]. QFD utilizes method for translating customers’ requirements from the product, to the company can offer to best fit the customer requirements through the integration of many processes and aligning them to the customer’s requirements [7].

QFD is the integration process that improved the product planning or improved designs and processes [13]. The main ideas of QFD are customer requirements. Customer requirements are what the customers want from the product. In the QFD technique, customer requirements are translated into measurable goals and the competitive advantage of the market/customers are considered. By implement-ting of QFD technique, all company employees are geared towards listening to customers, and inter-functional teamwork is strengthened. QFD applications have many benefits for the reduction of quality-related problems.

In this research, the literature proposes two main QFD implementation methods based on the matrix-shaped charts [14] The ‘Akao matrix of matrices’ [12] is the most comprehensive

QFD implementation model in which each matrix details a specific aspect of the development process. The focused approach, known as ‘the Four-Phase model’, is the most common QFD implementation technique in which the product can be developed as several components assembled together into the final product.

The Four-Phase model consists of product development steps [14], and this charts concept in the QFD system has an advantage of providing a “constancy of purpose” among the four phases. The main implementation of QFD is the generation of charts corresponding to the Four-Phase model [15]. This research applied the Four-Phase model to the improvement of durian chips product. The Four-Phase model consists of four steps:

Phase 1 is House of Quality (Product Planning);

Phase 2 is Design Deployment (Part Deployment); Phase 3 is Manufacturing Planning (Process Planning);

Phase 4 is Production Planning (Production Operations Planning) [7]

In this research, researchers are only focused on Phase 1 as well as.

House of Quality

The House of quality (HOQ) model utilizes a matrix presentation, referred to as the HOQ model, to translate the Voice of Customers (VOCs) through product design and development. In the HOQ model, the implement steps of the planning phase for a new product are integrated [16]. The four steps of HOQ are WHAT (customer requirements), HOW (company measures, technical requirements or engineering characteristics),

relationship (between WHAT and HOW), and HOW MUCH (target value). The HOWs of one phase become the WHATs of the next phase. As meanwhile, the HOQ provides a direct link from phase to phase [6].

HOQ is comprised of six main parts, as shown in Fig. 1 [7], [12], and is a, systematic structured to transform the customer's requirements for a product into prioritized technical requirements that can be further measured deployed to the development and production process. Although the contents of HOQ differ in presentation, a more detailed description as displayed by the sub-parts in Fig. 1 provides a nearly full account of the key elements of HOQ as addressed by various authors [16], [17]. In this research, researchers are conducted to improve the durian chips product into 3 steps. First, the customer requirements (WHATs) for durian chips are identified. The second is a planning matrix to investigate the strategic importance rating of each customer requirement. The third, technical requirements (HOWs) corresponding to the customer requirements are identified [17], [18], [19]. The technical requirements are matrix representing the performance level of each characteristic is decided.

Additionally, the customer requirements (WHATs) for durian chips are employed in this research.

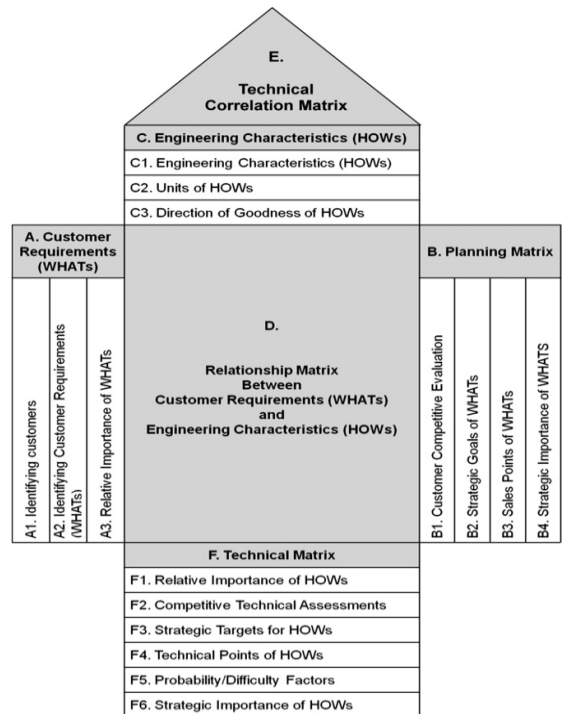


Figure 1 House of Quality (HOQ) technique [17]

The main objective of this research was to develop durian chips product through applications of Quality Function Deployment (QFD) technique. The minor objectives of this research were (1) to identify what customer requirements of QFD technique from durian chips product and (2) to construct a HOQ model and determine technical requirements for durian chips product.

Application of QFD in Food Product

Researchers have conducted literature reviews on the topic of QFD technique for the development of food product. First, Researchers provided a review of resilience literature in its support the context of durian chips product and later its application within the organization. Using keywords such as “Durian Chips Product” and “Quality Function

Deployment” (National and International Journals) on databases and Google Scholar, they collected and analyzed 39 papers, in which 4 papers were on organizational QFD technique for the development of a food product and only 2 papers were on applications of QFD technique for durian chips product.

They focused on the perspectives, concepts, and methodologies in the QFD technique for durians chips product literature. Their findings indicate that theoretical framework and research methodology establishing has been the main focus of researchers within the area of QFD technique, and empirical studies are lacking. Nevertheless, the researchers have been conducted into the local area to develop to develop durian chips product through applications of QFD technique. They suggested more focus on empirical methods such as case study and survey, which can significantly add to and validate theoretical and research methodology.

In the case of food products, the design and development to meet the needs of customers is important. Especially agricultural products that have a large amount of output each year. And often have a low price such as rice, rubber, fruits, etc. From 39 of research articles that presented QFD application in Agriculture Industry, QFD technique is applied in agriculture product from 2005 onwards. The application are in various forms, such as the design and development of foods and beverages, design and development of equipment and machinery, design and development of herb, and design and development of packaging for food and beverages, as shown in Fig 2.

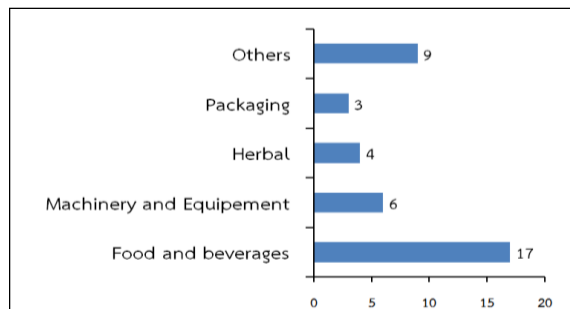


Figure 2 Classification of the Agricultural Product

Researchers have searched 39 articles, most of the article applied QFD for Food and beverages (17 articles or 44% of the cases). Besides, it was found that QFD is applied for Agriculture Equipment and Machinery (15%), Herb (10%), Packaging (8%) and others (23%). Articles on the use of QFD for development of food and beverages state the QFD is potentially a useful tool. QFD would increase customer satisfaction and decrease the development time and cost.

The QFD Four-Phase Model divides a product development process into four phases or steps. The first phase is to collect customer needs for the product. From 39 articles, it was found the 23 articles or 59% of the case applied only the first phase. The second phase of QFD transform the prioritized technical measures in the first phase in to part characteristics. The second phase are presented in 4 articles. The third phase transform part characteristics into process parameters which presented in 4 articles. Subsequently, the forth phase finally transform process parameters into production requirement or operations. The forth phase QFD are presented in 8 articles or 21% of the case, as presented in Table 1.

Table 1 The number of QFD applications

No	The number of QFD	Articles
1	Phase 1 Product Planning	23
2	Phase 1 and Phase 2	4
3	Phase 1, Phase 2 and Phase 3	4
4	All 4 Phase of QFD	8
	Totals	39

Researchers have been selected the crucial journals that support the research results relatively. Our study differs from previous work in several ways: first, instead of conducting the review on the concept of durian chips product in several ways, researchers have focused only on applications of QFD for durian chips product and related practices using a comprehensive literature review. Second, our review is exhaustive and covers both practitioners' and academic journals, book reviews, conference proceedings, and other related reviews and reports. Our study covers all publications from 1996 to 2017, collecting publications in previous studies.

Methods

Design

The research methodology was a quantitative method. This research included both the QFD and House of Quality (HOQ) technique was employed in this research. A customer requirements survey was conducted for Chanthaburi Province. The 384 customers were selected by simple random sampling, and were collected through a questionnaire surveying during May–August 2016. Furthermore, the application of QFD method to develop durian chips has been reported the customer requirements to translate the technical requirements.

Instrumentation

The questionnaire was comprised of four sections. The first section employed 11 items surveyed respondents to rate of each durian chips product by using a 5 point Likert's rating scales, where 1 = not important at all and 5 = extremely important. A total of respondents were identified based on the relevant literature and classified into three categories: durian chips-related attributes and a customer demand.

The questionnaire consisted of 3 parts were: (1) the demographic of respondents; (2) items of customer requirements surveyed and (3) open-ended question. To accomplish of this research, the sampling sizes were to explore the customer requirements and the rating of customer satisfaction through a questionnaire. This step can be done by Equation 1:

$$n = \frac{P(1-P)Z^2}{d^2} \quad (1)$$

Where n is the sampling size, P is the expected proportion at 50%, Z is a normal random variable (1.96) and d is the margin of error in estimating P (0.05) [18]. The questionnaire was employed for surveying about customer requirements. As a result, statistically was yield at 95% confidence interval, it was found that at least 384 customers.

Data Collection

A questionnaire was collected at Pa-Klab durian chips product group at Thamai District, Chanthaburi Province during May – August 2016.

Data Analysis

A total of 384 surveys were delivered resulting in a response rate of 100%. Data was analyzed by using computer programming. Descriptive statistics were performed.

Results

To identify what customer requirements (CRs) of QFD technique from durian chips product.

Demographic of Respondents

Among the 384 respondents, were obtained 100% and divided into female (59 %) and male (41%). The respondent's age ranged from 21-30 years old (34 %) and 31– 40 years old (23%). The married status was 53% marriage. The education background was non degree (52%) and Bachelor's degree (40%), Student (23%) and Farmer (23%).

Customer Requirements

This research was to identify what customer requirements of QFD technique from durian chips product. The results showed that customer requirements as 'Voice of Customers (VOCs)', 'WHATs', 'wants'. It was the first step of QFD, as well as the most important step in the product planning process. As a result, the items used to measure the customer requirements for the research were obtained from literature reviews. The customer's perception on the identified product requirement attributes was found by use of the survey as shown in Fig 3.

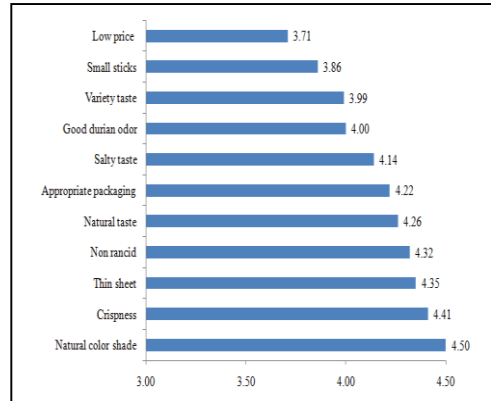


Figure 3 Customer's requirements about durian chips product

From Fig. 3, most of customer's requirements about durian chips product were the natural color shade (4.50), crispness (4.41), thin sheet (4.35), non rancid (4.32), natural taste (4.26), appropriate packaging (4.22), salty taste (4.14), good durian odor (4.00), variety taste (3.99), small sticks (3.86) and low price (3.71), respectively.

To construct a HOQ model and determine technical requirements for durian chips product.

Technical Requirements

In this research, a QFD conceptual model conducted to translate Voice of Customers (VOCs) into the technical requirements. In this step, technical requirements (also called 'product development', 'HOWs') derived by calculating of Geometric Mean for reliable of data, which is will using its importance (IMP). This step can be done by Equation 2:

$$IMP = \sqrt[n]{N_1 \times N_2 \times N_3 \times \dots \times N_n} \quad (2)$$

Where IMP is the importance rating, N is the satisfaction value of each customer

requirement and n is number respondents [19]. Result of calculating IMP as Figure 5. After that, put the customer requirement or customers voices which was attributed data and IMP to the left side of Phase 1 product planning or HOQ to input data of process [12], [16].

The third step, the translating of customer requirements into technical requirement were translating the natural taste into grading, translating salty taste into seasoning and translating variety taste into adding variety taste as shown in Table 2.

Table 2 Technical Requirement

Customer Requirement	Technical Requirement
Natural taste	Grading
Salty taste	Seasoning
Variety taste	Adding variety taste
Non rancid	Drying
	Storage station
	Storage time
Good durian odor	Adding durian odor
Crispness	Drying
	Size of thin sheet
	Storage station
	Storage time
	Type of oil
	Oil content
Natural color shade	Grading
	Oil content
Thin sheet	Size of thin sheet
Small sticks	Size of sticks
Appropriate packaging	Safety
	Vacuum packaging
	Easy to use

Low price	Reasonable prize
-----------	------------------

The fourth step was to find out the relationship between customer requirements and technical requirement by using symbol and score of relationships in Table 1. The relationship level of natural taste and grading is strong relationship, relationship level of salty taste and grading was not relationship level of Natural taste and seasoning was medium relationship as shown in Fig 4.

The sixth step was developing of technical requirements, which were grading (80%), 4-5 kilogram of weight and development direction was target the better (○). Seasoning was added a little salt, sugar and flavoring, and development direction of Seasoning was larger the better (↑) and targets of Adding variety taste was classification of customer by Mood Consumption Concept consists of 4 group which are; (1) Intuition group (2) Innovation group (3) Satisfaction group and (4) Perfection group and development direction of Adding variety taste is target the better (○) etc.

The seventh step was calculating of important weight of each technical requirement [20]. This step shall be done by Equation 3:

$$IW = \sum(RL \times IMP) \quad (3)$$

Where IW is importance weight, RL is relationship level and IMP is the importance rating, Result of calculating IW as Fig 4.

The eighth step was calculating of importance relative weight (% Relative) [20]. This step shall be done by Equation 4:

$$\% \text{ Relative} = \frac{IW}{\sum IW} \times 100 \quad (4)$$

Where (%) relative is importance relative weight and IW is importance weight. The

result showed that calculating (%) relative as shown in Fig 4.

Finally, the technical requirements were ranking by technical importance relative weight (% Relative) as shown in Fig 4.

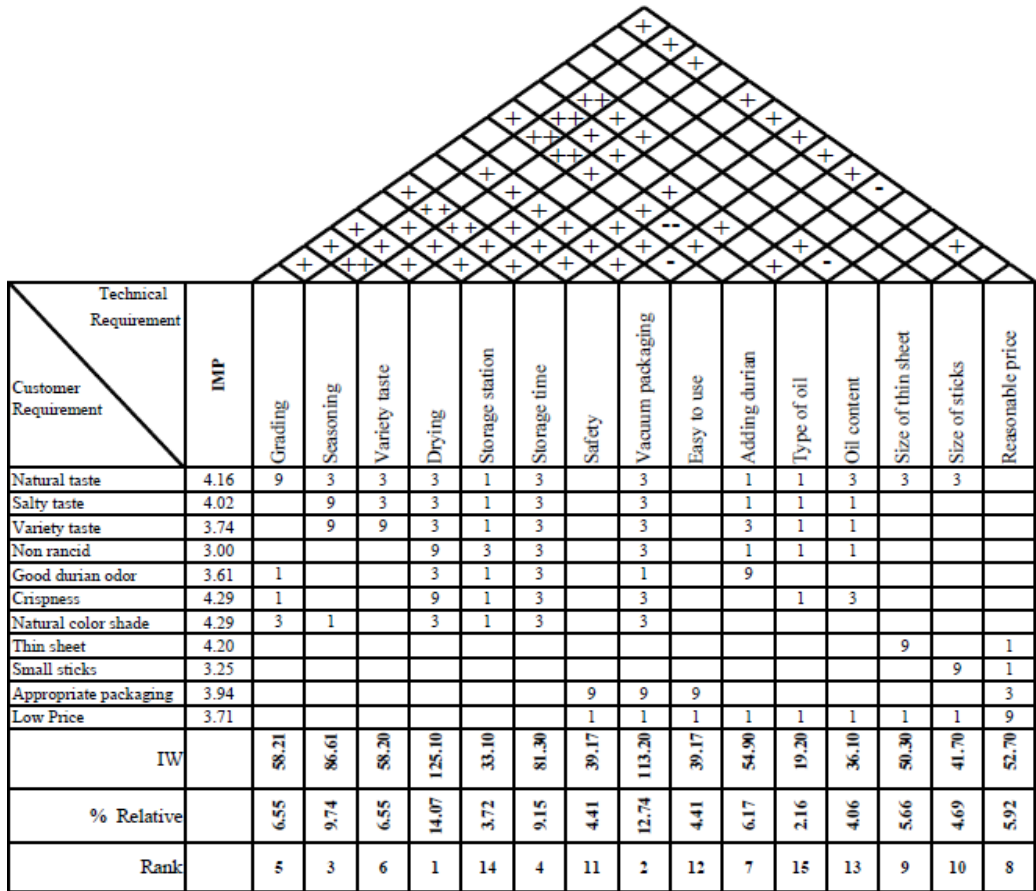


Figure 4 Construct a House of Quality (HOQ) of durian chips product

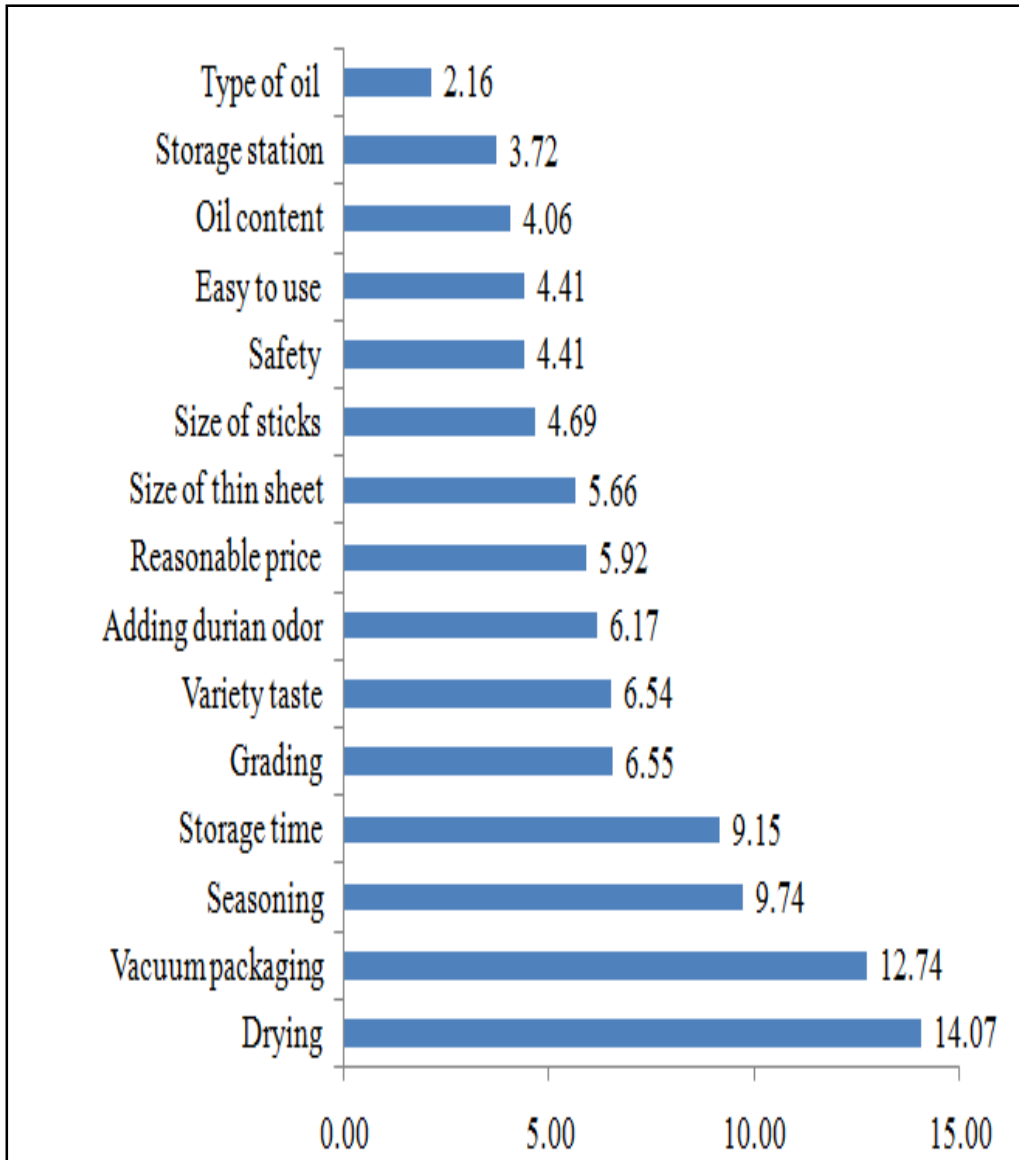


Figure 5 Technical requirements of durian chips Product

From Fig 5, most of technical requirements about durian chips product were drying (14.07%), vacuum packaging (12.74%), seasoning, storage time, grading, variety taste, adding durian odor, reasonable price, size of thinsheet, size of sticks, safety,

easy to use, oil content, storage station and type of oil with 9.74%, 9.15%, 6.55%, 6.54%, 6.17%, 5.92%, 5.66%, 4.69%, 4.41%, 4.41 %,4.06 %,3.72% and 2.16 %, respectively.

The initial importance levels, as well as he calculated weight of customer requirements by using HOQ technique, were

revealed that the calculation of relative important to translate the technical requirements identified that the 'packaging improvement', 'development of seasoning and storage time' and 'grading' were the highest requirements to the overall improvement of durian chips.

Discussion

Durian chips product is known as one of the most popular Chanthaburi Province foods to Thai consumers. To increase the consumption rate of durian chips product in the current market, this study determined customer requirements technique by applying QFD and HOQ technique with an objective to develop a product for the requirement. The survey for customers was conducted.

First, this research found that the respondent's recognition rate (100%) of durian chips product were highly effectiveness. These findings suggest that it is important to develop customer's requirements by using QFD technique about durian chips product. The results found that the natural color shade, crispness, thin sheet, non rancid, natural taste, appropriate packaging, salty taste, good durian odor, variety taste, small sticks and low price were customer requirements [19], [20], [21].

Second, this research was to construct a HOQ model and determine technical requirements for durian chips product. As a result, the most important attributes are drying, vacuum packaging, seasoning, storage time, grading, variety taste, adding durian odor, reasonable price, size of thin sheet, size of sticks, safety, easy to use, oil content, storage station and type of oil, respectively.

However, based on the initial importance levels, as well as the calculated weight of customer requirements, the five most significant customer requirements were the calculated weight of customer requirements by using HOQ technique [18], [22]. The research found that the 'packaging improvement', 'development of seasoning and storage time' and 'grading' were the highest requirements to the overall improvement of durian chips. The development of strategies for the improvement of durian chips product; therefore, in terms of customer's purchase convenience is needed.

The important research finding suggests another important limitation is related to the quality targets. The values and process parameters indicated in the matrix were not tested because this is a pilot work and were not developed in a company. There was no access to laboratories to perform the tests needed. The values shown are references that should be reviewed when real-life applications are employed in the local setting. This research differs from the conventional application of QFD because it considers the actors of the productive chain in the first matrix, assigning them the responsibility of being concerned with the qualities required by customers [9], [10]. This application focused on a different type of organic food, which has features beyond those traditionally customer requirements towards a local food, such as socio-economic sustainability development [11].

To increase the consumption rate of durian chips product in the current market; it is worth noting that the product development team using the QFD must be

multifunctional as suggested by Cheng and de Melo Filho [11], covering the functions of marketing, Research and Development, and production engineering. In this research some experts were consulted during the stages of proposed application [18], [19], [20], [21].

The study suggests the top five strategies for improving durian chips product by considering the relative importance and technical requirements. This study has some limitations. Data for the study was only collected in Chanthaburi Province of Thailand. The study could be expanded to various tastes, processes, so the findings can be generalized into larger customers. Additionally, investigating relationships between the customer requirements and the engineering characteristics should conduct the next research. To compensate this defect of this study, the relationship matrix between customer requirements and engineering characteristics and the technical matrix applied which adopted QFD for the concrete industry can be considered for the future studies.

Moreover, the findings strongly support the improvement method is essential for applications of QFD technique for design and development. It considered the importance of product design in technical requirements. This research supported an efficiency method for product research and design tool that considers the food production process, quality control, cost revenue and customer demands.

Conclusion

The objective of this research was to develop durian chips product through applications of Quality Function Deployment

(QFD) technique. The minor objectives of this research are (1) to identify what customer requirements of QFD technique from durian chips product and (2) to construct a HOQ model and determine technical requirements for durian chips product. The development of durian chips product was employed. Applications that used QFD specifically in the development of durian chips product were established in the existing knowledge. This research was then based on a QFD technique and a HOQ model from the literature, as well as from other studies that used QFD in the development of food products. This research supported an efficiency method for product research and design tool that considers the food production process, quality control, cost revenue and customer demands.

It was conducted that the applications of QFD to develop food products improve certain adaptations, considering that the 'packaging improvement', 'development of seasoning and storage time', and 'grading' have natural variations in composition [18], [20], [21], [22]. The many interactions between the ingredients and the influence of the productive processes on the functional properties of the product, as well as the influence of the technical requirements on the ingredients, ensure that the development of durian chips product have more variables than that of a food product. Therefore, this research might fit the development of other food products.

Acknowledgement

The researchers would like to sincere gratitude thanks to Department of Industrial Engineering, Faculty of Engineering, Ubon Ratchathani University, Ubon Ratchathani, Thailand, for supporting this research.

References

- [1] Office of Agricultural Economics. 2016. **Important agricultural products and trends for 017**.<http://www.oae.go.th>. Accessed 23 November 2016. (*in Thai*)
- [2] Bhothisawang, J. 2005. **A Study of local wisdom for making community products One Tambon One Product (OTOP) in East Coast Central region**. M.B.A. Thesis, Burapha University. (*in Thai*)
- [3] Thai Industrial Standard Institute (TISI). 2016. **List of Producers and Product in Chanthaburi and Rayong Province of Thai Community Product standard**. <http://tcps.tisi.go.th/public/en/certificatelist.aspx?province>. Accessed 23 November 2016. (*in Thai*)
- [4] Chiarakul, T. 2014. "The Problem and the Adaptation of OTOP to AEC," **Executive Journal**. 34(1): 177-191.
- [5] Gover, C. P. M. 1996. What and how about Quality Function deployment (QFD). **International Journal of Production Economics**. 46-47: 575-585.
- [6] Quinn, R. R. 2002. Quality function deployment (QFD). A case study. In: **Proceeding from PSTC's of the 25th anniversary technical meeting**, Atlanta, GA: PSTC.[7] Yodwangjai, S. 2015. Product Design and Development Process. **UBU Engineering Journal**. 8 (1): 131-141. (*in Thai*)
- [8] Tan, K. C. and Shen, X. X. 000.Integration Kano's model in the planning matrix of quality function deployment. **TotalQualityManagement**. 11: 1141-1151.[9] Viaene, J. and Januszewska, R. 1999. QualityFunction deployment in the chocolateindustry. **Food Quality and Preference**. 10: 377-385.
- [10] Benner, M. and et al. 2003. Quality function deployment (QFD). Can it be used to develop food products? **Food Quality and Preference**. 14: 327-339.
- [11] Brusset, X. and Teller, C. 2017. Supply chain capabilities, risks, and resilience. **International Journal of Production Economics**.184: 59-68.
- [12] Akao,Y.1990.**Quality functiondeployment. Integrating customer requirements into product design**. Cambridge, MA: Productivity Press.
- [13] Kumar, A., Antony, J., and Dhakar, T. S. 2006.Integrating quality function deployment and benchmarking to achieve greater profitability. **Benchmarking: An International Journal**.13: 290-310.

- [14] Cohen, L. 1995. **Quality function deployment. How to make QFD work for you.** Massachusetts, MA: Addison-Wesley Publishing Company.
- [15] Prasad, B. 1998. Review of QFD and related Deployment techniques. **Journal of Manufacturing Systems.** 17: 221–234.
- [16] Chan, L. K. and Wu, M. L. 2002. Quality function deployment. A comprehensive review of its concepts and methods. **Quality Engineering.** 15(1): 23–35.
- [17] Hauser, J. R. and Clausing, D. (1988). The House of quality. **Harvard Business Review.** 66(5/6):63–73.
- [18] Homkhiew, C., Ratanawilai T. and Pochana, K. 2012. Application of a quality function deployment to design and develop furniture products. **Songklanakarin Journal of Science and Technology.** 34 (6): 663- 668.
- [19] Kengpol, A. 2005. **The Design and Development of a New Product by Using Quality Function Deployment (QFD) Technique for SMEs.** Research Report, Department of Industrial Engineering King Mongkut's Institute of Technology Nork Bangkok. (*in Thai*)
- [20] Reuangkird, D. 1996. **Product Development of Durian Chips.** M.Sc. Thesis, Kasetsart University. (*in Thai*)
- [21] Thirakawin, P. and Hongvaleerat, C. 2010. Effect of Process Parameters on quality Attributes of Durian Chips. **Agricultural Science Journal.** 41(3/1): 265-268. (*in Thai*)
- [22] Waisarayutt, C. and Tutiayapak, O. 2006. Application of quality function deployment in instant rice noodle product development. **Kasetsart Journal Natural Science.** 40: 162–171. (*in Thai*)