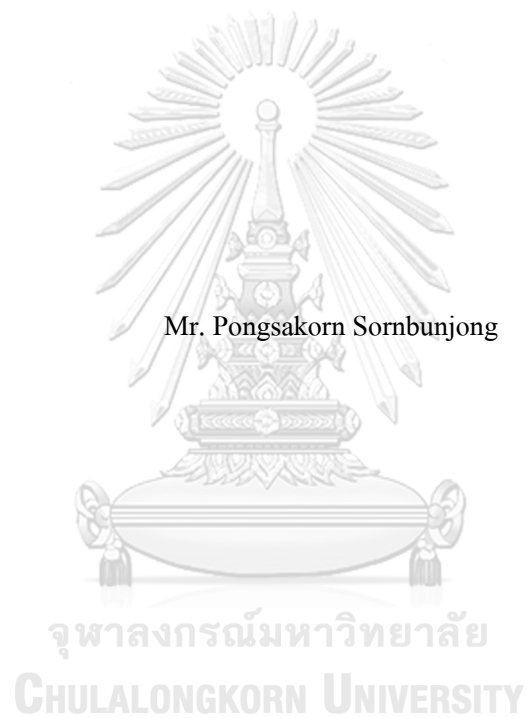


QUALITY ENHANCEMENT OF SHRIMP PASTE AND PACKAGING IMPROVEMENT
FOR A LOCAL MANUFACTURER



A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering in Engineering Management

(CU-Warwick)

Faculty of Engineering

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การปรับปรุงคุณภาพกะปิและบรรจุภัณฑ์สำหรับผู้ผลิตพื้นบ้าน



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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พงศกร ศรบรรจง : การปรับปรุงคุณภาพกะปิและบรรจุภัณฑ์สำหรับผู้ผลิตพื้นบ้าน. (QUALITY ENHANCEMENT OF SHRIMP PASTE AND PACKAGING IMPROVEMENT FOR A LOCAL MANUFACTURER) อ.ที่ปรึกษาหลัก : ศ. ดร.ปารเมศ ชูตีมา, อ.ที่ปรึกษาร่วม : รศ. ดร.ชูเวช ชาญสง่าเวช

การวิจัยครั้งนี้มุ่งเน้นไปที่คุณภาพของ บริษัท ผู้ผลิตกะปิ โดยเน้นที่การพัฒนาคุณภาพผลิตภัณฑ์กะปิตราปลาทูทองซึ่งเป็นผลิตภัณฑ์หลักของบริษัทการศึกษา รวมถึงการปรับปรุงบรรจุภัณฑ์ โดยปัจจุบันผลิตภัณฑ์นี้ใช้แผ่นพาราฟินเป็นปิดเหนื่อเนื้อกะปิเพื่อใช้เป็นวัตถุเพื่อถนอมอาหาร ซึ่งผิดข้อกำหนดของทาง องค์การอาหารและเกษตรแห่งสหประชาชาติ / องค์การอนามัยโลก และสำนักงานคณะกรรมการอาหารและยา (อย.) ของประเทศไทย

ขั้นตอนการวิจัยแบ่งเป็นสามขั้นตอน ขั้นตอนแรกได้แก่ การปรับปรุงคุณสมบัติทางกายภาพและทางเคมีของกะปิ โดยเบื้องต้นมีการส่งตัวอย่างไปทดสอบที่ห้องปฏิบัติการวิจัยทดสอบอาหาร ของจุฬาลงกรณ์มหาวิทยาลัย เพื่อเปรียบเทียบกับมาตรฐานอุตสาหกรรมของกะปิในประเทศไทย มอก.1080 2535 จากผลทดสอบ จึงนำไปสู่การปรับปรุงปริมาณอีเสต์ ราและเปอร์เซ็นต์ความชื้นในผลิตภัณฑ์

การดำเนินการในขั้นตอนที่ 2 เป็นการปรับปรุงบรรจุภัณฑ์ และรสชาติผลิตภัณฑ์ โดยใช้เครื่องมือในการปรับปรุงคุณภาพ 3 อย่าง ได้แก่ Quality function deployment (QFD), Failure mode and effects analysis (FMEA) และ Statistical process control (SPC) เพื่อจัดลำดับความสำคัญของปัจจัยทั้งเชิงคุณภาพและเชิงปริมาณที่จำเป็นต่อความต้องการของลูกค้า ผลการวิจัยพบว่ารสชาติของกะปಿನั้นมีความสำคัญที่สุดในทุกองค์ประกอบ รองลงมาคือความสอดคล้องกับมาตรฐานอย. ถัดไปคือ ความง่ายในการเปิดฝาบรรจุภัณฑ์ เนื้อสัมผัสของกะปิ สีของกะปิ และกลิ่นของกะปิตามลำดับ จากการทดสอบแบบอำพราง (Blind test) พบว่าผลิตภัณฑ์ที่มีข้อดีเปรียบเทียบกับคู่แข่งคือ สีรสชาติของกะปิ แต่ข้อที่ควรปรับปรุงโดยด่วนคือบรรจุภัณฑ์และฉลากเพื่อนำไปสู่การได้รับใบรับรองมาตรฐานอย. หลังจากพิจารณาทางเลือกต่างๆ บรรจุภัณฑ์ที่ได้พิจารณาเลือกคือ บรรจุภัณฑ์ที่มีฝาเลือกแบบเปิดปิดง่าย (Easy open ends, E.O.E.) สำหรับการปรับปรุงฉลากบรรจุภัณฑ์ ได้มีการเพิ่มเติมรายละเอียดข้อมูลที่เป็นต่างๆเช่น ข้อมูลภาษาอังกฤษ ข้อมูลทางโภชนาการ วันหมดอายุและวันที่ผลิต ซึ่งกว่านั้น ยังได้มีการปรับปรุงขนาดของบรรจุภัณฑ์ให้เหมาะสมต่อการใช้งานของลูกค้ามากขึ้น โดยขนาดเล็กปรับเปลี่ยนจาก 145กรัม เป็น 180กรัม และ ขนาดใหญ่จาก 580กรัม เป็น 700กรัม

การดำเนินงานในขั้นตอนที่ 3 เป็นการวิเคราะห์ทางการเงิน โดยเปรียบเทียบต้นทุนก่อนปรับปรุงและหลังปรับปรุงต่อผลิตภัณฑ์ 1 กิโลกรัม พบว่าต้นทุนโดยรวมเพิ่มขึ้นประมาณ 4.9 เปอร์เซ็นต์ สำหรับผลิตภัณฑ์ขนาดเล็กและ 8.4 เปอร์เซ็นต์ สำหรับผลิตภัณฑ์ขนาดใหญ่ จึงควรกำหนดราคาใหม่ให้สูงขึ้น ราว 10 เปอร์เซ็นต์ จึงจะคุ้มค่าการลงทุน อย่างไรก็ตามยังต้องมีการลงทุนในการปรับปรุงโรงงานผลิตกะปิเพื่อเตรียมพร้อมสำหรับการขึ้นทะเบียนอาหารและยา ซึ่งเป็นข้อเสนอแนะในการทำวิจัยในอนาคต

ข้อสรุปจากงานวิจัยนี้พบว่า การปรับปรุงผลิตภัณฑ์และบรรจุภัณฑ์ของผลิตภัณฑ์พื้นบ้านเช่น กะปิ ดังที่ได้ดำเนินการในบริษัท การศึกษานี้สามารถเพิ่มความสามารถในการแข่งขันให้กับบริษัทได้เป็นอย่างดี จึงสมควรส่งเสริมให้มีการให้มีการวิจัยในลักษณะเดียวกันนี้ ในผลิตภัณฑ์พื้นบ้าน อื่นๆ ในอนาคต

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The present research focuses on the quality of the shrimp paste manufacturing company by emphasizing product quality improvement as well as packaging improvement for the shrimp paste, which is the main product of the Case Study Company. Presently, the product uses paraffin to cover the shrimp paste for food preservation, which is prohibited by Food and Agricultural Organisation of the United Nations (FAO) / World Health Organisation (WHO) and Thailand's Food and Drug Administration (FDA).

The research procedure may be divided into 3 phases. The first phase consists of improvement to the physical and chemical properties of the shrimp paste. The sample product was tested at Food Test and Research Laboratory (FTRL) of Chulalongkorn University, according to Thailand Industrial Standard Institute (TISI) no. 1080 2535 for shrimp paste. The results led to the subsequent improvement in yeast, mould and percentage of moisture content in the product.

The second phase involves the improvement to the packaging and taste of the shrimp paste product. Three quality improvement tools are used, namely Quality function deployment (QFD), Failure mode and effects analysis (FMEA) and Statistical process control (SPC) in order to prioritise the qualitative and quantitative factors that the customers demand. It was found that the taste of shrimp paste is the most important factor. This was followed by conformance to FDA standard, ease of lid opening, texture, colour, and odour of shrimp paste. Based on the blind test, the product as-is is already superior to the competitors in terms of colour and taste of shrimp paste. However, the product packaging and labelling need to be improved as a prerequisite to receiving the FDA certificate. After considering several alternatives, the product packaging chosen in this research was the easy-open ends (E.O.E.). For the labeling, additional information was added such as product information in the English language, nutrition facts, and expiry and manufacturing dates. Moreover, the size of packaging was recommended to be adapted according to customer usage: the small size is changed from 145g to 180g and the large size is changed from 580g to 700g.

The third phase of the research procedure is the financial analysis comparing the costs per kilogram of the product before and after improvement. It was found that total cost increases 4.9 percent for small size and 8.4 percent for the large size. It was recommended that the price should be increased by up to 10 percent to accommodate the cost increase. However, it is noted that investment is needed for future improvement to the shrimp paste factory in preparation for the FDA registration, which is recommended for further research.

Field of Study: Engineering Management

Student's Signature

Academic Year: 2018

Advisor's Signature

Co-advisor's Signature

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Thanks to Reangwa company who supplied packaging for the safety lock type

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จุฬาลงกรณ์มหาวิทยาลัย
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Chapter 1 Introduction

1.1. Shrimp paste

In this research will use shrimp paste company as to improve the quality. Shrimp paste is an essential fermented ingredient in traditional Asian foods commonly found in South East Asian and North East Asian. In each country, they called shrimp paste differently. In Thailand, we called shrimp paste as “Kapi.” In Indonesia, they know as “Terasi.” In Burma, they perceive as “Ngapi.” In India, they know as “Dangpuithu.” Malaysia called them as “Belacan.” In Vietnam, they sprit into “mắm.” Finally, the last one made from shrimps/prawns. In Philippine called “Bangoong alamang.” In China, they know as “Hom Ha.” (Naomichi I, 1998)

However, shrimp paste has used the method of fermentation. Fermentation is a common practice in food preservation, and it plays a vital role in the improvement of nutritional and functional properties of foods (Steinkraus, 2002). In the process of fermentation, the amino acid is synthesizing in large quantities. The selected microorganism is cultured with nitrogen and carbohydrate. L-form of amino acid produced. Then Umami taste, which is a compound of glutamate is created from 2-oxoglutarate by reducing ammonia fixation that uses the enzyme glutamate dehydrogenase during the fermentation process. The umami tastes depending on glutamate concentration. (Sano, 2009).

In each country, they had different methods of making shrimp paste. For example, the Philippines used the shell of shrimp to mixed within their shrimp paste “Bagoong alamang”. When it was fermenting for an extended period, it will be decomposed and become a semi-liquid paste. (Hajeb P, Jinap S, 2012) However, the most country they mixed shrimp or krill with salt first and then sundried, the duration of sundried is depending on each country, and the ratio of salt to shrimp also depends on each country recipe. In Thailand, usually, they used krill (acetes or Mesopodopsis species) mixed with salt at a ratio of 3-5:1. After that, it will be sundried for few days to decrease moisture content and collected into Fermentation containment. The fermentation process took about two months until the flavour developed. (Phithakpol, 1993). Referring to shrimp paste, it is a fermentable good which can last longer up to 5 years or more. It means it is not perishable goods. It depends on how to storage those products. If it is storing in cold-temp, the product will last longer. It creates an opportunity for shrimp paste as an oversea delivery product as its lifetime are longer.

Furthermore, the fermented shrimp product can be categorised into sauces pastes and lacto-fermented product. Those products in Southeast Asian countries are shown in the table below.

Country	Shrimp sauce	Shrimp paste	Fermented shrimp
Burma	<i>Ngan pya ye</i>	<i>Seinsanga-pi</i> <i>Hmyinnga-pi</i>	
Cambodia	<i>Nam tom</i>	<i>Kapi</i> <i>Pra hoc</i> <i>Mam ruoc</i>	
Indonesia		<i>Terasiudang</i>	
Malaysia		<i>Belacan</i>	<i>Cencalok</i>
Myanmar	<i>Pazungampya ye</i>	<i>Nga-pi</i> <i>Seinza</i> <i>Hmyannga pi</i>	
Philippines	<i>Alamang-patis</i>	<i>Bagoong-alamang</i> <i>Buronghipon</i> <i>Dinailan</i> <i>Lamayo</i>	<i>Balao-balao</i>
Thailand	<i>Nam kapi</i> <i>Nam khoei</i>	<i>Kapi</i>	<i>Jaloo</i> <i>Koongsom</i>
Vietnam	<i>Nam tom</i> <i>Nuoc mam tom chat</i>	<i>Mam ruoc</i> <i>Mam tom</i> <i>Mam tep</i>	

Table 1 Fermented shrimp paste products in Southeast Asian countries (Hajeb P, Jinap S, 2012)

1.2. Company profile

1.2.1. History

The company owned by a family. The shrimp paste company is called “Kapi Tra Pla Bu Thong” or “Goby fish shrimp paste”. The company was established since 1988 by Tippimol panich, which the name follows from the initiator’s Last name. The company located in Chumphon province, Southern Thailand. The company relied on one supplier. Which called “Wassana”, is a local supplier who seizes for other local Kapi makers in all over Chumphon and nearby province.



Figure 1 Goby fish logo

1.2.2. Organisation



Figure 2 Organisation of Kapi Tra Pla Bu Thong company

The organisation of the company is tiny due to it is a local business. However, Mrs Somjai Sornbunjong, who is CEO of the company, manage to do accounting, order material, deal directly with the supplier. She handles with all office works with an assist from Mr Tawatchai Sornbunjong, who act as the manager. Mrs Kongjit Panurai, who is the head of work, will manage to control all of the operations.

1.2.3. Supplier delivery

The factory makes a contract with Wassana to delivery shrimp paste raw material only compose of special shrimp spices (acetes for third water krill on March). The company cooperated with Wassana for more than ten years. Before that factory had tried other type of shrimp pastes from different suppliers, but the quality is not meet satisfaction. The raw material will be delivered seasonally because krill will be massively grouped near shore in the shallow of mangrove from January to March. Krill that got caught on January was called first water krill (Nam rack). The appearance of krill is minimal, but it is best to compose Nam Pherik Kapi (Thai shrimp paste chilli sauce). Krill that got caught on February called second water krill (Nam Song) it is best for both Nam Pherik Kapi and Pherik Kapi (condiment for curry). 3rd water krill got caught from March is best for Pherik Kapi. (Darumarth, 2008). If detected krill excluded from this period (January-March), the shrimp paste contaminated with sand, fish, and another sea organic. Besides, there is not much krill to catch.

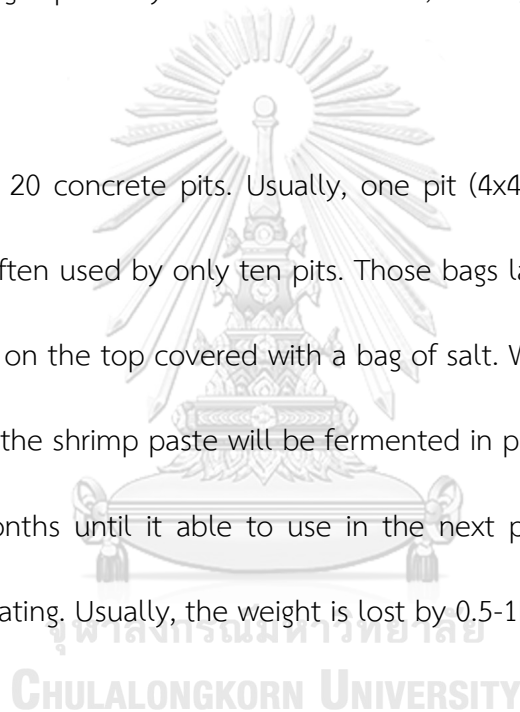
The delivery starts from July – October. Because local makers will have fermented their krill until it is favourable around three months before selling to Wassana and then Wassana will deliver those raw materials to the factory, the frequency of delivery depends on supplier contribute goods from local makers. The transportation of goods is by door to door method as one picked up truck with 100 bags and 30kg/bag so 3,000kg/trip. One year will be about 50,000-60,000kg/year.

1.2.4. Storage

In the factory has 20 concrete pits. Usually, one pit (4x4x1.5m.) can contain up to 6,000 kg per pit. Often used by only ten pits. Those bags laid down in order with five layers of bags and on the top covered with a bag of salt. While the shrimp paste was storing in the pits, the shrimp paste will be fermented in pits. The fermenting process is up to three months until it able to use in the next process. After ferment, the moisture is evaporating. Usually, the weight is lost by 0.5-1kg from 1 bag of 30kg.

1.2.5. Product & Packing

After that, shrimp paste is taken out from bags and added with salt, then mixed it with hand until it becomes consolidated. Then put it into the bottle by the side and press it until it has no space of air void. Then use melted paraffin to cover on the top to protect moisture evaporated. There are two sizes available, which are 135g. &



580g. The finished goods are packing into a paper box. 1 box contained 12 bottles of 580g (big) or 32 bottles of 135g. (small) as shown in figure 3.

The general expense of raw material, Plastic bottle used around 10,000 bottles/month, Paraffin used around 250kg/month., the Paper box used around 1,000 boxes/month, for these suppliers we deal more than ten years.



Figure 3 Shrimp paste products on supermarket shelf (big = 580g & small = 135g)

1.2.6. Distribution & delivery to the customer

The distribution of product mostly by wholesaler which a minimum amount of 100 boxes of significant size and 50 boxes of small size. Usually, we distributed mainly to 5 distributors. Which first distributor is at Songkhla province in southern Thailand with the frequency of delivery of 200 boxes of big size per month (1,392kg/month). The second distributor is also at Songkhla province, the amount and frequency of delivery are 100 boxes of big size per month (696kg/month). The third distributor located in Yala province, which is the bottom part of Thailand. The amount is 50

boxes of big size per month (348kg/month). The fourth distributor located in Bangkok with an amount of 50 crates of big size per 2 months (174kg/month). The fifth distributor located in Lampang, the northern of Thailand, with the amount of 10 boxes per month (70kg/month). In total, the amount of shrimp paste solely around 32,160kg per year. Therefore, there is a large amount of shrimp paste left over since overall delivery per year is around 40,000-50,000kg.

We delivered to a small shop and supermarket in the local area but no own retail shop. Furthermore, there is available on Facebook for the online retail shop since 2017, but it has not been participated or put afford into it.

The company hired the third party to deliver the product to a customer who is “Kerry”. The price that shows on Facebook has included the transportation cost.

1.3. Quality

Many definitions are referring to quality. Some said it is a measure of excellence with a free of defect or it can be described a the degree of excellence. However, one of the most successful statisticians in the field of quality is W. Edwards Deming defined quality as *“Good quality means a predictable degree of uniformity and dependability with a quality standard suited to the customer. The underlying philosophy of all definitions is the same consistency of conformance and performance, and keeping the customer in mind”* (Chandrupatla, 2009). In this dissertation, The quality issues of shrimp paste related to the company is raised.

Which parts of shrimp paste company that need to improve and in what circumstance that the countermeasures are drawn up to solve the quality issues. The quality of the shrimp paste company is dividing into two main categories, which are Product and Organisation. Furthermore, tools such as TQM (total quality management) and other standard related to shrimp paste product is reviewing in this thesis.

The shrimp paste product, the chemical and physical properties will be review in the literature review in order to compare with TISI-1080-2535 and other past papers that already examined with other shrimp pastes. Therefore, it can conclude the company's shrimp paste quality compare with other shrimp paste if the physical properties not passed the standard of TISI-1080-2535. Then it needs to find countermeasure in order to make the product pass the qualification. Moreover, the point of occurrence that needs to be an issue. It is the packing method where paraffin material was used to fill on the top of the surface of the shrimp paste. As a result to protect shrimp paste from moisturising because the shrimp paste dewatering on the surface, It makes salty water on the top surface as a consequence when salty water become dried on the surface. The salt water will disappear into shrimp paste, but the customer able to visualise white matter on the surface which looks not appetising and also the life-shelf will be shorter without paraffin covered. Besides, Paraffin or mineral oil that used for protecting shrimp paste moisturising, it is prohibited in importing to EU in 2009 since Joint FAO/WHO expert committee on

Food Additives (JECFA) has removed acceptable daily intake (ADI) because they found negative impact in small creatures. Food and drug administration of Thailand has warned the consumer of shrimp paste not to select shrimp paste with paraffin due to the safety and health issue. (MGRonline, 2007) Which in the literature review will be reviewed more into details about paraffin and how to take countermeasure by using different packaging and remove the paraffin. Furthermore, total quality management is applied using the guideline of Food and drug administration as the guideline nearly cover all of the necessity, such as improve organisation, shop floor, and product. Therefore, submission of approval for food and drug administration to prove that the product has satisfied the standard. The details of Thailand's Food and Drug Administration submission is reviewing at the end of this thesis.



1.4. Objectives

The research will contribute to the Shrimp Paste Company in Thailand to capture the quality issues in term of organisation and product. Consequently, from the study, the shrimp paste company should be able to enhance its quality. However, the packaging is the only trail with a prototype which not dramatically change in the package. The prototype will be established and survey among existing customer to gain feedback. Then the thesis will give a brief idea for the management to make the decision of package changing or not. Moreover, the main objective is “to improve product quality and packaging” which scopes are describing below:-

1. To determine shrimp paste chemical & physical properties compare with TISI-1080-2535
2. To compare chemical properties of shrimp paste with other local shrimp paste in Thailand and overseas.
3. To discover packaging without using paraffin
4. To increase value to the product
5. To determine the possibility in food and drugs administration registration
6. To assess the likelihood of changing packaging with the concern of financial

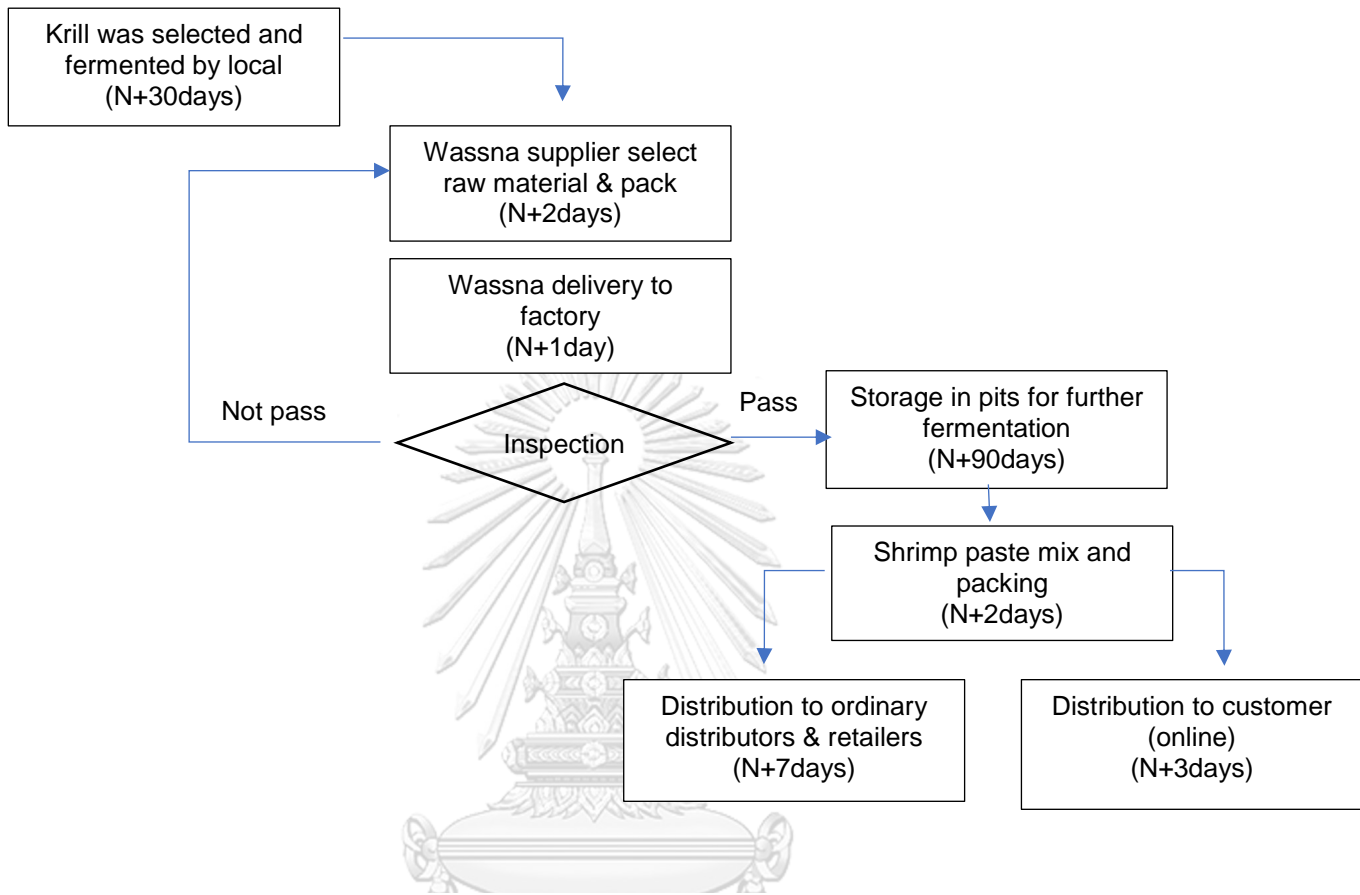


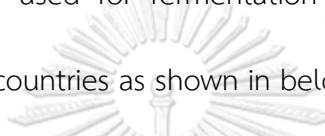
Figure 4 Process flow of shrimp paste company
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The problem of packaging is pointing at paraffin, which it effects as a quality for a whole company because its unable to register food and drug administration in Thailand. Furthermore, the improvement of shrimp paste quality is first implemented by identify the company’s shrimp paste properties and compare with features of other shrimp pastes and TISI-180-2535 standard.

Chapter 2 Review of Literature

2.1. Shrimp paste chemical properties

The shrimp paste chemical properties is reviewing through samples from various countries such as Thailand, Philippines, Korea, Malaysia, Indonesia. First of all, the species of *Acetes* shrimp used for fermentation in Southeast Asian. The *Acetes* species divided based on countries as shown in below table.



Country	Species
Burma	A. <i>indicus</i>
	A. <i>intermediuc</i>
	A. <i>vulgaris</i>
Indonesia	A. <i>japonicus</i>
	A. <i>sibogaesibogae</i>
Malaysia	A. <i>japonicus</i>
	A. <i>erythraeus</i>
	A. <i>sibogaesibogae</i>
Philippine	A. <i>erythraeus</i>
	A. <i>intermedius</i>
	A. <i>vulgaris</i>
Singapore	A. <i>erythraeus</i>
	A. <i>indicus</i>
	A. <i>vulgaris</i>
Thailand	A. <i>japonicus</i>

Table 2 *Acetes* species used for fermentation in Southeast Asian Countries (Hajeb P, Jinap S, 2012)

In Thailand, *Acetes* species that most used for fermented is *japonicus*.

These species are related to Glutamic acid, which, as mentioned in chapter 1 that the glutamic acid is corresponding to the taste of umami. The below chart is shown glutamic acid rate compared with each other countries. The highest free of glutamic

acid is Belacan (Malaysia) with 4207 mg/100g and followed by Kapi (Thailand) with 1647 mg/100g.

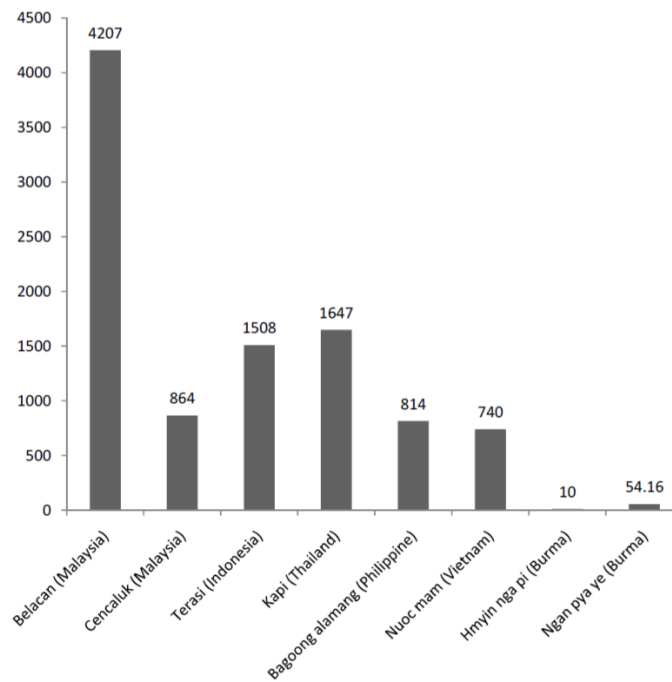


Figure 5 Level of free glutamic acid (mg/100g) in fermented shrimp products (Hajeb P, Jinap S, 2012)

The proximate composition of shrimp pastes in each country is reviewing. The method of sampling and measuring the parameters of both chemical and physical might be slightly different, but the outcome is similar. Most of the ways are a reference to the Association of Official Analytical Chemists. (AOAC, 1990). The unit will be adapted so that it is comparable such as convert dried matter into water content. The results of proximate composition in each country will be illustrated

only parameters mentioned in TISI-1080-2535 (see chapter 2.3). If it is not showing, it means that the data is unavailable.

Shrimp paste	Ash (%)	NaCL (%)	pH	Aw	Moisture (%)	Protein (%)	Fat (%)	Nitrogen
TISI-1080-2535	<= 0.5	>=36	6.5 – 7.8	N/A	<=45	-	-	>=58
SK1	20.69	10.96	6.22	0.75	51.72	-	-	11
SK2	18.92	13.44	7.07	0.72	43.38	-	-	41
SK3	19.05	10.81	6.91	0.73	42.05	-	-	36
SK4	16.65	11.32	6.6	0.76	53.91	-	-	7
SK5	14.45	11.60	6.76	0.76	54.68	-	-	11
SK6	18.78	12.24	6.77	0.75	49.16	-	-	19
SK7	19.47	14.27	6.85	0.73	48.37	-	-	32
SK8	20.58	12.51	6.7	0.71	42.37	-	-	38
SK9	15.62	12.63	6.74	0.74	42.02	-	-	15
SK10	15.33	12.81	6.87	0.74	48.64	-	-	28
SK11	19.37	10.04	6.86	0.73	38.94	-	-	22
SK12	16.07	12.18	6.84	0.73	40.78	-	-	33
SK13	17.06	12.07	6.9	0.7	32.59	-	-	23

SK14	20.40	12.42	6.82	0.69	27.35	-	-	31
SK15	12.79	12.35	6.2	0.71	39.02	-	-	46
SK16	15.68	13.00	6.12	0.76	49.25	-	-	5
SK17	18.65	12.87	6.8	0.72	37.60	-	-	27
SK18	22.13	13.29	6.69	0.76	44.65	-	-	4
SK19	13.56	11.66	6.79	0.73	44.82	-	-	35
SK20	13.10	11.87	6.82	0.73	43.38	-	-	33
SK21	14.81	12.56	6.41	0.75	51.05	-	-	14
SK22	12.77	10.44	6.85	0.7	35.99	-	-	13
SK23	18.92	12.41	6.89	0.72	39.95	-	-	23
SK24	14.16	10.24	6.85	0.73	43.13	-	-	15
SK25	13.21	11.73	6.89	0.68	29.06	-	-	19
SK26	19.22	10.97	6.85	0.73	45.72	-	-	30
SK27	13.03	12.56	6.77	0.72	35.52	-	-	14
SK28	21.81	10.21	6.79	0.74	48.30	-	-	34
SK29	13.96	11.99	6.74	0.77	53.27	-	-	16
SK30	12.21	11.16	6.62	0.74	43.34	-	-	15
SK avg	16.75	11.95	6.73	0.73	43.33	-	-	23
KK1	23.78	21.79	7.62	0.71	38.47	23.22	1.21	60
KK2	22.53	22.96	7.57	0.70	39.37	25.14	1.99	68

KK3	20.95	21.21	7.31	0.72	44.23	21.67	1.05	64
KK4	23.29	21.79	7.42	0.72	44.74	21.22	1.24	63
KK5	22.18	22.38	7.31	0.73	46.68	21.50	1.06	65
KK6	22.33	21.79	7.28	0.71	37.62	21.08	1.01	52
KK7	22.57	21.21	7.45	0.71	38.62	21.74	0.98	57
KK8	24.50	21.75	7.22	0.71	37.95	23.23	1.29	59
KK9	25.21	22.11	7.14	0.72	43.05	23.18	1.34	65
KK10	25.86	22.58	7.20	0.72	42.28	25.13	2.05	69
KK11	25.52	21.53	7.70	0.73	44.81	18.95	0.69	56
KK12	30.86	22.45	7.24	0.72	44.05	21.74	1.08	63
KK13	25.08	21.56	7.45	0.71	37.36	22.36	1.17	58
KK14	22.56	19.78	7.01	0.74	46.85	21.83	1.04	64
KK avg	24.09	21.78	7.35	0.72	41.86	22.29	1.23	61.64
MB	19.15	14.94	7.56	0.73	47.92	30.38	0.63	-
KS	13.95	12.87	8.50	0.77	21.13	56.59	0.82	-
PS1	-	14.79	7.75	0.70	47.08	14.79	0.80	-
PS2	-	12.89	7.62	0.73	61.68	12.89	1.56	-
PS3	-	15.11	7.71	0.71	55.02	15.11	1.17	-
PS4	-	14.83	6.81	0.72	51.82	14.83	0.86	-
PS avg	-	14.40	7.47	0.72	53.90	14.41	1.10	-

IT	29.12	16.75	7.53	-	37.41	25.42	6.11	-
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Table 3 Various shrimp paste parameters comparison

Data is from different kinds of literature as mentioned behind each type of shrimp paste below

SK= Southern Kapi (Uraivan Wattanakul; chutinchu Sutjarit; Janejira Suwanno;

Yupadee Zunsim, 2011),

KK=Klongkone Kapi (Naruemon Prapasuwannakul; Kowit Suwannahong, 2015),

MB=Malaysia belecan & KS=Korean shrimp paste (Young-Boong kim, Yun-Sang choi,

Su-kyung Ku, Dai-Ja Jang, Hajah Hasnah binti Ibrahim, KiBong Moon, 2014)

PS=Philippine Shrimp paste (Pilapil, 2013),

IT=Indonesia Terasi (Ingrid S. Surono, Akiyoshi Hosono, 1994)



According to above data in the table, SK (southern Kapi) was selected randomly from the local market in southern provinces, 1kilogram per 1 sample which are Trang, Songkhla, Krabi, Satun, Phatthalung, Nakhon Si Thammarat, and Ranong provinces. The samples were kept in a refrigerator with an utterly close package before experimenting. They concluded that 30 samples were 100% not passed the requirement for ash regarding TISI standard, but in fact, ash value in TISI is considered only ash that not dissolved in acid. Also, the same as NaCl or salt was 100% not passed the TISI standard. These might have resulted from customer needs as most of

the southern customer prefer low salty for Nam prik Kapi and curry paste. Whereas pH, 13% not passed. The moisture content was not moved TISI by 37%. Moreover, Nitrogen was not passed TISI by 100%. (Uraivan Wattanakul; chutinchu Sutjarit; Janejira Suwanno; Yupadee Zunsim, 2011) Therefore, shrimp paste in southern of Thailand is mostly not meet the standard of TISI 1080 2535. Despite, there still a gap to be fulfilled and to enhance the quality of chemical properties in shrimp paste of southern Thailand.

Referring to 14 samples of KK (Klongkone Kapi) were selected randomly from Klongkone district in Samut Songkram province. There are three different lots used; for each lot, three samples were purchased and mixed as the composite sample. All samples packed in a plastic bag and stored at -20 °C before analyses. (Naruemon Prapasuwannakul; Kowit Suwannahong, 2015).

The results showed that 100% did not pass ash TISI 1080 2535 standard. Interestingly, Nitrogen analysis has given 85% that means only two failed of the rule which below 58. Whereas, southern shrimp pastes had 100% below standard. These might be results of adding starch to the shrimp paste and decrease the amount of shrimp, but KK shrimp paste has no carbohydrate; therefore, the nitrogen is formed high as a consequence of more density of shrimp in KK shrimp paste. Besides, the level of NaCl was not meet the standard of TISI 1080 2535 by all of the samples, but they were about twice higher of NaCl than in the southern shrimp pastes. The pH

values of KK shrimp paste was slightly higher than southern shrimp paste because the local southern shrimp paste had added up starch which it might turn into acid. Therefore, this results in lower pH value in SK shrimp paste. The moisture contents seem to be passed the limit of TISI 1080 2535 as only 2 were over 45% of moisture content. Water activity value of KK shrimp pastes was similar to SK shrimp pastes. The author mentioned that water activity value of 0.70 to 0.75 can limit the growth of food pathogens and preserve the food from microbial spoilage at ambient temperature (Chirife, 1989).

Regarding foreign shrimp paste, the value is similar to Thai shrimp paste. If compared to TISI 1080 2535, none of them passed the requirement, including Thai shrimp pastes. Also the same as NaCl, there is no passed standard on NaCl. Interestingly, Korean shrimp paste has rich of protein twice others, and low moisture content because the shrimp paste might ferment for an extended period and also it is corresponding to water activity value as it is highest with 0.77. As lower water activity, the growth of spoilage microorganisms, so prolonging the shelf-life of the product. (Motano, 2001). Therefore, the higher fermented will higher water activity, which lower shelf-life of the product. However, the nutrition parameter will increase. Terasi, the percentage of fat is very high, and it might depend on the source of shrimp. Meanwhile, the Philippine shrimp paste contained a high amount of water content, which mean it might ferment in a too short period.

2.2. Shrimp paste Physical properties

The physical properties of shrimp paste regarding TISI 1080 2535, it is referring to texture, odour, and taste, debased and adulterated matters. The SK (southern Kapi) determined through a process of TISI 1080 2535 (Uraivan Wattanakul; chutinchu Sutjarit; Janejira Suwanno; Yupadee Zunsim, 2011), noted that from studies of physical properties, they found that 21 samples debased with starch as accounting for 70% not passed TISI 1080 2535 standard. Therefore, this might result from cost reduction in the product to add flour into shrimp paste and increase the amount of overall shrimp paste. Besides, that flour will help shrimp paste to form texture stickier and more homogeneous, this lead to deceiving the customer. Furthermore, with add up of flour, sugar, MSG. As resulted, in lower shrimp in the shrimp paste caused the lower percentage of nitrogen which according to studies, there is 100% not passed for nitrogen test in shrimp paste.

Moreover, analysis of colour in samples found 14 samples that have included food colour in their product. There are about 47% that found mixed of food-grade colour in the sample. The merchants may want to attract customer and hidden the realistic colour from the customer. This problem is deceiving the customer. Which surely it did not pass requirement of TISI 1080 2535. (Uraivan Wattanakul; chutinchu Sutjarit; Janejira Suwanno; Yupadee Zunsim, 2011)

Regarding to adulterated matters observation with bared eyes, the study found that are nylon rope 11 pieces, grit 6 pieces, shell 5 pieces, piece of plastic 4 pieces, piece

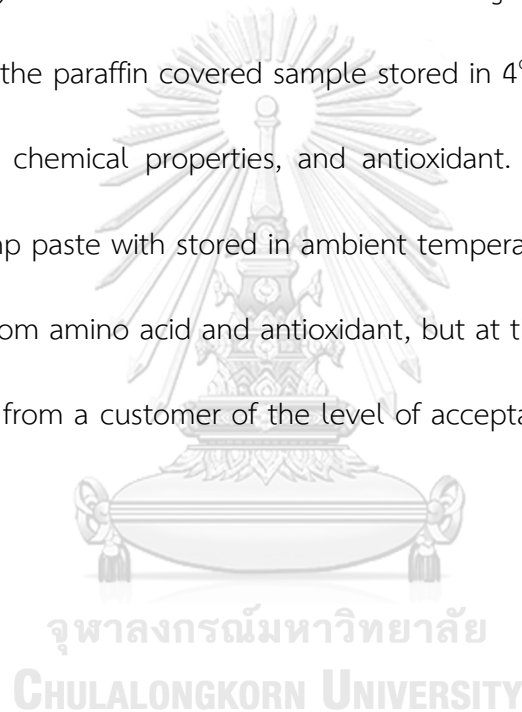
of wood 4 pieces, insects 3 pieces, piece of flour 2 pieces, crab leg 2 pieces, grass 2 pieces, red piece 2 pieces, hair 1 piece, worm 1 piece. The insects and worms might occur from the process of fermentation with no completely closed. (Uraivan Wattanakul; chutinchu Sutjarit; Janejira Suwanno; Yupadee Zunsim, 2011)

The colour of the shrimp paste can be measured by colour meter with show result in EIS system, L* is lightness, a* is redness/greenness and b* is yellowness/blueness. Regarding dissertation of (Narumon Prapasuwankul; Sakutra Kumpshu, 2015), studies the condition of storage in ambient temperature and no air condition in packaging which reacts with physical-chemical properties and antioxidant of Kapi Klongkone product in the time of 6 months. They manage to collect a sample of 1 month fermented and put it into a polypropylene bottle of 250gram. There are 4 bottles, first 2 without paraffin wax on the top and second 2 with paraffin wax on the top. They stored those 4 samples in the cabinet with the control temperature of 35°C and also stored in 4°C. On the one hand, the results without paraffin shown that stored in 35 °c, developed of formaldehyde nitrogen, amino nitrogen, and ammonia nitrogen. Therefore, this increased the ability of antioxidant with measurement of DPPH, FRAP of shrimp paste.

The brown colour increased (A420nm) corresponding with lightness (*L) that decreased and decreased of (a*) redness/greenness but increased of (b*) yellowness/blueness. This lead to the colour of shrimp paste turns redder with a

darker tone. On the other hand, the result of covered with paraffin (no-air) showed that the increase of brown colour is lower than without paraffin sample. As well as an antioxidant is lower developed, and the darker tone of colour is less developing in this sample. Especially for the samples that both stored in 4°C, there is nearly no developing in colour, chemical properties and antioxidant.

Nevertheless, they found a decrease of amino nitrogen in the without paraffin sample. Whereas, the paraffin covered sample stored in 4°C showed no result of the change in colour, chemical properties, and antioxidant. They concluded that the results show shrimp paste with stored in ambient temperature will develop nutrition fact of the food from amino acid and antioxidant, but at the same time, it may have a negative impact from a customer of the level of acceptance on colour, odour and taste.



There is research about colour versus fermentation of shrimp paste, which the period of fermentation is up to 6 months. (Thanyaporn Kleekeyai et al, 2016). They investigated for Kapi Ta Dam (black) and Kapi Ta Deang (red). Kapi Ta dum is mysid shrimps (*M.orientalis* and *indices*), mostly found in mangrove channel. Kapi Ta Deang made from planktonic shrimps (*Acetes* sp.) which found in the coastal area of

Andaman sea. Both shrimp pastes were packed and fermented in ambient temperature up to 6 months.

The colour measures are implementing by CIELAB colourimetric L*, a*and b* measurement using a hunter lab ultrascan XE colourimeter with universal software version 4.10. The sample was mixed and measured in a clear polyethene bag with 3 different locations; the average value reported. (Thanyaporn Kleeekayai et al, 2016)

Their results of colour measurement are modified from bar chart into the table as shown below

Kapi Ta Dam

Colour parameter	0 month	2months	4months	6months
L*	42	38	36	35
a*	10.5	9	7.5	7
b*	9.5	9	5	6

Kapi Ta Daeng

Colour parameter	0 month	2months	4months	6months
L*	40	40	38	36

a*	9.5	9	8.5	8
b*	4	6.5	9.5	8.5

Table 4 Kapi Ta Dum & Kapi Ta Deang colour measurement in each period of fermentation adapt from (Thanyaporn Kleekayai et al., 2016)

The Kapi Ta dam decreased in value of a* and b* might be from the degradation of carotenoids in the product. Whereas in Kapi Ta Deang, the value of b* had increased because it could be from the coincidence of the Maillard yellow-brown pigment formation and degradation of carotenoids. (Thanyaporn Kleekayai et al, 2016). The results are very similar to (Narumon Prapasuwankul; Sakutra Kumpshu, 2015) as L* and a* decreased and b* is increased for planktonic shrimp paste.

2.3 TISI-1080-2535 (TISI, 1992)

1. Scope of TISI

1.1 This product industry standard requires to satisfy characteristic, food additives, food contaminants, hygienic condition, sign and label, sampling & justify, and shrimp paste experiment

1.2 This product industry standard is only covered shrimp paste or product made from shrimp

2. Definition

2.1 Shrimp paste is defined as a product from fermented shrimp with an optimum amount of salt, dried to eliminate wet, squeeze until crushed and fermented once again in a period for shrimp paste to taste natural.

3. Characteristic properties

3.1 General Physical

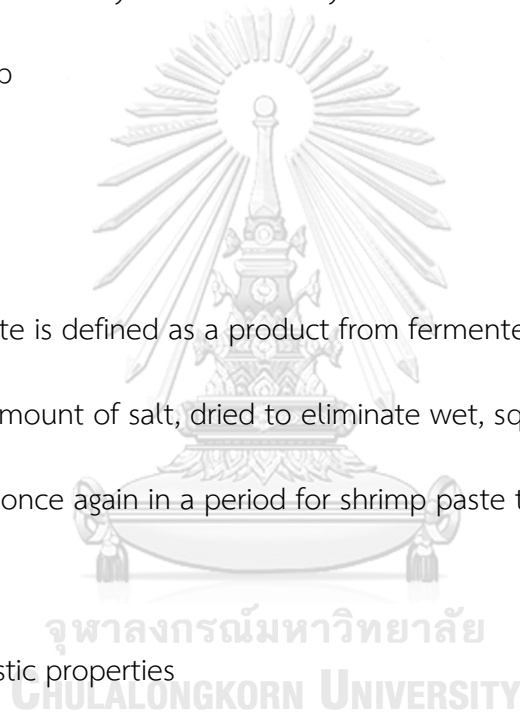
3.1.1 texture odour and taste

3.1.1.1 texture

Homogenous fine texture, adhesive, and not much dried and much wet

3.1.1.2 odour

Smell naturally as shrimp paste, No fishy smell, No ammonia smell, No musty smell



3.1.1.3 Taste

Taste of Umami, Appropriate salty, No bitter

Regarding 10.1 after the test, the point should not be less than 3 points

3.1.1.4 Colour

Observe naturally of shrimp paste, for instance, grey with pink, purple with grey, purple with red, red-brown.

The test is done by observation

3.2 Debased

Must not include degraded such as Tapioca starch or other flour

The test must follow procedure 10.2

3.3 Adulterated matter

No sand, grit, the dirt of insects, rats, birds

The test must follow procedure 10.3

3.4 Chemical properties

Must follow the table below

No.	Properties	Tolerance	Method of analysis
1.	Total nitrogen gram per kilogram of dried weight must not less than	58	AOAC (1990) no. 940.25
2.		36	AOAC (1990) no. 937.09

3.	Salt amount (NaCl) percentage of dried weight must not less than	0.5	AOAC (1990) no. 938.08 & no. 941.12(c)
4.	Ash amount (not dissolve in acid) percentage of dried weight must not exceed	6.5 to 7.8	No. 10.4
5.	pH (acid – alkali)	50	No. 10.5
6.	Nitrogen from amino acid * gram per kilogram must not less than	7	No. 10.5.2
7.	Ammonia nitrogen * gram per kilogram must not exceed	45	AOAC(1990) no. 950.46(B)
	Moisture percentage not exceed		

Noted that units compared from the weight of the sample that removed moisture and salt

Table 5 TISI 1080 2535 Chemical properties

4. Food Preservatives

4.1 Preservatives

Unacceptable of using preservatives except for sulfur dioxide that attached from raw material or occurred from natural fermentation and degradation, must not exceed 20mg per kilogram.

The analysis method must follow AOAC (1990), and analysis of sulfur dioxide must follow AOAC (1990) no.962.16

4.2 Colour

No acceptable of using any additive kinds of food colour

Follow AOAC (1990) no. 930.38 (A)

4.3 Substitution of sweet instead of sugar

No acceptable of substitution of sweet instead of sugar

Follow AOAC (1990) no. 957.09 and no. 941.10

5. Contaminants

5.1 Contaminants matter that might occur in the product must not exceed the requirement in the table below

No.	Contaminants	Tolerance Mg / kg	Method of analysis
1	Mercury	0.5	AOAC (1990) no. 971.21
2	Lead	1.0	AOAC (1990) no. 972.25
3	Cadmium	1.0	AOAC (1990) no. 973.34

Table 6 TISI 1080 2535 Contaminants matter

6. Hygienic properties

6.1 hygienic of the product must meet the standard of TISI 34

6.2 Shrimp paste must have microorganism not exceed the requirement below

6.2.1 The total microorganism must not exceed 1×10^5 colony per sample of 1 gram

AOAC (1990) no. 966.23 (C)

6.2.2 Coliform with MPN method must not less than 3 per sample of 1 gram

AOAC (1990) no. 966.24

6.2.3 Staphylococcus aureus must not found in sample 0.1 gram

AOAC (1990) no. 989.37

6.2.4 Salmonella must not found in a sample of 25 gram

AOAC (1990) no. 967.25 to 967.28

6.2.5 Clostridium perfringens must not found in a sample of 0.01 gram

AOAC (1990) no. 976.30

6.2.6 Yeast and mould must not exceed 50 colonies per sample of 1 gram

AOAC (1990) no. 940.37 (E)

7. Containment

7.1 Shrimp paste must contain in clean, dry, and corrosion resistance with a completely closed end package.

7.2 Net weight of shrimp paste in the container must not be less than the label

8. Sign and label

8.1 At each package, must at least has number, alphabet or sign that could specify the details below quickly and clearly.

(1) Name of product

(2) Ingredients

(3) Net weight in gram or kilogram

(4) Month, year of packing

(5) Name of manufacturing factory, address, a sign of commercial that registered, in case of a foreign language must have a similar meaning to the Thai language.

8.2 The manufacturing whom able to meet the standard, to display the standard mark of TISI must pass the consideration and permit from a committee of TISI.

9. Sampling and justify

9.1 Generation means shrimp paste that has similar ingredients, colour, procedure, delivery, or sells/buy in the same time interval.

9.2 Sampling and acceptable must be according to the requirement below or use another sampling method that similar academic standard and plan.

9.2.1 Sampling and acceptable for the test of general physical, debased, adulterated matter, containment, and sign & label

9.2.1.1 Sampling by randomly in the same generation according to the amount in the table shown below, the first test for a sign and label then test for a general physical, debased, degraded matter

9.2.1.2 Amount of samples that not pass no. 3.1 no. 7 and 8. Must not exceed the acceptable amount in the table shown below. Moreover, every sample must follow regulation in no. 3.2 and 3.3 so that this generation of shrimp paste passed the requirement.

Generation size	Size of sample	Acceptable
Unit of containment	Unit of containment	number

Not over 150	2	0
151 to 500	8	1
501 to 3200	13	2
3201 to 35000	20	3
Over 35000	32	5

Table 7 generation of shrimp paste

9.2.2 Sampling for analysis of chemical properties, food preservatives, contaminants

9.2.2.1 Use the samples from the previous testing, mixed samples of 1,000kg.

Input into clean and dried container and completely closed.

9.2.2.2 The sample must meet no. 3.4, no.4 and no.5, that the shrimp paste passed the TISI

9.2.3 Sampling for analysis of microorganism

9.2.3.1 Sampling randomly from the same generation with 5 unit of containment and mixed as a combined sample.

9.2.3.2 The sample must meet the requirement in 6.2 so that the shrimp paste is satisfied as TISI standard

9.3 Judging criteria

The shrimp paste samples must follow 9.2.1.2, 9.2.2.2 and 9.2.3.2, the generation of that shrimp paste passed TISI standard

10. Experiment procedure

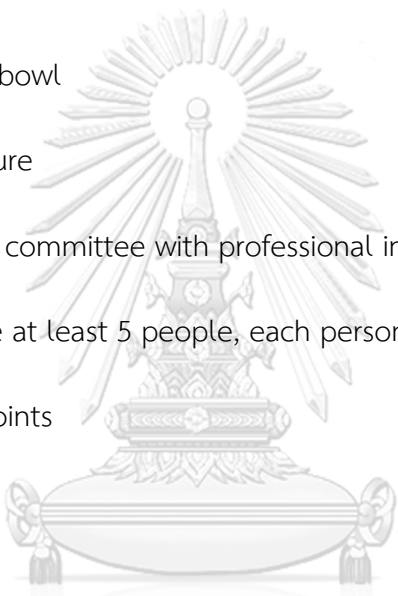
10.1 texture, odour and taste

10.1.1 Apparatus

10.1.1.1 Ceramic bowl

10.1.2 Test procedure

10.1.2.1 A testing committee with professional in texture, odour and taste of shrimp paste at least 5 people, each person separated from investigation and giving points



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10.1.2.2 Criteria for marking

Properties	Level of judging	marks
Texture	Fine texture with a high level of homogenous, adhesive and not too wet and not too dried	5
	Fine texture with the good of	4

	<p>homogenous, adhesive and not too wet and not too dried</p> <p>3</p> <p>Fine texture with homogenous, adhesive and not too wet and not too dried</p> <p>2</p> <p>Rough texture or too wet or too dried</p> <p>1</p> <p>Rough texture or too wet or too dried, can see clearly</p>	
Odour	<p>The excellent smell of shrimp paste</p> <p>5</p> <p>The good smell of shrimp paste</p> <p>4</p> <p>The smell of shrimp paste</p> <p>3</p> <p>Fishy smell and ammonia smell</p> <p>2</p> <p>Rotten smell and musty smell</p> <p>1</p>	

Taste	Umami taste	5
	Umami taste with little salty	4
	Umami taste with a lot of salt	3
	Salty taste or bitter	2
	No taste of shrimp paste	1

Table 8 Criteria for marking

10.2 Debased test

Measure shrimp paste of 1 gram, add distilled water into the sample and stir it until it is homogenous. Then drop iodine into the sample; the result must no appear of blue.

10.3 Adulterated matter

Measure shrimp paste of 20 gram, input it into Wildman trap flash 1000cm³ as shown in fig. below. Add hot water 200cm³ and add paraffin oil 20 cm³. Stir it softly, then add 500 cm³ of water and 20cm³ of paraffin oil. Then stir it again, add water until it filled the top part of the bottle. After that, wait until it splits into layers, pulls the rubber up to the top part of the bottle, and then add paraffin oil through the filter paper no.1 with an assistant of vacuum

atmosphere. Then wash the paraffin that attached on filtration paper. Identify the filtration paper by eyes or 10 times microscope.

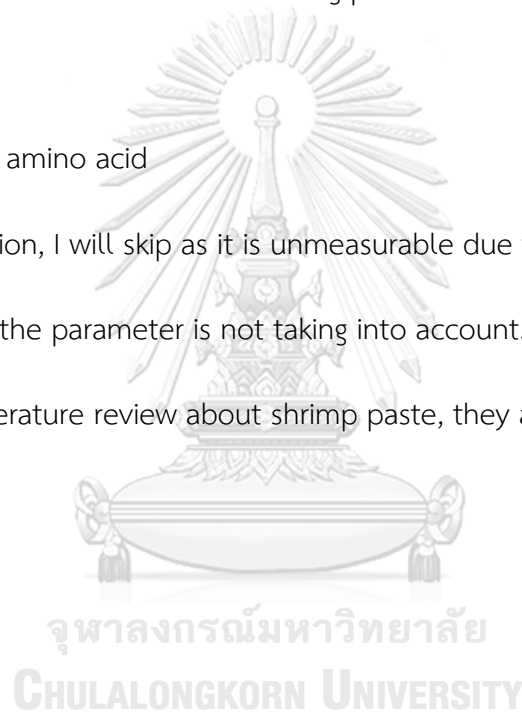
10.4 pH test

Measure shrimp paste sample of 10 gram, add distilled water 20cm³ in a 50cm³ beaker. Stir it well before using pH meter to measure.

10.5 Nitrogen in amino acid

In this portion, I will skip as it is unmeasurable due to faulty equipment.

Therefore, the parameter is not taking into account. Furthermore, based on another literature review about shrimp paste, they also did not measure this parameter.



10.6 Moisture content

10.6.1 Test procedure

Measure shrimp paste sample of 5 gram, oven it at 103 °C until the weight is constant. Put it in desiccator cabinet until it becomes at ambient temp. Then re-measure the weight again.

10.6.2 Formula

$$\text{Moisture content \%} = \frac{W - W_1}{W} \times 100$$

W

Equation 1 Percentage of Moisture content

When W is weight before oven in gram

When W1 is weight after oven in gram

2.4 Paraffin wax

Paraffin wax is a chemical compound which collected from petroleum as dewaxing light in lubricating oil stocks. Paraffin has colourless, white and transparent. It consists of a mixture of solid straight-chain hydrocarbons. Its melting point ranges from 48°C to 66°C. (Britannica, 2019). Whereas the high melting point of paraffin can refer to microcrystalline wax. Usually, it is transformed into products such as candles, paper, polishes, and others. The paraffin wax, first produced in 1867 (Britannica, 2019).



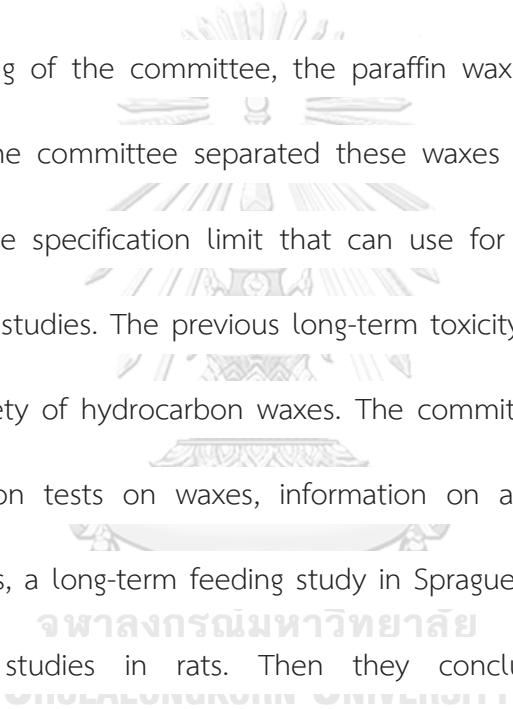
Figure 6 Example of paraffin on top of shrimp paste

However, As mentioned earlier in chapter 1, that the packaging, it included with paraffin wax on the top of shrimp paste; as a result, to preserve shrimp paste with the same odour, colour, taste, and life-shell because it is an anti-oxidation reaction as no oxygen entering the shrimp paste. Furthermore, the paraffin wax used in shrimp paste product is the low melting point. However, from the source that mentioned Joint FAO/WHO expert committee on Food Additives (JECFA) has withdrawn acceptable daily intake (ADI), research into more information. The papers are review in the next paragraph.

There is a report from the world health organisation in 1995, illustrate the committee of Joint FAO/WHO expert. The report is about the evaluation of certain food additives and contaminants. Thus, this report is covered all of the food addictive and contaminants not only specific for paraffin wax. Therefore, mineral oil and paraffin part are selected for further reviews.

The food-grade mineral oils were reviewed by the committee at 37th meeting. The meeting reconsidered of 2 experiments of 90-day feeding studies in Fisher 344 rats. The first experiment feeding with both oleum-treated and hydrogenated mineral oils. The 1st experiment shown that haematological (blood) changes, deposition of mineral oil in the liver, spleen and lymph nodes were reported. 2nd experiment shown that deposition in liver, spleen and lymph nodes were reported delicately.

There is no blood system diagnose in the second experiment. Therefore, conclude of the meeting was that the committee agreed to reconsider those effects and need further investigation and recommend that the food grade mineral oil should come from commercial use. Then the ADI was extended after the 37th meeting. (FAO/WHO, 1995)



During 39th meeting of the committee, the paraffin wax and microcrystalline wax were identified. The committee separated these waxes by their specification and concluded that the specification limit that can use for food compared to those tested in previous studies. The previous long-term toxicity studies were suitable for identifying the safety of hydrocarbon waxes. The committee reviews the results of extraction, migration tests on waxes, information on absorption, metabolism of hydrocarbon waxes, a long-term feeding study in Sprague-Dawley rats and series of 180-day feeding studies in rats. Then they concluded that paraffin and microcrystalline waxes were non-toxic and non-carcinogenic.

Nevertheless, they mentioned that 90-day study on hydrocarbon waxes was made by newer processes and by traditional methods was underway. The results will be exposed after they become available.

(FAO/WHO, 1995)

At the present meeting, The committee review the results compared the result as discussed above and the results of three other recent 90-day studies in F344 rats on a range of mineral oils and waxes. The materials tested show below:-

1. Mineral oils: N10(A), N15(H), P15(H), N70(A), N70(H), P70(H) and P100(H).
2. Paraffin waxes: low-melting-point wax (LMPW) and intermediate-melting-point wax (IMPW).
3. Microcrystalline waxes: high-melting point wax (HMPW) and high-sulfur wax (HSW).

Note: Oils may be obtained from crude oil sources of naphthenic (N) or paraffinic (P) origin and by either the conventional acid (oleum)-treatment process (A) or the hydrogenation or hydrotreatment process (H). Thus a P100(H) oil refers to paraffinic oil with a viscosity of 100 cSt produced by the hydrogenation process and a N10(A) oil to a naphthenic oil with a viscosity of 10 cSt produced by the acid-treatment process. (FAO/WHO, 1995)

The dose levels used were 0.002%, 0.02%, 0.2% or 2 % in the diet (equivalent to 2, 20, 200 or 2000mg per kg of body weight per day), except for IMPW, for which the lowest dose level was 0.02% (equivalent to 20 mg per kg of body weight per day). (FAO/WHO, 1995)

However, the discussion of the committee in Mineral oils will overlook as tried to focus more on Paraffin (LMPW) as it related to this research. On the one hand, they mentioned that neither HSW nor HPW accumulated in any tissues and produced any effects. On the other hand, the incidence of inflammatory lesions in the mitral valve of the heart was significantly increased in rat 0.2% or 2% LMPW and sometimes in rats fed other materials. The committee considered that the significance and treatment-related incidence could be clarified by re-examination of the histological data on all treated. (FAO/WHO, 1995)

In the conclusion of committee, the food-grade mineral oils and paraffin and microcrystalline waxes are complex mixtures of hydrocarbons and other material. It was evident from the results of the new 90-day studies that the absorption and subsequent toxicity of these materials are associated with their physical properties rather than crude oil source or refining method. The oils and waxes with a high NOEL contain a more significant proportion of hydrocarbon components of high relative molecular mass (high carbon number) and have higher viscosities than those with a low NEOL, which contain a higher proportion of hydrocarbon components of lower relative molecular mass (low carbon number). Mineral hydrocarbons are specified, on the whole, using ranges of physical and chemical parameters. The results of the studies considered at the present meeting were applicable not only to the particular

materials tested. Despite, other mineral hydrocarbons having physical and chemical parameters falling within the same ranges. The committee decided to withdraw, alter or allocate ADIs for mineral oils and waxes as set out in Table 1. For paraffin waxes, the previous ADI “not specified” was withdrawn because toxicological effects observed at all dose levels. (FAO/WHO, 1995)

NOELs and ADIs for mineral oils, paraffin waxes and microcrystalline waxes tested in 90-day studies in F344 rats

Substance	NOEL (mg per kg of body weight per day)	ADI (mg per kg of body weight)
LMPW	< 2	ADI withdrawn ^a
IMPW	< 2	ADI withdrawn ^a
N10(A) oil	2	0-0.01 ^b
N15(H) oil	< 2	0-0.01 ^b
P15(H) oil	2	0-0.01 ^b
N70(A) oil	2	0-0.01 ^b
N70(H) oil	2	0-0.01 ^b
P70(H) oil	200	0-1 ^c
P100(H) oil	2000	0-20
HSW	2000	0-20 ^d
HMPW	2000	0-20 ^d

^a Previous ADI “not specified”.

^b Temporary group ADI.

^c Temporary ADI.

^d Group ADI.

Table 9 NOEL and ADIs for mineral oils, paraffin waxes and microcrystalline waxes

tested in 90-day studies in F344 rats (FAO/WHO, 1995)

2.5 Tools and Techniques

2.5.1 Quality function deployment

Quality function deployment (QFD) is a tool that approaches to convert customer needs and requirements into plan and procedure to satisfy product or service that meet those needs and requirements. QFD was introduced by Yoji Akao in 1966. (Suziyanti M. et. al., 2013). QFD, user needs, and requirements are directly related to the “voice of the customer”. Voice of the customer (VOC) is a term to describe stated and unstated customer needs and requirements. The VOC can capture in various ways such as direct discussion or interviews, survey, focus groups, customer specification, observation. The customer needs customized into product planning matrix or “house of quality”. The matrix rated from low to high level correlated with what’s and how’s of product/service requirements or characteristics to meet the needs. VOC has to keep in mind that it is diverse, which mean no monolithic; there are varieties of needs. (crow, 2002) Moreover, the customer referred to the distributor, wholesaler, retailer, and consumer as a consequence to take this into account so that QFD is work effectively.

The requirement can categorise into 3 producing requirement, which is primary, secondary and tertiary. These 3 would form an affinity diagram, for example, a case

study of seat plane. The primary is passenger feel comfortable. The secondary may consist of comfortable upright and comfortable reclined. Whereas, tertiary is a breakdown from both, as for comfortable right, referred to armrest folds right away, wide enough, enough leg room. The tertiary for comfortable reclined might be doing not hit the person behind when reclining the seat, the back can be adjusted to any position and does not slip. However, customer requirement, there are graph illustrate customer satisfaction and degree of achievement, as shown below. (Roberts, 2006)

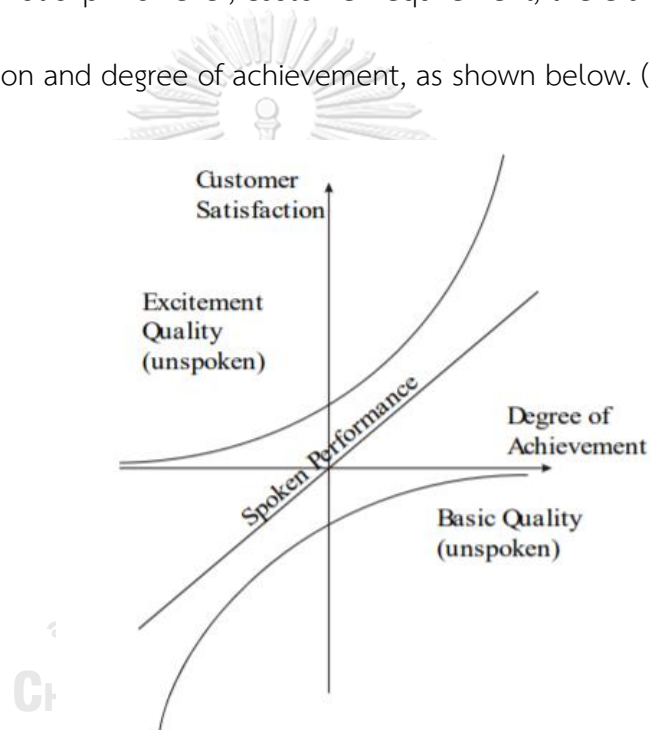


Figure 7 The Kano model of quality (Roberts, 2006)

The Kano model illustrates the essential quality and excitement quality, which they are unspoken quality, as the spoken quality is in the middle. The spoken quality is the quality in each product must already meet the requirement, but the unspoken quality is like a hidden quality that surprise or beyond the expectation of customer

to receive a higher degree of customer satisfaction and achievement. In order to capture out the unspoken requirement is an ideal circumstance.

The QFD matrix or else called “ House of quality”, the first part is central QFD matrix which consists of what’s and how’s. “what’s” is the requirement of customer that is both internal and external factors. “how’s” is the product or process parameter that customer requirements.

The diagram shows below.

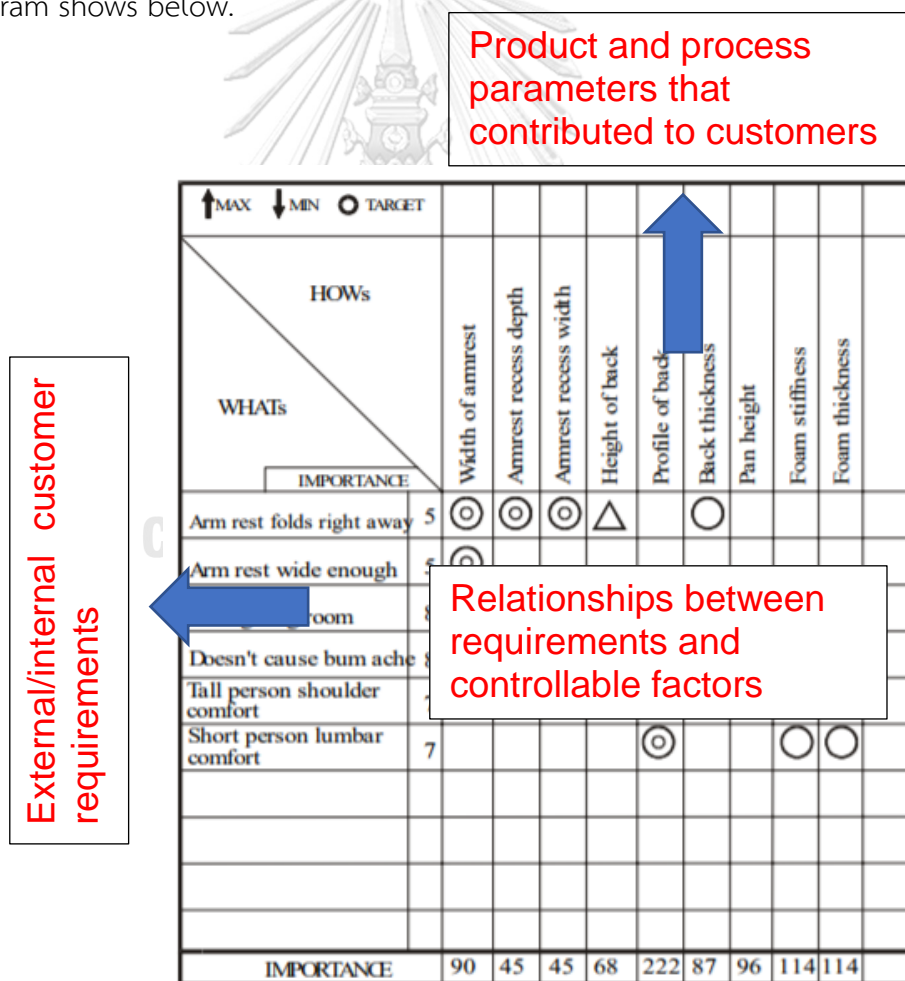
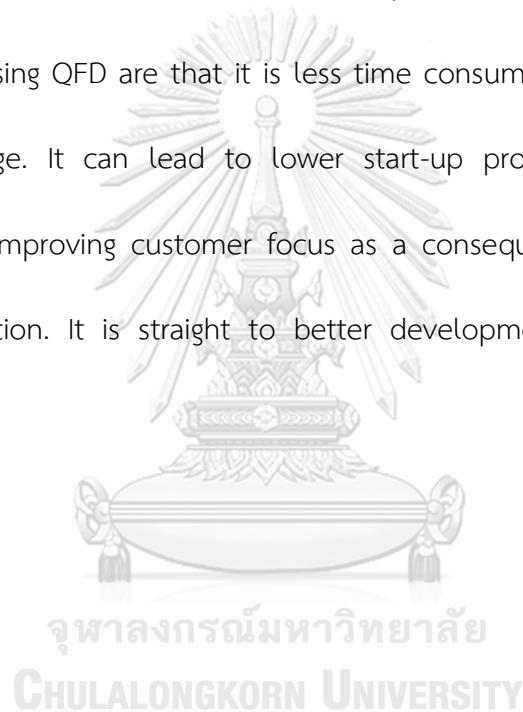


Figure 8 The central of QFD Matrix adapted (Roberts, 2006)

After conducted central of the matrix, the rest of the parts are QFD roof, to scores correlated of product and process parameters. The customer rating, to visualise score of our company with a competitor company scored from customer requirements. The target for product and process parameters. There is competitive assessment, to know what to do in order to fill the gap or maintain the lead — also technical and regulatory requirements. The full model of the QFD chart is shown below.

The benefits of using QFD are that it is less time consuming to develop. It is fewer and earlier change. It can lead to lower start-up problem, especially in cost. Admittedly, it is improving customer focus as a consequence, and it is increasing customer satisfaction. It is straight to better development of product & service design.



Relationships between product & process parameter

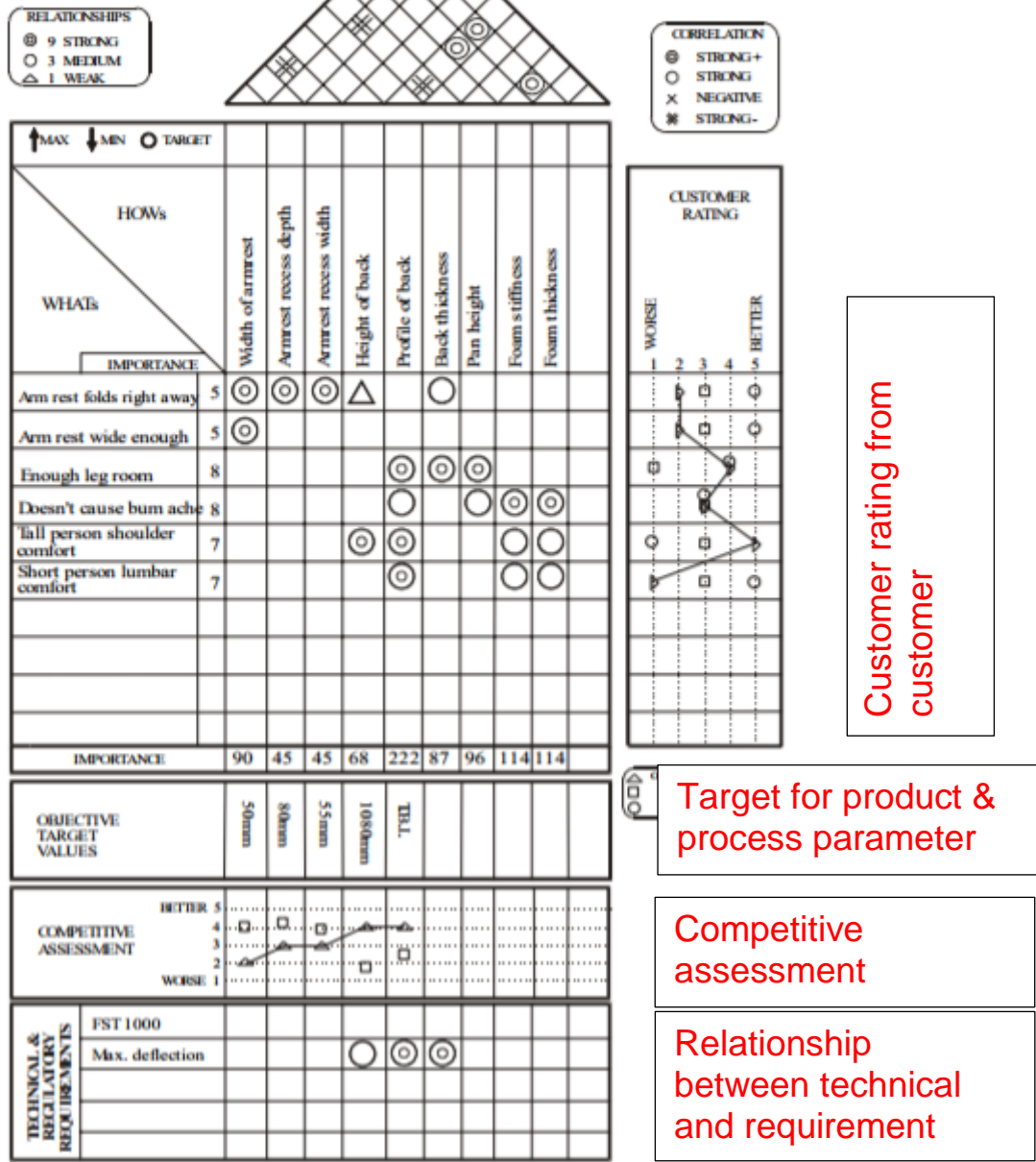


Figure 9 The QFD chart adapted (Roberts, 2006)

2.5.2 Failure Mode and Effects Analysis

The FMEA was used in early 1940 by the U.S. military, and it is the analysis method of procedures that would possibly cause failure and effect in those procedures. The failure mode means how it might fail, errors, defects, mainly effected to the customer inessential way.

The effects analysis is the consequence follow from the failure. The failure mode and effects analysis are tools that identify the actions in the risk of failures which used in continuous improvement. FMEA is used in the design and production stage as it can develop the current products or services. (Tague, 2005).

The procedure to implement FMEA is described as detail below adapted from (Tague, 2005)

1. Recruit team with cross-functional with diverse knowledge of processes, product or service, and customer needs such as designer, manufacturer, inspector, maintenance, purchasing, supplier, sale & marketing, and customer service.
2. Identify the scope of FMEA, where is the limit of the boundaries
3. Help to fill-in the FMEA form, first of all, raise the activity/task and related function of the activity and task
4. Identify the potential failures of this activity that possibly occur

5. Identify the potential effects of each failure
6. Identify the potential cause/mechanism of failure
7. What is the current design control of that activity
8. Determine the scores for severity, probability, and detectability (1-10)
9. The severity is how much this failure will impact the company
10. The probability is how possible that this failure would happen
11. The Detectability is how easy to detect the failure by using current control
12. When all of the 3 scores are known, then the RPN score is computed by multiple.
13. The score could be judge by rule of three, by scoring 3, 6 and 9 so that the score can obviously virtualise.
14. RPN score, the failures can be prioritised in which task to be taken countermeasure first.
15. The action and target are set
16. After initiating the countermeasure then rescoring those 3 indicators again.

The below table is shown FMEA blank form

Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	S e v	Potential Cause(s)/ Mechanism(s) of Failure	P r o b	Current Design Controls	D e t	R P N	Recommend e d Action(s)	Responsibilit y & Target Completion Date	Action Results				
											Actions Taken	New Sev	New Occ	New Det	New RPN

Table 10 FMEA blank form

2.5.3 Quantitative research

The quantitative research is described as systematic investigation of phenomena by gathering quantifiable data and performing statistical, mathematical or computational techniques. The gathering information techniques from the essential source of data such as potential customer can do through sampling methods, online surveys, online polls, and questionnaires. The results are in numerical format. After analysis of the result, then the development of product and service is initiated. (Bhat, 2019)

There are 2 methods to conduct the quantitative research which are (Bhat, 2019)

1) Primary quantitative research methods

It is most widely used for market research. The feature of this is that the researcher focused on collecting data directly, not depending on the data collected in previous research. The primary research can be categorized into

3 steps

A) Techniques and type of studies (step1)

A1. The survey research

The survey is used commonly for all quantitative research methods and studies. The survey used to ask questions to a sample of respondents, using many types such as online polls, online surveys, paper questionnaires, etc. Multiple survey questions can ask. It can be conducted for a specific target for audience group and across multiple

groups with comparative analysis. The importance of this type is that the sample of respondents must be randomly selected.

- Cross-sectional surveys

It is observational surveys, conducted in a situation where the researcher intends to collect data from a sample of the target population at a given point in time. The survey data is gaining from the people who are doing similarity in all variables but except for the variables which are considered to collect in the research. That one of the variables will stay constant. The limitation of this survey is the cause and effect relationship of a variable cannot be known because it collects only on period not continuous period.

- Longitudinal surveys

It is also the observational surveys, but it is conducting in the various timeline, in order to observe the change of respondent behaviour. it can be to survey various variables in various period frame.

A2 Correlational research

The comparison between 2 entities is invariable. It is comparison research conducted to identify the relationship between 2 entities, how one impact the other one. The data can collect by observation.

The researcher tends to manipulate one of the variables to have a dynamic in order to receive the desired result of variables, in term of relationship, impact, cause, and effect.

A3 Causal-comparative research

The research method is also called “quasi-experiment research”, it is depended on the factor of comparison of the research. Use for the researcher to conclude about the relationship of cause-effect of 2 or more variables. Where the one variable is dependent and another independent variable. The data can collect upon the observation. The statistical analysis is used to identify the outcome of the research.

A4 Experimental research

The experiment research relies on a theory or more theories. This research used in natural sciences. After stating the statement, efforts to understand the validity or invalidity and to be the judge whether the theories, statements are right or wrong.

B) Data collection methodologies (step2)

The second step of primary quantitative research is to collect data. The sampling method can divide into probability sampling and non-probability sampling.

B1 The probability sampling

It is used to filter individuals from the population and create samples in probability sampling. Participants of the sample are randomly selected.

- Simple random sampling – random selection of elements for a sample
- Stratified random sampling – a large population is divided into the group, member of the sample are chosen randomly from the group
- Cluster sampling – Divide into the cluster using geographic parameters
- Systematic sampling – the Starting point is a random sample, and all the other element chose from a fixed interval

B2 The non-probability sampling

It is where the researcher's knowledge and experience are used to create samples.

- Convenience sampling- Sample are chosen only due to one prime reason

- Consecutive sampling- similar to convenience sample but except for researcher will choose a single element or group of the element to conduct research consecutive in a time
- Quota sampling – select elements base of researcher knowledge to form a personalities group
- Snowball sampling – conducted with the target audience, which is difficult to contact and gain information.
- Judgemental sampling – the sample is created only based on the researcher’s experience and skill.

The data collection after sampling, the fundamental level of measurement is identified, such as multiple-choice question in survey which they have to be nominal, ordinal, interval and ratio measurement scales. The question has to be different types such as closed-end questions, multiple choice with the differential scale of question and rating scale question.

The survey distribution can be distributed through email, buy respondents, embed survey website, social distribution, QR code, SMS survey, etc.

C) Data Analysis Techniques (step3)

C1 After collecting the data, it can be used for analysis by using analysis tools such as SWOT analysis, or any other tools that related to the data such as QFD.

2) Secondary quantitative research methods

The secondary quantitative research is the data from the existing source or secondary data. The data can be found, such as data from the book, statistic from the internet, government, educational institute, and commercial information sources.

2.5.4 Qualitative research

The qualitative research is referring to quality data which can be generating as a small scale of research (less than 50 respondents) compared to quantitative research. It is a non-directive question and open-ended question. It is exponentially interactive; the question and probes can be a million ways depending on the answer. Non-statistic as no percentages or count. Interpretative as it is always using why question. It is Ethnographic is that observation is a part of proper qualitative research.

There is a guideline of qualitative for packaging design which available on the internet that would review. (Thomas, 2016) The technique of the qualitative is intensely expressing in this journal. The focused group is the most important for the qualitative technique, usually less than ten for the research, but it not recommended as they might be biased. Such as one of the respondents in the focus group blurt out some fact or opinion about the brand or package design, others might be awareness, knowledge, the perception will be changed. For packaging research, the author recommends for depth interviews and ethnography because both methods avoid most of the bias. The depth interview provides excellent detail up to 10 times as much information from a single respondent from the focus group. During the depth interview, it evident that the respondent is unable to hide the fact of their response. These called the face to face interview, which bases one by one, the respondent can be observed through their behaviour (voice, tone, and inflexion) while answering the question. The Tricky sampling, the question needed to be prepared with questions to accomplish tasks.

The store visit is another way that the researcher could do the data collecting by observation. Such as look at the shelf and define what the characteristic of the retail displays is, how long the shopper takes to examine the display and make a choice. What did the customer pick?

The interview

The author persuaded to ask the beginning question with background and hobby of the respondent in order to make the respondent more relax. Then the next set of question that should be asking is like, how often have you consume this product? Then the researcher should ask about a specific brand that they consumed. The next type of question is to ask about new shopping in the previous packaging related to the product categories because the researcher can note about the colours, patterns, designs, images that the respondent has been shopping in order to cross-check the observational of the respondent. The new packaging design would be handle (prototype) along with the competitor's product; the question would be about which package design is most eye-catching, which one the best job for protecting the product. The researcher could follow with the question and probes, striving to understand the package design elements that drive consumers' preferences and perception, so that the prescription for design improvement could be revealed from the customer. (Thomas, 2016)

2.5.4 Statistical Process control (SPC)

Statistical process control techniques are used to measure data in the process. The highlighted value would be benefit from more of identification. This method, the user will be able to identify the variation within the process, then understand that variation and initiate to improve process quality. The SPC, take the sample to randomly sampling the variation that occurs in the process and compute the means, means upper limit and means lower limit. The range calculates the range upper limit and range lower limit. Then the graph is plotted. Therefore, the variation is learned and easily visualise. The improvement of quality should improve the SPC graph. Where all the formulas are shown in the figures below.

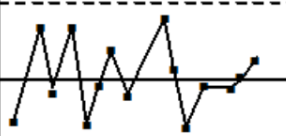
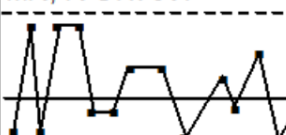
CONTROL		CHART TYPE			
CENTRAL TENDENCY: \bar{X}, \bar{X} CHART  $UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \bar{R}$ $\bar{\bar{X}} = \frac{\sum \bar{X}}{k}$ $LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \bar{R}$		# OF OBSER. (n)	\bar{X}	R	$\sigma = \frac{\bar{R}}{d_2}$
VARIATION: MR, R CHART  $UCL_R = D_4 \bar{R}$ $\bar{R} = \frac{\sum R}{k}$			A_2	D_4	d_2
		\bar{MR}	$\frac{2.66}{1.880}$	$\frac{3.268}{3.268}$	$\frac{1.128}{1.128}$
		n = 2	1.880	3.268	1.128
		n = 3	1.023	2.574	1.693
		n = 4	0.729	2.282	2.059
		n = 5	0.577	2.114	2.326
		ANY SAMPLE SIZE	$\sigma_A = \frac{\sigma_1}{\text{SQR}n}$	A: AVERAGES I: INDIVIDUALS SQR: SQUARE ROOT	
SPECIAL CAUSES EXIST WHEN: <ul style="list-style-type: none"> • RUN - 7 PTS ONE SIDE OF THE CTR LINE • TREND - 6 SUCCESSIV E INC OR DEC PTS • CYCLES • PATTERNS • STRATIFICATION • HUGGING • MEAN SHIFTS >1σ • POINT OUTSIDE CONTROL LIMITS • TWO POINTS IN A ROW NEAR LIMITS 					

Figure 10 SPC formulas (qualityone, 2019)

2.6 Packaging

Regarding 2.4, paraffin wax used, which is unacceptable by Europe and Thailand's Food and Drug Administration. Therefore, this research aims to improve the package without using paraffin. The studies of the packaging of shrimp paste are, to begin with, the shape and material of the package. The existing package is rounded can shape with polypropylene material. There are two sizes available, 135grams and 580grams. However, in this studies only used the small size for development as a prototype and launch a survey to get customer feedback.

Firstly, the aims of the packaging are for storage, food preservation and protect the product in optimal time and cost. In order, to ensure the quality and safety of the product for customer satisfaction. Secondary, the other functions are to attract marketing with effectively distributed. Thirdly, the packaging must be suitable for consumption, such as the convenience of using, handling, etc. The company is not achieved in first and second points because, in shrimp paste product, paraffin's task is used to delay microorganism developing in order to preserve physical properties of shrimp paste itself; as a result to satisfy the customer but due to the matter of the fact that paraffin is not safe for usage. The second point is unachieved because the packages itself and label were not standardised which cannot build trust to customers.

2.6.1. The development of packaging consideration on 2 parts

(Food Solution Network, 2011)

- 1) Packaging structure, design with technical data and physical properties of packaging which focused on packing, preserving, shelf life and appropriate for distribution and transportation.
- 2) Graphic, the design of packaging will inspire the customer to buy and communicate to the customer. It can persuade purchasing power from the customer by graphic focusing and decoration which build impression to the customer

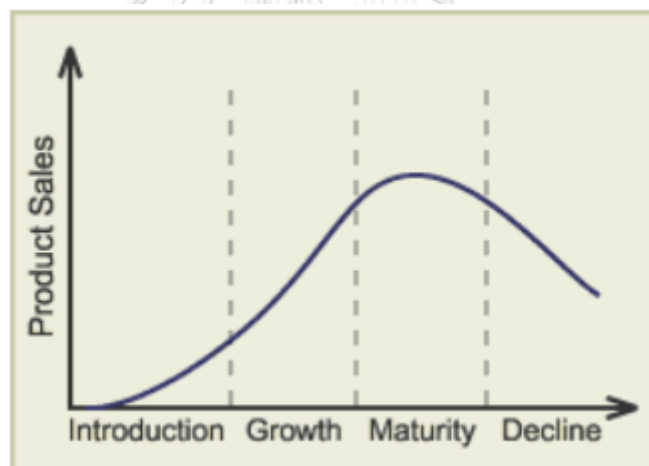


Figure 11 Product life cycle (quickMBA.com)

The introduction stage is to seek for market and introduce into market, growth stage is product rapidly increase in sale, maturity stage is when product is saturated and competitiveness with the initiate of decrease in the sale. Lastly, the decline is where the product is discontinuing to sale.

2.6.2. *The factor that packaging should be improving correlated to the product life cycle.*

(Food Solution Network, 2011)

1) External factor

The external competition, where the product must develop in order to compete with competitors, especially when nearly reach decline stage, improvement of packaging is aimed for extension of maturity period even though the profit has reached its maximum.

Shifting channel of distribution, for instance, sell in hypermarket must consider to change to appropriate packaging such as grouping product for transportation, change type of transportation, and deliver to the distribution centre of a business partner.

Another external factor is according to law; for example, the law forced to the labelling nutrition label. Therefore, the packaging needs to develop labelling.

2) Internal factor

In the industry, there usually at the point where the product is faced decline period. Thus, everyone tried to survive by redesign, develop a new product into the market. In the redesign of the new product must consider its life cycle and must design packaging for the product in advance.

3) Technology

Technology disruptive is always a factor to consider in packaging development such as bar-code, non-contact printing, aseptic packing, so the packaging needs to adapt align with the technology

The development of packaging should result in both short-term and long-term as short term is attracted rapidly higher profit, which in the long term is still able to maintain the sale.

2.6.3. The factors that need to consider before developing packaging

(Food Solution Network, 2011)

1) What is the product?

The information of the product must be sufficient in term of its chemical, physical, shape, size, volume, proximate, ingredient, nutrition fact, the process of manufacturing, quality inspection, the guideline of consumption, the product will be spoilage under which condition, appropriate graphics and most important is building a unique selling point.

2) Beneficial and needs of the consumer

The target of the customer must set according to marketing analysis, which the product needs to meet with the customer such as know how much of

customer intake per time, seasonal product, merchandising product.

Therefore, all of this should lead to product compatibility with the customer.

3) Type of Packaging

Properties of packaging considered according to

3.1 Consideration upon its tasks such as protection, quality preserve, convenient

of usage, cost saving in transport, design graphic must with label and component of a label which divided into

- Primary packaging, consideration of compatibility between product and package, primarily attract customer
- Secondary packing, the necessity of grouping packages for put it on the shelf to attract customer
- Distribution packing, ability to protect the product, a label from transportation



Figure 12 Commercial packaging (Food Solution Network, 2011)

3.2 Consideration of the physical properties of packaging, the physical properties of packaging divided into 3 types. Which are Rigid packing, semi-rigid packing, and flexibility packing?

- Rigid packaging, glass, can, bottle and plastic. This type of packaging is the most used because it is high durability, high shape stability, convenient to use on the conveyor, appropriate to use with liquid packing machine for vacuum process with high pressure.
- Semi-rigid packaging, plastic forming with hot blow air, this type of packaging is limited to force resistance both compression and tension.
- Flexible packaging, plastic bag, and paper, this form of packaging could not keep its shape or remain dimensioning.

2.6.4. Plastic packaging types

Plastic is a type of material that normally used globally for storage and packaging. These included daily product intakes such as a bottle of water and containment beverage. There are SPI (society of the plastic industry) code available for each type of plastic. There are 7 codes of SPI. (Mertes, 2010)

1. Polyethylene Terephthalate (PETE or PET), recyclable
2. High-Density Polyethylene (HDPE), recyclable
3. Polyvinyl Chloride (PVC), recyclable but call your recycler
4. Low-Density Polyethylene (LDPE), recyclable but call your recycler

5. Polypropylene (PP), unrecyclable
6. Polystyrene or styrofoam (PS), unrecyclable
7. Miscellaneous plastics (polycarbonate, polylactide, acrylic, acrylonitrile butadiene, styrene, fibreglass, and nylon), unrecyclable

Each type of plastic has different properties. They used in different condition based on their properties. (99precycling, 2018)

1. PET sometimes absorbs orders and flavours from the food and drinks. It commonly used for beverage bottles, medicine jars, rope, clothing and carpet fibre.
2. HDPE is very safe, high chemical resistance, generally used for store milk, motor oil, shampoos, and conditioners soap bottles, detergents and bleaches. It is not safe to reuse as food and drink container.
3. PVC used for all kinds of pipes and tiles; its properties should not contact with food.
4. LDPE usually used for plastic bag, film and squeezable bottle, deficient strength
5. PP has a strong structure and high melting point, used for lunch boxes, margarine containers, yoghurt port, and syrup bottle. The plastic cap typically made from PP, this type of plastic able to oven in the microwave.

6. PS used for disposable coffee cups, plastic food boxes, plastic cutlery, and packing foam made from PS. It is usually used for one time and throw away.

The table below shows the properties of each plastic








Plastic Types	General Propeties	Common Uses
 PETE Polyethylene Terephthalate	High heat resistance High melting point of 245°C Clarity & Toughness Solvent resistant	Mineral water bottles, soft drink bottles High heat resistance food trays and roasting bags Medicine jars Fibers for clothing
 HDPE High Density Polyethylene	Excellent moisture and chemicals resistance Rigid and strong Soft waxy surface Permeable to gas	Milk and non-carbonated drinks bottles Construction pipe, furniture Food Packaging Shampoo and mouthwash bottles Household fences, plant pots
 PVC Polyvinyl Chloride	Excellent transparency Hard and rigid Good resistance to chemicals, grease and oil Sinks in water	Window and door frames Medical products Pipes and fittings, wire and cable sheathing, guttering Synthetic leather products
 LDPE Low Density Polyethylene	Ease of processing Strong and tough Flexibility Floats in water Low melting point	Packaging films, bubble wrap Shopping bags Frozen food bags Wire and cable applications Highly-resistant sacks
 PP Polypropylene	Excellent resistance to heat, chemicals, grease and oi Strong and tough, Versatility Floats in water High melting point	Bottle tops, biscuit wrappers Ketchup and syrup bottles Refrigerated containers Plant pots, drinking straws Hinged lunch boxes
 PS Polystyrene	Versatility and clarity Insulation Easily formed Glassy surface Sinks in water	Egg boxes, food boxes Fast food trays Disposable cups Video cases, packaging foam Coat hangers, CD cases
 OTHER	There are other polymers that have a wide range of uses, particularly in engineering sectors. Normally sinks in water.	PA: Nylon, used for fiber textiles ABS: Acrylonitrile butadiene styrene PC: Polycarbonate, used for cups, bottles

Table 11 Table (99recycling, 2018)

2.6.5. Opening Lid

The opening lid that available and possibly to improve with shrimp paste is E.O.E type and safety lock type. Which both of this possible because it needs to protect the air outside to enter into the product. The E.O.E type is easy to open end, where it developed in the late '70s for convenience of opening and food perseverance. The E.O.E. is functionally for convenient of open. It has developed for steel and aluminium for process food, non-processed food, fruit juices application, and non-food product. The ends accommodate metal, plastic and composite containers whose diameter is ranging from 52-54mm to 99mm. (Crownlmballaggiitalia, 2019).



Figure 13 The example of E.O.E (Crownlmballaggiitalia, 2019).

Two suppliers in Thailand found for E.O.E. with plastic can, which are Gikit and Laz-step. There are various sizes of PET containers to choose from both suppliers. Eventually, Laz-step, they did provide the material of lid that will prevent corrosion occurring. They have only the lid that made of steel and aluminium. On the other hand, Gikit, they provide aluminium lid with PP covered under the lid for food

perseverance which it manages to prevent from salt corrosion. The E.O.E require particular machine in order to seal the container with the lid.

Moreover, the safety lock plastic container used globally. It ensures that the product is locked 100% with no liquid or product inside spill to outside. The lock will ensure the customer that it would not be open before receiving within the customer's hand.

The lid also not pop-out even the container is squeezed. Therefore. Only one supplier found, who provides safe lock plastic because even though order from another supplier, they just provided the product from Reangwa.

Reangwa provided many types of plastic product container.



Figure 14 The safety seal plastic bottle from, <http://www.reangwa.co.th>

Chapter 3 A Justification of the Research Methods Used

3.1. Chemical, hygienic and proximate properties experiment research

The samples of Goby fish brand shrimp paste collected into polypropylene of 1000 grams for 3 samples, which equal to 3,000 kilograms. The samples sent to Food research and testing laboratory (FRTL), Faculty of Science, Chulalongkorn University.

The laboratory certified for ISO/IEC 17025.

The samples sent on 29th March 2019, the examination of samples started on 1st April 2019

The results completed announced on 8th May 2019. However, the results will discuss in chapter 4. However, the method of identifying each parameter is not discussed in details because it was not a professional field of industrial engineering. However, the name of each method will be shown below for each parameter identified.

3.1.1. Lists of testing with methods (chemical)

Lists of testing	Methods
Ash does not dissolve in acid (per dried weight)	AOAC (2016), 941.12 (B)
NaCl (per dried weight)	AOAC (2016), 937.09
pH	TISI 1080-2535
Benzoic acid	T 029 based on Bull. Dept. Med. No.4,

Sorbic acid	Vol.40, 1998, p.467-469
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Table 12 Lists of testing with methods (chemical)

3.1.2. Lists of testing with methods (hygienic)

Lists of testing	Methods
Total Plate Count	FDA BAM, online, 2001 (Chapter 3)
Coliforms	FDA BAM, online, 2017 (Chapter 4)
S. aureus	ISO 6888-3 : 2003
C. perfringens	FDA BAM, online, 2001 (Chapter 16)
Salmonella spp.	ISO 6579 : 2002 / Corl : 2004
Yeast & Mold	FDA BAM, online, 2001 (Chapter 18)

Table 13 Lists of testing with methods (hygienic)

3.1.3. Lists of testing with methods (proximate)

Lists of testing	Methods
Calories	Method of Analysis for Nutrition Labeling, Virginia : AOAC International ; 1993, p. 106
Total fat	AOAC (2016) 922.06
Protein	T 058 based on AOAC (2016) 981.10
Total carbohydrate	Method of Analysis for Nutrition Labeling,

	Virginia : AOAC International ; 1993, p. 8
Sugars	T 082 based on AOAC (2016) 982.14
Sodium	AOAC (2016) 984.27
Ash	AOAC (2016) 938.08

Table 14 Lists of testing with methods (proximate)

3.1.4. Physical analysis

Lists of testing	Methods
Water Activity	AOAC (2016), 978.18
Moisture content	AOAC (2016) 938.08
Synthetic food colour	TIS 696-1987 by HLPC
Cadmium	AOAC (2016), 999.10
Lead	AOAC (2016), 986.15
Mercury	AOAC (2016), 974.14

Table 15 Physical analysis

3.1.4.1 Color measurement

Furthermore, the appearance of the colour of shrimp paste will be determined by colourimeter which measures by myself to discover the colour by using colourimeter of CHN spec CS-10 to measure the change of L*, a*, b* based on CIE lab parameter, in period of fermentation (2 months) in 3 different packages. The samples will prepare with 3 kinds of bottles. 1. Existing bottle (polypropylene) with paraffin 2.

Safety lock (polypropylene) 3. Easy end open bottle (polyethene terephthalate).

Regarding this analysis, be able to know the possibility of able to store the shrimp paste in the new packages or not.

CIELAB, the value of $L^*a^*b^*$ is initiated by Richard Hunter, where L^* is lightness, a^* is red/green value and b^* is blue/yellow value. The a^* is shown in x-axis and b^* in y-axis as shown below in the figure

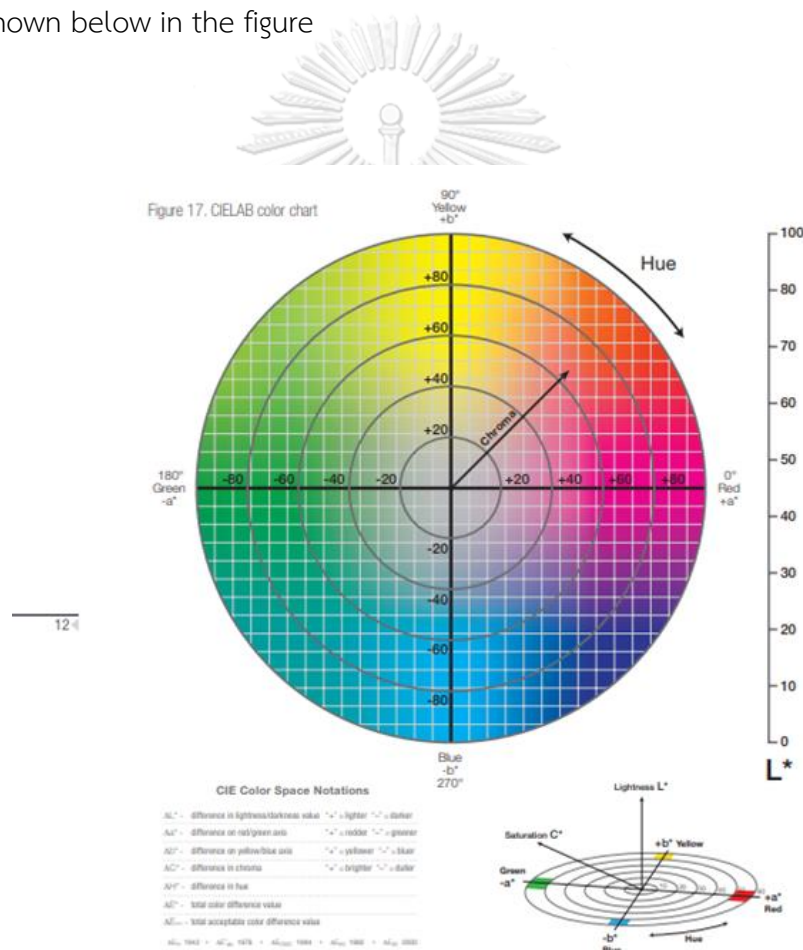


Figure 18. The L^* value is represented on the center axis. The a^* and b^* axes

Figure 15 CIELAB colour chart (Mouw, 2018)

3.1.4.2 Net weight measurement

The SPC used in net weight measurement in order to see improvement of before and after of packing shrimp paste into the new packaging. The new packaging is once measuring the weight (W_p) and after packing the weight will be measured again, which is the gross weight (W_g). Whereas the subtraction of gross weight to the W_p (net of packaging weight), it will result in the net weight of shrimp paste (W_n). The assumption of 10 samples of packing. Then we identify the mean, whereas the new 10 samples of packing should result better with using the controllable equipment.

$$W_n \text{ (net weight of shrimp paste)} = W_g \text{ (gross weight)} - W_p \text{ (packaging weight)}$$

Equation 2 Net weight

3.2. Research methods

3.2.1 FMEA

The FMEA was prior launched based on researcher and owner of Shrimp Paste Company past experienced. The brainstorming established in order to gain items and functions in each process of delivering product from company to distributor and until the customer consumed the product. It categorized into five items which deliver the product to distributors, the customer buys product on the shelf, handling the product, unpack product for usage, and store product to consuming again. The delivery of the product to the distributor was able to control by the capability of the truck. Therefore, it is controllable. Moreover, the shrimp paste mechanism of volatile,

over fermented is inspected three times by supplier, deliver to the factory by the worker, and before packing by the worker. Therefore, it is sufficient to design control.

The customer selected competitor product has one failure mode of customer unselected the product from the shelf, these might occurs because the label is not attractive label and packaging, insufficient data on the label, not meet their requirements such as volume, price, shape, size, colour, odour, etc. The failure of handling the product is related to the durability of the product and shape. The failure in an opening is the comfort of opening for usage. Furthermore, the authentic taste, colour, texture, the odour will be known after the customer already open the package. The product shelf life failure depends upon pass experience of the user.

However, the survey is launch in question no. 5, where the sampling of participants is randomly select, they do not need to be existing customer or competitor customer.

Which they able to rating each factor from 5 to 1, where 5 is the highest and 1 is the lowest. See more detail of question in Appendix A.

System		Design packaging		Potential				FMEA Number		Project I				
Subsystem				Failure Mode and Effects Analysis				Prepared By		Pongsakorn S.				
Component				(Design FMEA)				FMEA Date		10/05/2019				
Design Lead		shrimp paste packaging		Key Date				Revision Date						
Core Team								Page		1 of 6				
Item / Function	Potential Failure Mode(s)	Potential Effect(s) of Failure	S e v	Potential Cause(s)/ Mechanism(s) of Failure	P r o b	Current Design Controls	D e t	R P N	Recommended Action(s)	Responsibility & Target Completion Date	Action Results			
											Actions Taken	New Sev	New Occ	New Det
- Deliver product to distributor	- Product damage	- Packaging broke (rejected)	9	Exceed capacity	3	Not overload capacity	3	81	Maintain					
		- shrimp paste mechanism failure (volatile, over fermented), rejected	9	-fail of inspection	3	3times inspected (supplier/deliver/worker)	3	81	Maintain					
- Customer buy product from shelf	- Customer select competitor's product	- (unattractive labeling, packaging) Loss of opportunity to offers product to customer	3	Requirement overlooked	9	Based on pass experience	6	162	-launch survey to know user requirement					
		- (Not meet requirement price, shape, size, color, volume of packaging) Loss of opportunity to offers product to customer	3	Requirement overlooked	9	Based on pass experience	6	162	-launch survey to know user requirement					
		- (No standard F/D, TISI, Haram) Loss of opportunity to offers product to customer	3	Priffin used unable to pass qualification	9	unknown data	9	243	-launch survey to know user requirement					
- Handling the product	- Drop the packaging / broke	- Packaging is slippery or not hand catchy	3	- packaging not handily	3	unknown data	9	81	-launch survey to know user requirement					
- Unpacking product for usage	Unable/difficulty in opening	-The cap was hard to open	3	Cap design failure	3	unknown data	9	81	-launch survey to know user requirement					
		- Paraffin was hard or unknow way to open	3	design failure	6	Based on pass experience	6	108	-launch survey to know user requirement					
	- bad physical properties (bad odor, texture, taste)	-Customer disastisfy with its properties -bad reputation	9	Product failure	3	3times inspected (supplier/deliver/worker)	3	81	-launch survey to know user requirement					
- Product storage for reconsume	Product failure before limited shelf-life	- Unconsumable product - Bad reputation - customer disastisfy	9	- Product/packaging failure - Store in unsuggest place	3	unknown data	9	243	-launch survey to know user requirement					

Table 16 FMEA shrimp paste analysis

The first two questions are set to determine gender and age to observe the customer range. The third question is to assess company existing customer and

competitor customer. The fourth question is set for buying the product such as buy for food ingredients, noodle, and open for specify purpose answer. The fifth question is to determine the voice of the customer through factors that correlated to product selecting by measurement of rating. The elements are standards of Thai food (food and medical administration, TISI, Muslim), characteristic of shrimp paste product and packaging. The sixth question is to measure customer rating regarding company product or competitor product. Question no.7 -10 is to measure the consumption rate as a result to determine the appropriate size of packaging.

3.2.2 Quantitative method

The quantitative method is selected to survey questionnaires. It is a cross-sectional survey as it is limited to time constraint. The research initiated from 15 May 2019 until 30 May 2019. The survey divided into an internet-based and paper-based. The internet-based is questionnaires input into survey monkey. Whereas the respondents are raised by promoted through social media such as Facebook Goby fish fan page and personal line application (randomly). The questions sample based on the FMEA analysis of product selecting. The questions listed in Appendix B. There are ten questions which are:-

1. Gender?
2. Age?
3. Have you regularly bought Thai brand shrimp paste as choices provided below?
4. What are your purposes of buying shrimp paste?
5. In what scale to measures of product selecting?
6. Regarding what have you chose in no.1, please identify each value of the shrimp paste you chose?
7. Usually how often did you consume shrimp paste?
8. Usually how much you use shrimp paste for 1 time of your cooking?
9. Usually, 0.5 kg of shrimp paste, how long have to take to consume or use?
10. Usually after used of shrimp paste, the spare will be store in?

In question 1 and 2, aimed to know customer gender and age in order to discover customer segments and their appropriateness in deciding to answer the questions. In question no. 3, this question aimed to divided into company's customer and competitor's customer. In question 3, the photo of the product shows, so that the customer can recognise their regular brand easily.

Question no. 4 is to analyse the purpose of buying shrimp in order in the design stage to deliver a package that aligns with the usage. The questions in no. 5 is rating the elements that customer possibly to selecting the product. Therefore, this should

lead to the measurement of a significant degree of customer requirement. Whereas, the question in no.6 should illustrate the rating of customer requirement between the company's customer and competitor's customer. In no. 7 to 10 is to know customer requirement by asking the consuming rate, to design the size of the package according to customer needs.

3.2.3 Qualitative method

The qualitative method usually is open for the respondents to answer the questions. In this part of the research, Researcher, CEO and manager of Goby Fish Brand Company. First, we travelled to our customer, who is one of our distributors in Hat Yai province. We had a chance to interview Miss Hong, who is the owner of the shop. The topic was about the shrimp paste. The question to ask her are:-

What are products that sold here?

Does this shop sell for both retailer and wholesaler?

Then ask a more profound question that might be useful to the research such as,

How many brands of shrimp paste sold here?

Who did they sell the shrimp paste to?

What is the sale of those shrimp pastes per month?

Then gave her a prototype of new packaging and asked her opinion. The result of the qualitative interview shall reviewed in the next chapter.

Then after that, we have a chance to reveal into Gim Yong market, which is one of the most popular markets in Hat Yai province. In this market mostly, they sell dried food and fruits. Then we take an observation in order to collect data from the market. We have found one of the shops that sold our product, so we ask her a few questions. Nevertheless, one of the shops is our customer as a distributor, but they did not show our product at retail, it only available for wholesaling. Then we also ask a few questions about the shop.

Then we traveled to the local market in Hat Yai which mostly they sold fresh ingredients here; there are many shops soles our product. We also had a chance to interview with them, such as where did they get this product from and how was the sale of this product compared to the others. Also, we asked her about the taste of the products compared to the others. The results of the interview will be discussed in the next chapter.

After walked around the local market, then on the next day we travelled to Ranong province where the goby fish company get the raw material. We visited Wassana, who is our royal supplier which deal business for more than ten years. We started the interview Wassana. The example of questions is; How the process was done in her factory with observation to collect data.

How many shrimp paste brands that you provide the raw material to?

How many grades of shrimp paste?

I gave her the prototype of the new package and asked her opinion? Which the result of this qualitative interview will be discussed later in the result.

3.2.3.1 Blind tasting

There is a Thai curry restaurant near Bangbo District, Samutprakarn province. The restaurant open from 6 o'clock until 15 o'clock. They have been asked for the involvement of research by offered shrimp paste to the restaurant. This restaurant always serves Nam Prik Kapi (Thai spicy shrimp paste sauce) for free with vegetables. Therefore, the method of blind taste is that there will be 2 colours of small bowls which 1 bowl (brown) consist of other brand and another bowl (pink) consist of goby fish brand. The ingredient of spicy sauce will be added at the same volume, included shrimp paste. Then asked them to serve those bowls at the same time and ask co-operation from customers to vote which of the bowl has a better taste. The brand of shrimp paste is not revealed to customers. The results of this test will correct all day long from opening until closing of the restaurant, which the duration is 3 days. The result is shown in the result chapter.



Figure 16 Small bowl (brown and pink) used for a blind tasting

The result of blind testing is further calculating by using an independent t-test which method is providing in section 3.8.

3.3 Analysis method

3.3.1. FMEA

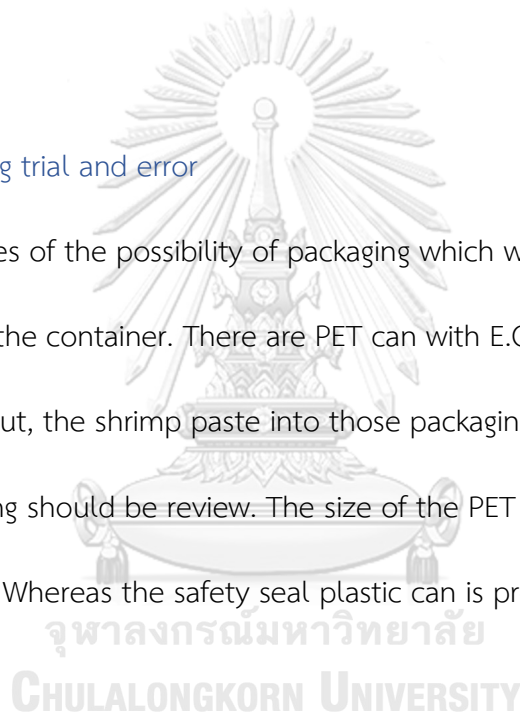
The FMEA method is used to identify the failure mode and effect analysis, in the beginning, to identify the questions for the survey in order to find related customer requirement. After the data was successfully corrected the QFD method is used in product development as a consequence to improve the quality of the product to meet with the customer requirement which based on a relationship with the controllable factors.

3.3.2 QFD

The QFD is used after the result of the survey is analysed. The relationship between shrimp paste's customer requirement and controllable factors should be identified and plot into Housing of quality. The parameter of packaging should be included to analyse the possibility of improving the product and packaging to meet customer satisfaction.

3.4 Product packing trial and error

There are two types of the possibility of packaging which will be examined to put in shrimp paste into the container. There are PET can with E.O.E. and PP can with safety seal lock. After input, the shrimp paste into those packaging. The result in the trial and error of packing should be review. The size of the PET with E.O.E. can is provided by Gikit Company. Whereas the safety seal plastic can is provided by Reangwa Company.



The size of the PET with E.O.E. is should for 180ml, which is the closest to the existing packaging, which is at 135ml. It is called GKPE180, which aluminium size of 211. The dimension of the can is shown below.



Figure 17 Gikit packaging GKPE 180 with compare to existing

The size of PP with safe lock from Reangwa is used for 130g, which is called RW1680 type. Which the dimension is provided below. This packaging came from observation around the supermarket. “Mae Pranom” company who is selling Nam Prik (Thai spicy sauce) for a decade in Thailand and their products are sold on shelf in an ordinal supermarket in Thailand.



Figure 18 Reangwa packaging RW1680 with compare to existing

The measurement of successful packing is based on the colour development of shrimp paste inside each packaging. The colour will measure in L^* a^* and b^* . The measurement will implement after two months of fermentation which will compare to the original (shrimp paste with paraffin) as mention in section 3.1.4.1. On the one hand, If the colour slightly changes, that means the microorganism is slowly developing and able to keep shrimp paste perseverance. On the other hand, if the colour of L^* is significantly higher than the original one, that means this packaging is a failure in shrimp paste perseverance.

3.5 Product's Profit margin

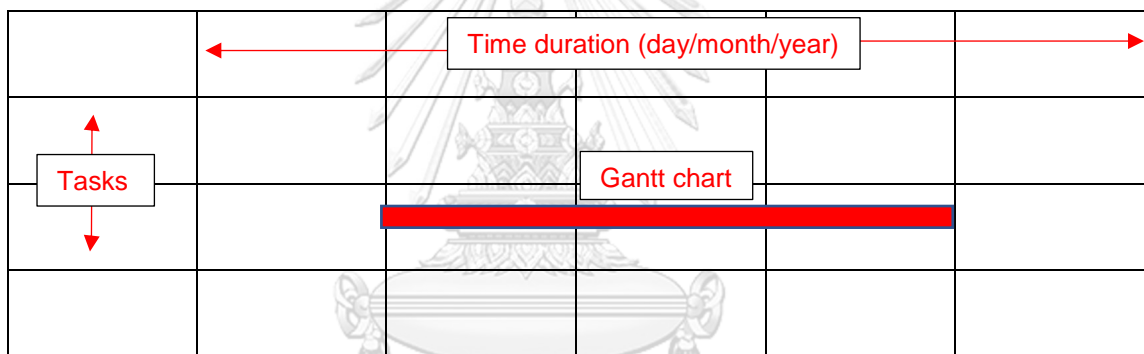
The product's profit margin will tell how much the selling price is "markup". Therefore, it can be able to determine which product in the company contribute most profits relate to the cost of the product. The calculation for a profit margin of a product is starting with selling price (the charge for customers) and subtract with the cost of obtaining the product. It could be referring to gross profit. Moreover, the profit margin is a ratio where gross profit is divided by the selling price, which generally it is called "profit margin" (Merritt, 2018). The table below illustrates the value which obtains for one product

Table of Product's profit margin calculation		Product A (existing)	Product B (new)
Selling price			
Obtaining price	Raw material cost		
	Packaging cost		
	Packaging transportation		
	Paraffin		
	Expense cost (machine)		
	Expense cost (worker)		
Gross profit margin (selling price – obtaining price)			
Profit margin (gross profit/selling price)			

Table 17 Product's profit margin calculation

3.6 Schedule plan

The schedule plan is specific tasks listed, and the duration of those tasks are shown in the schedule. Therefore, it describes a specific time of each activity to happen in a specific time. The tasks are typically shown on the left side of the column (y-axis). While on the right side of the whole row (x-axis) is shown with the Gantt chart, which relied on a time constraint.



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 Table 18 Figure Schedule plan description
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The schedule plan set not only based on the completion of the thesis but try to forecast the possibility of change packaging. The process before registration of the Food and Drug Administration should be included, such as preparation of the area, equipment, documentation, etc. The schedule plan should be related to financial forecasting. Then I should be able to see a clear image of possibilities in changing packaging.

3.7 Financial forecasting

In this section, the financial statement of the goby Fish Company is reviewed. The financial contents that should review our balance sheet and breakeven point. It is globally used as assets equal to liabilities sum with equity. Furthermore, the breakeven point is also taken into account to compute units to be sold to be equal to total revenue.

3.7.1 Balance sheet

Balance sheet formula is $\text{Assets} = \text{Liabilities} + \text{Equity}$, (Murphy, 2019)

Assets

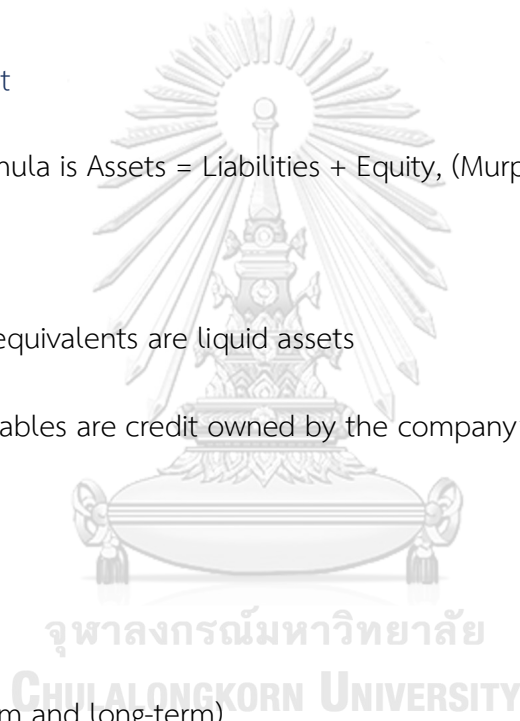
- Cash and cash equivalents are liquid assets
- Accounts receivables are credit owned by the company's customer
- Inventory

Liabilities

- Debt (short-term and long-term)
- Rent, tax, and utilities
- Depreciation
- Expense (wages)
- Dividends

Equity

- Owner's equity where asset subtract liabilities



- Shareholder's equity

The balance sheet should be a review on the previous year (2018), this year (2019) and forecast for next year (2020). The second half of 2019 is forecasting based on the change in packaging plan.

3.7.2 Breakeven point

The breakeven point is where total revenue is equal to the total cost. Where both profit and loss is equal to zero.

There are 2 costs involved, fixed and variable. Fixed cost does not vary to a number of units sold such as rent, lease, debt, investment and etc. Variable is very on the number of units sold (labor cost, raw material cost, transportation and etc.

(GeorgeBrown, 2014)

Formula

Total revenue = price x number of units (TR = P * X), (revenue function)

Total cost = variable cost x number of units + total fixed cost (TC = VC * X + FC), (cost function)

$$\text{BEP, } TR = TC$$

$$PX = VC * X + FC$$

$$\text{BEPX} = FC / (P - VC) \quad , \text{ where } p = \text{price}$$

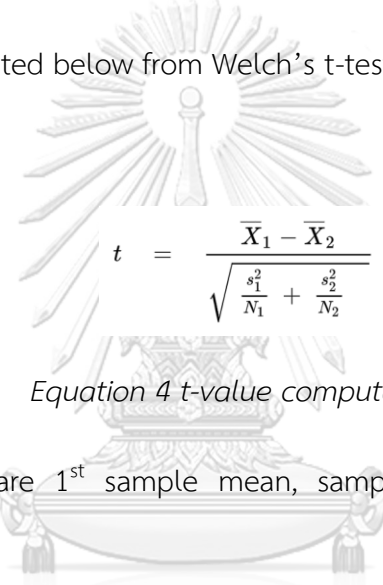
Equation 3 Break even point

3.8 Independent (Unpaired) 2 sample T-tests

The unpaired samples t-test used when two sets of independent samples which different in mean values. Whereas, the paired t-test is a form of blocking and have higher power than unpaired tests when paired units are similar concerning “noise factors” that are independent of membership in two groups compared (Rice, 2006)

The test used when it assumed that the two distributions have the same variance.


The formulas are illustrated below from Welch’s t-test (Welch, 1974)


$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

Equation 4 t-value computation

Where \bar{X}_1 , S^2_1 , N_1 are 1st sample mean, sample variance and sample size, respectively.

The degree of freedom ν can be calculated by


$$\nu \approx \frac{\left(\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2} \right)^2}{\frac{s_1^4}{N_1^2 \nu_1} + \frac{s_2^4}{N_2^2 \nu_2}}$$

Equation 5 Variance computation

Here $\nu_1 = N_1 - 1$, the degrees of freedom for first variance estimate

$\nu_2 = N_2 - 1$, the degrees of freedom for second variance estimate

The statistic test is done after t and V have computed. The statistics are used with t -distribution to test one of the two possible null hypotheses. In this case, means is unequal, a one-tailed test is applied.

The t -distribution one-tailed test for alpha 0.05 is shown below

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05
two-tails	1.00	0.50	0.40	0.30	0.20	0.10
df						
1	0.000	1.000	1.376	1.963	3.078	6.314
2	0.000	0.816	1.061	1.386	1.886	2.920
3	0.000	0.765	0.978	1.250	1.638	2.353
4	0.000	0.741	0.941	1.190	1.533	2.132
5	0.000	0.727	0.920	1.156	1.476	2.015
6	0.000	0.718	0.906	1.134	1.440	1.943
7	0.000	0.711	0.896	1.119	1.415	1.895
8	0.000	0.706	0.889	1.108	1.397	1.860
9	0.000	0.703	0.883	1.100	1.383	1.833
10	0.000	0.700	0.879	1.093	1.372	1.812

Table 19 T-table (train, 2019)

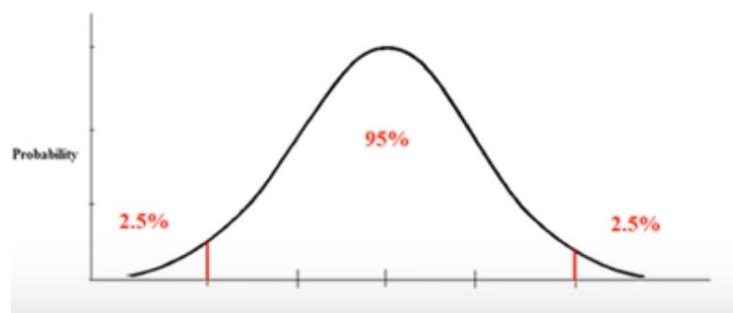


Figure 19 T-distribution graph (train, 2019)

Chapter 4 Results and Analysis

4.1 Chemical, hygienic and proximate properties experiment results

4.1.1. Chemical Lab testing results

Lists of testing	TISI 1080-2535	Lab results
Ash did not dissolve in acid (per dried weight)	Less than 0.5g	0.45g
NaCl (per dried weight)	More than 36g	37.12g
pH	6.5 – 7.8	7.46
Benzonic acid	Not detected	Not detected
Sorbic acid	Not detected	Not detected

Table 20 Chemical Lab testing results

4.1.2. Hygienic Lab testing results

Lists of testing	TISI 1080-2535	Lab results
Total Plate count	Less than 1×10^5 CFU/g	9,200 CFU/g
Coliforms	< 3 MPN/g	< 3 MPN/g
S. aureus	Not detected in 0.1g	Not detected in 0.1g
C. perfringens	Not detected in 0.01g	Not detected in 0.01g
Salmonella spp.	Not detected in 25g	Not detected in 25g

Yeast & Mold	<50CFU/g	100 CFU/g
--------------	----------	------------------

Table 21 Hygienic Lab testing results

4.1.3. Proximate Lab testing results

Lists of testing	Lab results per 100g
Calories (kcal)	111.80
Total fat (g)	2.16
Protein (g) N x 6.25	22.03
Total carbohydrate (g)	1.06
Sugars (g)	Not detected
Sodium (mg)	7186.61
Ash (g)	23.15

Table 22 Proximate Lab testing results

4.1.4. Physical Lab testing results

Lists of testing	TISI 1080-2535	Lab results
Water Activity	Not mentioned	0.72
Moisture content	Less than 45	51.60
Synthetic food color	Not detected	Not detected
Cadmium	Less than 0.5mg/kg	0.037mg/kg
Lead	Less than 1.0mg/kg	0.050mg/kg

Mercury	Less than 1.0mg/kg	Not detected
---------	--------------------	--------------

Table 23 Physical Lab testing results

4.2 Quantitative research results

The data below is from the internet-based with 44 respondents combined with paper-based 16 respondents, which totally of 60 respondents. The questions can be referring to Appendix B.

Q1 result

Answer Choices	Responses	
ชาย male	53.33%	32
หญิง female	46.67%	28
	Answered	60

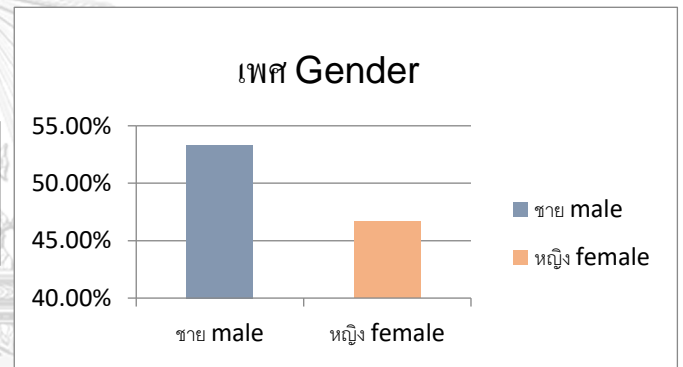


Figure 20 result of a survey by gender

There are 60 respondents through the internet and paper-based questionnaires survey. 32 are male, and 28 are female. There are percentages of 53.33% of male and 46.67% of female.

Q2 result

Answer Choices	Responses	
น้อยกว่า Under 18	0.00%	0
18-30	28.33%	17
31-40	18.33%	11
41-50	15.00%	9
51-60	26.67%	16
มากกว่า Over 60	11.67%	7
	Answered	60

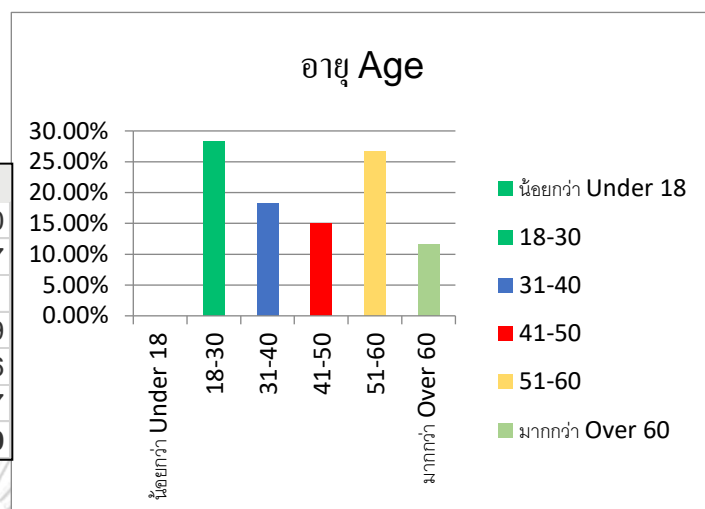


Figure 21 result of a survey by Age

There were zero of age below 18. Therefore the information is trusty due to maturity range. 17 respondents are in between 18-30. In the age range, 31-40, 41-50, 51-60, over 60, there are 11, 9, 16 and 7 respondents, as respectively.

Q3 result

Answer Choices	Responses	
ตราปลาหมูทอง Goby fish brand	46.67%	28
คลองโคน Klongkone	5.00%	3
ตราชูตราซัง Tra Chu Tra Chung	6.67%	4
ตรากุ้งไทย Tra Kung Thai	15.00%	9
ตราเรือใบ Tra Reung Bai	0.00%	0
ไม่เคยซื้อ Never bought	26.67%	16
	Answered	60

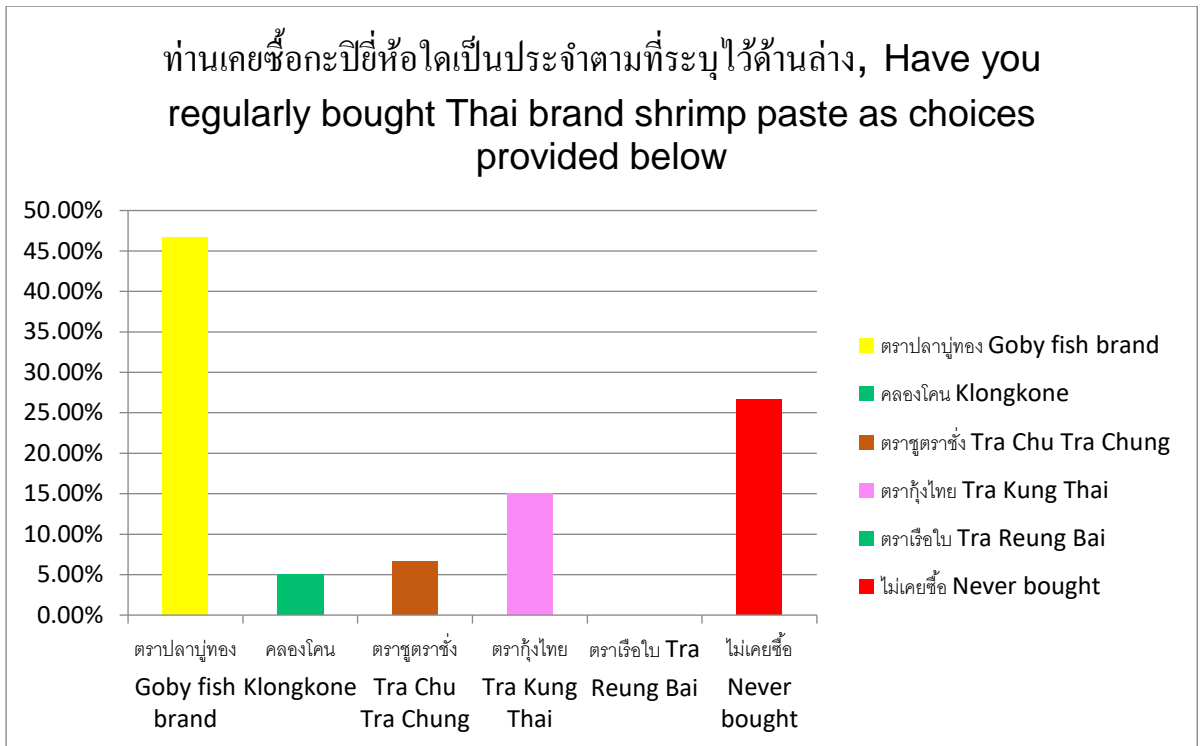
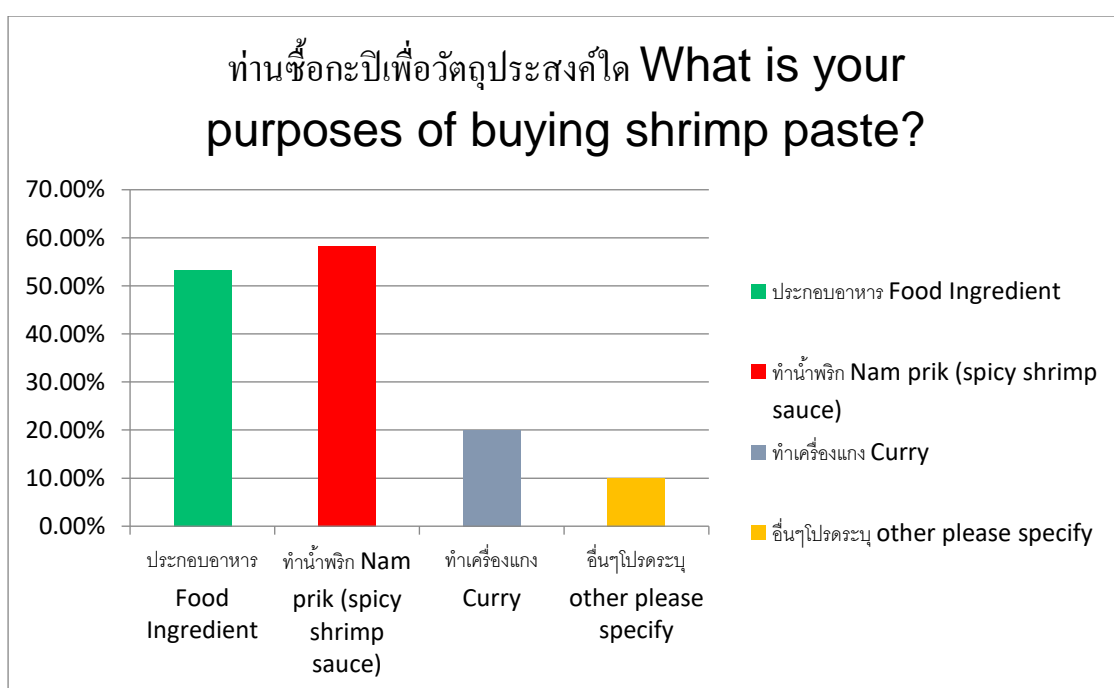


Figure 22 result of a survey by shrimp paste brand

There are 28 respondents, who are existing of goby fish brand, Tra Chu Tra Chung was selected by 4, and Tra Kung Thai was selected by 9. Klong Kone with 3 respondents. There are 14 of respondent who never bought shrimp paste. If calculate into a percentage, goby fish is 47%, Tra Chu Trac hung is 7%, Kung Thai is 15%. The product of Tra Chu Tra Chung and Kung Thai is an ordinary product which able to buy in the supermarket. The Klongkone product was chosen by 5%. There was no one chose Tra Reung Bai.

Q4 result

Answer Choices	Responses	
ประกอบอาหาร Food Ingredient	53.33%	32
ทำน้ำพริก Nam prik (spicy shrimp sauce)	58.33%	35
ทำเครื่องแกง Curry	20.00%	12
อื่นๆโปรดระบุ other please specify	10.00%	6
	Answered	60



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Figure 23 result of a survey by the purpose of using shrimp paste

The purpose of buying shrimp paste is mostly used for food ingredients with 53%, followed by Nam Prik Kapi, which is spicy shrimp paste sauce with 58% and 20% is for making curry. 10% with other species such as garnish for noodle, buy a gift, making sauce, and Nam pla wan.

Q5 result

	5	4	3	2	1	TotE	TOTAL score	priority
รสชาติของกะปิ Taste of shrimp paste	88.33%	53	3.33%	2	0.00%	0	4.85	1
มาตรฐาน อย. (อาหารและยา) Thai food and drug standard	72.88%	43	8.47%	10	1.69%	0	4.53	2
กลิ่นของกะปิ odor of shrimp paste	55.93%	33	30.51%	18	13.56%	8	4.38	3
วันหมดอายุ Expiry date	54.24%	32	32.20%	19	10.17%	6	4.36	4
ความสะดวกในการเปิดใช้งาน convenience of opening	48.33%	29	35.00%	21	13.33%	8	4.32	5
เนื้อของกะปิ texture of shrimp pate	50.00%	30	28.33%	17	18.33%	11	4.25	6
สีของกะปิ color of shrimp paste	42.37%	25	37.29%	22	16.95%	10	4.19	7
มาตรฐาน มอก. (อุตสาหกรรม) Thai industrial standard	50.00%	29	18.97%	11	22.41%	13	4.05	8
วัสดุของบรรจุภัณฑ์ (พลาสติก, แก้ว, กระป๋อง) material of package	31.03%	18	44.83%	26	20.69%	12	4.02	9
ปริมาณ volume	30.00%	18	35.00%	21	25.00%	15	3.88	10
ราคาของกะปิ price of shrimp paste	34.48%	20	32.76%	19	27.59%	16	3.85	11
รูปร่างของบรรจุภัณฑ์ (ทรงกระบอกเป็นต้น) shape of package	20.69%	12	34.48%	20	34.48%	20	3.62	12
สีสัน/ความสวยงามของฉลาก color and beauty of label	17.24%	10	34.48%	20	34.48%	20	3.50	13
มาตรฐาน ฮาลาล (อิสลาม) Muslim standard	15.52%	9	5.17%	3	20.69%	12	2.36	14

ท่านเลือกผลิตภัณฑ์ที่จะใช้ต่อไปเป็นตัววัดตามรายละเอียดด้านล่างสำคัญมากน้อยเพียงใด In what scale to measures

of product selecting? (1= สำคัญน้อยที่สุด least important, 5= สำคัญมากที่สุด most important)

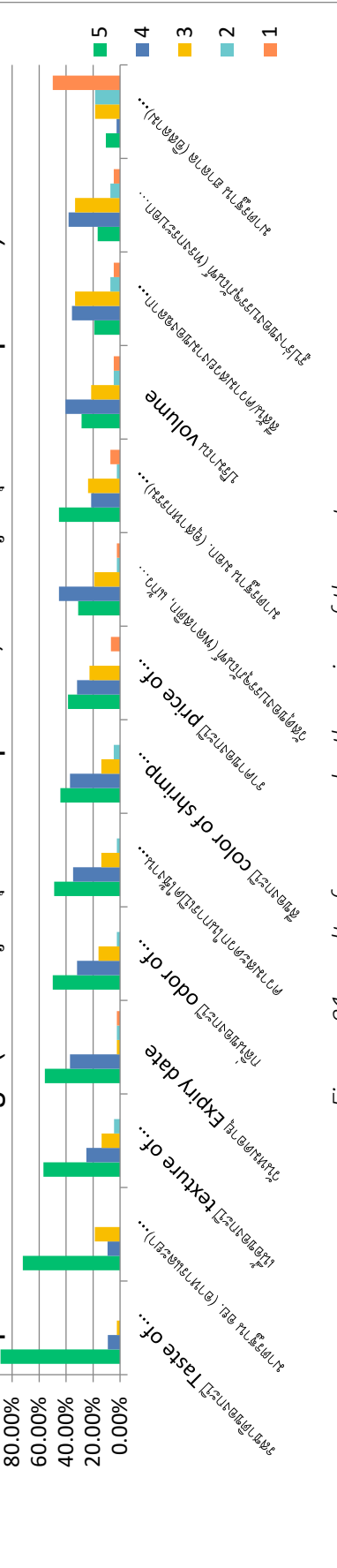


Figure 24 result of a survey by the voice of the custome

The result of question 5, shown the essentialness in the voice of customer regarding customer requirement factors correlated to customer product selection. The prioritise order was shown in the right column, whereas it is in prioritise order from the taste of shrimp paste, Thai's Food and Drug Administration standard, the odor of shrimp paste, expiry date, the convenience of opening, the texture of shrimp paste, color of shrimp paste, Thai Industrial standard, the material of package, volume, price of shrimp paste, shape of package, color and beauty of label and Muslim standard.

Regarding QFD, house of quality, this customer voice should be input on the left column where it is internal and external correlated to customer requirement. The prioritise order is already weight, as mentioned above.

Q6 result

Question no. 6 divided into 4 types of shrimp paste customer in order to measure the customer rating related to factors in no.5. First data is goby fish shrimp paste with 19 of respondent responded to this question.

	5	4	3	2	1	Total	Score					
กลิ่นของกะปิ odor of shrimp paste	74.07%	20	25.93%	7	0.00%	0	0.00%	0	27	4.74		
ความเหมาะสมของปริมาณ Appropriateness in volume of shrimp paste	62.96%	17	33.33%	9	0.00%	0	0.00%	0	3.70%	1	27	4.52
ความเหมาะสมของราคากะปิ Appropriateness in price of shrimp paste	59.26%	16	37.04%	10	3.70%	1	0.00%	0	0.00%	0	27	4.56
ความเหมาะสมของรูปร่างบรรจุภัณฑ์กะปิ Appropriateness in shape of packaging for shrimp paste	40.74%	11	40.74%	11	14.81%	4	3.70%	1	0.00%	0	27	4.19
ความแข็งแรงของบรรจุภัณฑ์ Durability of packaging	40.74%	11	44.44%	12	14.81%	4	0.00%	0	0.00%	0	27	4.26
ความทนของกะปิ (เก็บได้นาน) Life shelf	74.07%	20	22.22%	6	3.70%	1	0.00%	0	0.00%	0	27	4.70
ความสะดวกต่อการเปิดใช้งาน convenience in opening	62.96%	17	37.04%	10	0.00%	0	0.00%	0	0.00%	0	27	4.63
ฉลากมีข้อมูลครบถ้วนและน่าดึงดูด label is sufficient with information and attraction	40.74%	11	44.44%	12	14.81%	4	0.00%	0	0.00%	0	27	4.26
รสชาติของกะปิ Taste of shrimp paste	92.59%	25	7.41%	2	0.00%	0	0.00%	0	0.00%	0	27	4.93
สีของกะปิ color of shrimp paste	74.07%	20	22.22%	6	5.26%	1	0.00%	0	0.00%	0	27	4.70

Table 24 Customer rating for Goby fish brand product

Klong Kone's customer responded by 3 respondents. Therefore, the data might not be accurate, so I will be skipped for Klong Kone shrimp paste as the information is insufficient.

The data of the survey from 4 respondents for Tra Chu Tra Chung is shown below,

	5	4	3	2	1	Total	Score					
กลิ่นของกะปิ odor of shrimp paste	25.00%	1	0.00%	0	25.00%	1	25.00%	1	4	2.75		
ความเหมาะสมของปริมาณ Appropriateness in volume of shrimp paste	0.00%	0	25.00%	1	75.00%	3	0.00%	0	0.00%	0	4	3.25
ความเหมาะสมของราคากะปิ Appropriateness in price of shrimp paste	0.00%	0	25.00%	1	50.00%	2	25.00%	1	0.00%	0	4	3
ความเหมาะสมของรูปร่างบรรจุภัณฑ์กะปิ Appropriateness in shape of packaging for shrimp paste	25.00%	1	0.00%	0	75.00%	3	0.00%	0	0.00%	0	4	3.5
ความแข็งแรงของบรรจุภัณฑ์ Durability of packaging	25.00%	1	0.00%	0	50.00%	2	25.00%	1	0.00%	0	4	3.25
ความทนของกะปิ (เก็บได้นาน) Life shelf	0.00%	0	25.00%	1	50.00%	2	25.00%	1	0.00%	0	4	3
ความสะดวกต่อการเปิดใช้งาน convenience in opening	0.00%	0	75.00%	3	25.00%	1	0.00%	0	0.00%	0	4	3.75
ฉลากมีข้อมูลครบถ้วนและน่าดึงดูด label is sufficient with information and attraction	25.00%	1	50.00%	2	25.00%	1	0.00%	0	0.00%	0	4	4
รสชาติของกะปิ Taste of shrimp paste	50.00%	2	0.00%	0	25.00%	1	25.00%	1	0.00%	0	4	3.75
สีของกะปิ color of shrimp paste	50.00%	2	0.00%	0	0.00%	0	25.00%	1	25.00%	1	4	3.25

Table 25 Customer rating for Tra Chu Tra Chung

The data of the survey from 9 respondents for Tra Kung Thai is shown below,

	5	4	3	2	1	Total	Score					
กลิ่นของกะปิ odor of shrimp paste	44.44%	4	44.44%	4	11.11%	1	0.00%	0	0.00%	0	9	4.33
ความเหมาะสมของปริมาณ Appropriateness in volume of shrimp paste	55.56%	5	33.33%	3	11.11%	1	0.00%	0	0.00%	0	9	4.44
ความเหมาะสมของราคากะปิ Appropriateness in price of shrimp paste	55.56%	5	33.33%	3	11.11%	1	0.00%	0	0.00%	0	9	4.44
ความเหมาะสมของรูปร่างบรรจุภัณฑ์กะปิ Appropriateness in shape of packaging for shrimp paste	33.33%	3	55.56%	5	11.11%	1	0.00%	0	0.00%	0	9	4.22
ความแข็งแรงของบรรจุภัณฑ์ Durability of packaging	44.44%	4	33.33%	3	22.22%	2	0.00%	0	0.00%	0	9	4.22
ความทนของกะปิ (เก็บได้นาน) Life shelf	55.56%	5	33.33%	3	11.11%	1	0.00%	0	0.00%	0	9	4.44
ความสะดวกต่อการเปิดใช้งาน convenience in opening	66.67%	6	22.22%	2	11.11%	1	0.00%	0	0.00%	0	9	4.56
ฉลากมีข้อมูลครบถ้วนและน่าดึงดูด label is sufficient with information and attraction	55.56%	5	33.33%	3	11.11%	1	0.00%	0	0.00%	0	9	4.44
รสชาติของกะปิ Taste of shrimp paste	55.56%	5	33.33%	3	11.11%	1	0.00%	0	0.00%	0	9	4.44
สีของกะปิ color of shrimp paste	44.44%	4	55.56%	5	0.00%	0	0.00%	0	0.00%	0	9	4.44

Table 26 Customer rating for Tra Kung Thai

Q7 result

Answer Choices	Responses	
น้อยกว่า 1 ครั้ง ต่อสัปดาห์ less than 1 time per week	61.67%	37
น้อยกว่า 4 ครั้ง ต่อสัปดาห์ less than 4 times per week	36.67%	22
มากกว่า 10 ครั้ง ต่อสัปดาห์ more than 10 times per week	1.67%	1
	Answered	60

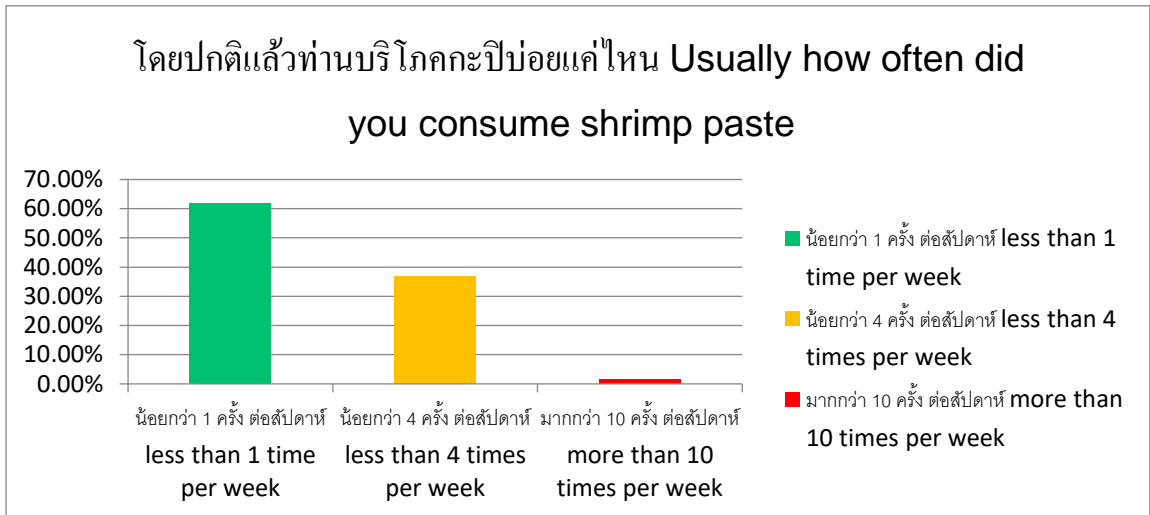


Figure 25 Survey result of frequency in consumption

Q8 result

Answer Choices	Responses	
1 ช้อนโต๊ะ 1 spoon	50.00%	30
2 ช้อนโต๊ะ 2 spoon	18.33%	11
มากกว่า 2 ช้อนโต๊ะ more than 2 spoon	10.00%	6
มากกว่า 10 ช้อนโต๊ะ more than 10 spoon	1.67%	1
ไม่ได้ทำอาหารเอง never cook by yourself	20.00%	12
	Answered	60

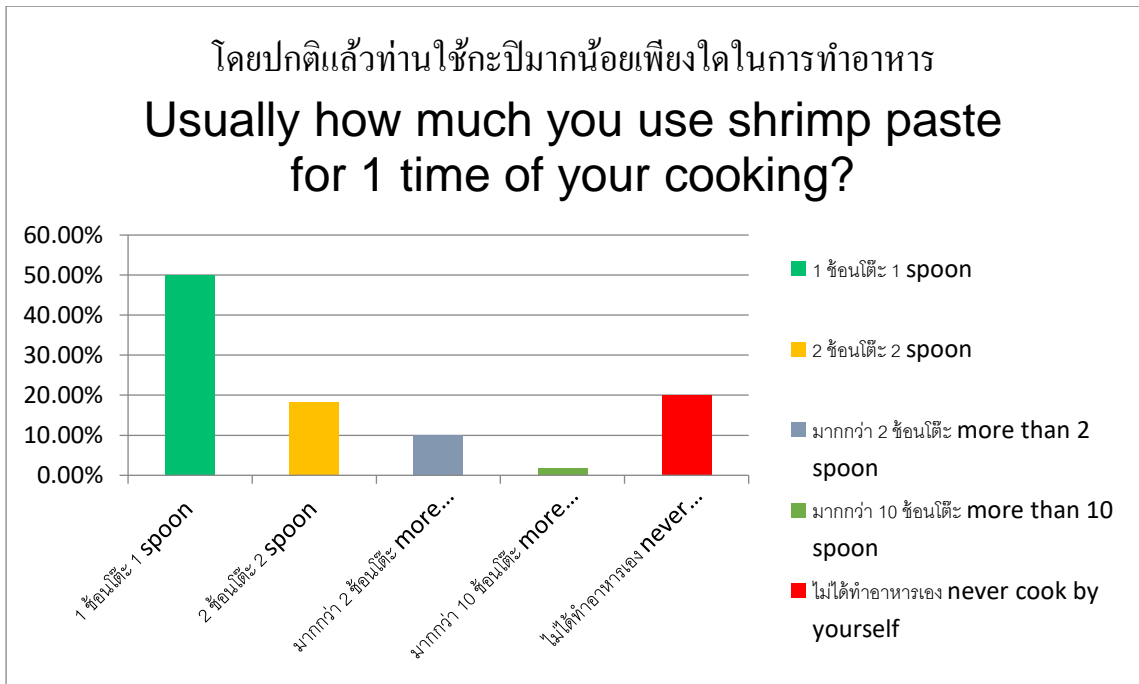


Figure 26 Survey result of the amount per one consumption

Q9 result

Answer Choices	Responses	
มากกว่า 1 ปี more than 1 year	27.12%	16
น้อยกว่า 6 เดือน less than 6 months	52.54%	31
น้อยกว่า 1 เดือน less than 1 month	20.34%	12
น้อยกว่า 7 วัน less than 7 days	0.00%	0
	Answered	59

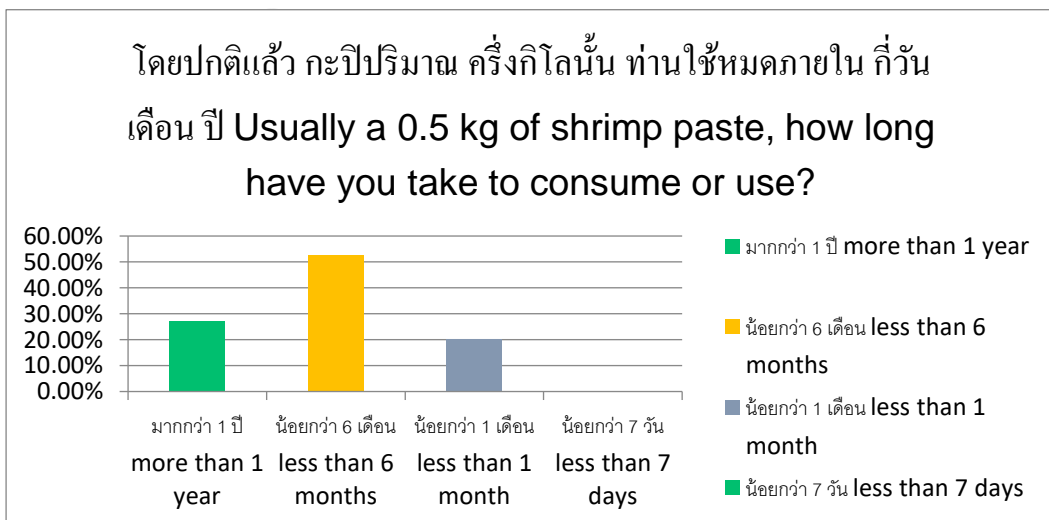


Figure 27 Survey result of 0.5 kg consumption

Q10 result

Answer Choices	Responses	
ในตู้เย็น In refrigerator	83.05%	49
ในอุณหภูมิทั่วไป ambient temperature	16.95%	10
บริเวณใกล้เตาทำอาหาร near cooking area	0.00%	0
อื่นๆ โปรดระบุ Other (please specify)	0.00%	0
	Answered	59



Figure 28 Figure Survey result of where to store the product



Regarding question 7 to 10, can assume the consumption rate by calculating the frequency and amount per serving. As mostly, in question 9, the answer is to use 500gram with less than 6months. There are 4 weeks in a month. Therefore, $6 \times 4 = 24$ weeks, from question 7, most of the customer consume less than 1 time per week. I will assume 18time per 2 weeks in the frequency of consumption. Thus, one

time of usage is 1 spoon, which is equal to 18g per serving. So 12 spoon is used within 24 weeks, which is equal to 12times multiple by per serving of 18g = 12times*18grams = **216grams**. It is the appropriate amount for packaging.

4.3 Qualitative research results

Interview results

4.3.1 Interview result with Mrs Hong, who is our distributor in Hat Yai.

What are products that sold here?

We sold every consumable product such as milk, fish sauce, shrimp paste, food ingredient, etc.

Does this shop sell for both retailer and wholesaler?

Yes, we sold both retail and wholesale but mostly sold by wholesale.

How many brands of shrimp paste sell here?

There are 2 brands, Kung Thai and Goby fish shrimp paste.

Where did you sell the shrimp paste to?

Local market, sold to Malaysia, another retail shop in Hat Yai

What is the sale of those shrimp pastes per month?

Kung Thai sells around 100 dozen per month and goby fish around 500 dozen per month

Then I gave her a prototype of new packaging and asked her opinion.

She positive agreed with the new packaging with EOE type, but the change in price must be reasonable. Not raise the price too high due to an existing customer will be panic.



Figure 29 Interview with Mrs Hong and her cousin at Hat Yai on 18 May 19

4.3.2 Interview result with Mrs Wassana who is our supplier in Ranong



How was the process done in her factory?

First, we bought raw material from local villagers, which they need to proceed according to the recipe of krill 85% and salt 15%, they completed in the dried process. Then we stored the product in the refrigerator room at a temperature around 7-10 °C, as shown below. They need to store shrimp paste as it is a seasonal

product where krill is not always available on the shore. Also, they store for food perseverance and not to let microorganism growth.



Figure 30 Refrigerator room to store shrimp paste at Ranong on 19 May 19

Then when the order from a customer is delivered, those shrimp paste in store will be dried outside at night one day as a consequence to gain ambient temperature and dehydrate the moisture. After that put the shrimp paste on to the Grinder machine, there are 2 types of grinder machine, 1. Fine grinder machine and 2. Rough grinder machine. The fine used for high-quality shrimp paste with no special ingredient added into the shrimp. The rough grinder machine is used to mix shrimp paste with a special ingredient such as coloured potato head, sugar, etc. which upon their customer requirement.



Figure 31 Grinder machine (fine on left and rough on right)

How many shrimp paste brands that you provide the raw material to?

There are Kung Thai, Tra Rueng bai, goby fish and local shrimp paste. The ingredient for Kung Thai brand shrimp paste is mixed with 30% of sugar with shrimp paste and added up with msg. They sold to Kung Thai brand around 30 Thai baht per kg.

Whereas Tra Rueng bai, they require to mix shrimp paste with fish in order to minimise their raw material cost, which sold around 25 Thai baht per kg. Interestingly, for local product, which sold around the village was added up with colour potato head. In order to minimise the cost and maximise profit, but this will lead to customer dissatisfaction. Meanwhile, for goby fish, they confirmed to deliver with high quality of shrimp paste with no mixed of any ingredient. It is the 1st grade of shrimp paste.



Figure 32 coloured potato head used to mix with shrimp paste for degrading

How many grades of shrimp paste?

There is various type of shrimp paste grade which produces according to customer requirements such as add up sugar, msg, potato head, etc. Their purpose is to degrade the product as a consequence to minimise the cost of production and increase their profitability, but they overlooked the quality of shrimp paste.

Then gave her the prototype of the new package and asked her opinion?

She agreed with the new packaging, but shrimp paste product, the importance of it is shelf life which need to store the product in packaging longer such as one year and see the result of the shrimp paste in size that it would last long until 1 year or not.

4.3.3 Local Market observation

The observation at Gim Yong market, there is one of our distributor called “Tum Lae Thong”. We observed at their shop without reveal of who we are. Then ask about the shrimp paste product that was retail sold here. It is only Kung Thong that was available. The Kung thong product is fraud product copy from goby shrimp paste brand (wording on the label). Which this distributor tried to make themselves as our competitor. The image of the Kung thong product is shown below. However, we ask deeper, are there any other product available, they said that “there is goby fish brand but we only wholesaling and not for retailing”



Figure 33 Kung thong product

Furthermore, one of the sidewalk shop in Gim Yong market beside Tum Lae Thong shop. There are several shrimp paste's brands sold here. The quality and price described by the owner of the shop.

The best quality is on the left, and then it goes down to the right side, as shown in the figure below.



Figure 34 Shrimp paste in sidewalk shop near Gim yong market

After we walked around the local market in Hat Yai, there are many shops that provided our product. So we stopped at one shop and asked about our product. I asked, “how was the sale of goby fish product”.

She answered that the product was a good sale. Then we ask where you had the product from? She said that it is from the middle man merchant and distribute through many shops in this local market.



Figure 35 Hat Yai local market observation product on the shelf

4.3.4 Product observation

As an observation from a supermarket in Thailand such as Tesco Lotus, 7-eleven, tops supermarket. I have found 3 brands that were sold on the shelf in the supermarket, which are Tra Chu Tra Chung, Tra Kung Thong, and Tra Rueng Bai. Then

I took the products and took an observation on its packaging and product. Those products are qualified for food and drug of Thailand standard.

Price list	Tra Rueng Bai	Tra Kung Thai	Tra Chu Tra Chung	Goby fish
90g		13 (0.14b/g)	20 (0.22b/g)	
135g				20 (0.15b/g)
175g	34 (0.19b/g)			
185g			40 (0.22b/g)	
200g		25 (0.12b/g)		
400g	64 (0.16b/g)	45 (0.11b/g)	77 (0.19b/g)	
500g	70 (0.14b/g)			
575g			107(0.19b/g)	
580g				80 (0.14b/g)
1000g		110 (0.11b/g)		

Figure 36 Retail price list of 4 brands shrimp paste in Thailand

From observation by the researcher and follow the regulation of TPCS61 (Thai community product standard) in the scoring of colour, odour and taste, which is score 1 to 3.

			
Tra Rueng Bai (145g)	Tra Kung Thai (90g)	Tra Chu Tra Chung (90g)	Goby fish brand (135g)
The material of packaging: PP no.5	The material of packaging: PP no.5	The material of packaging: PP no.5	The material of packaging: PP no.5
Can: Special made	Can: available on the market	Can: Specially made with all white	Can: available on the market
Lid: PE with label / 1 st layer of paraffin wax 2 nd layer of food grade paraffin	Lid: Pink PP rotate lid with label/aluminium foil	Lid: shrink plastic / white PP rotate lid with sticker label/paraffin paper	Lid: Red PP rotate lid with label/paraffin wax

			
<p>Level of kept odor : 2</p>	<p>Level of kept odor : 3</p>	<p>Level of kept odor : 3</p>	<p>Level of kept odor : 1</p>

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L*=43.53, a*=4.98, b*= 9.78	L*=41.52, a*=6.04, b*= 11.05	L*=32.92, a*=9.06, b*= 8.28	L*=45.88 a*=8.07, b*= 10.97
Color: 3	Color: 2	Color: 1	Color: 3
Odor: 3	Odor: 3	Odor: 1	Odor: 3
Taste: 2 (fishy)	Taste: 2 (sweet)	Taste: 2 (salty)	Taste: 3
Texture : 3	Texture : 3	Texture : 3	Texture : 2
Label: full label, only English description on ingredient. No nutrition fact	Label: full label, No English, Nutrition fact included	Label: full label, English description on ingredient and company address. Nutrition fact included	Label: half label, only English description on ingredient. No nutrition fact

Standard: Food & drug	Standard: Food & drug and GMP	Standard: Food & drug and GMP	Standard: No
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Figure 37 observation of shrimp paste 4 brands in Thailand (compared with competitors)

The observation of colour, Tra Rueng Bai, and goby fish has similar colour white dark pink colour. Kung Thai colour has grey-pink colour and Tra Chung has a dark brown colour. On the one hand, the possibility of Tra Rueng Bai and goby fish brand which got a lighter colour may result from the paraffin effect, which preserves better of colour appearance. On the other hand, Tra Kung Thai and Tra Chu Tra Chang have no paraffin, but they have aluminium foil and paraffin paper with fully covered on the lid to protect incoming of air into the packaging. Therefore, this still results in a change of colour appear to be darker as same as in literature review in section 2.2 because the longer the fermentation of shrimp paste as a consequence affects its colour appearance.

4.3.5 Blind tasting result

The table below shown result of a blind tasting of spicy shrimp paste sauce and let the customer decide which of spicy shrimp paste sauce has a better taste. The raw data is collected by the restaurant's worker.

Date	Brown (another brand)	Pink (goby fish band)
05/06/19	25	46
06/06/19	30	38
07/06/19	19	55

Table 27 result of blind testing

This test proofed that the taste of goby fish already satisfies the customer. It is unnecessary in adjusting the taste in goby fish shrimp paste as it is already delicious with a natural taste. Besides, to guarantee, the independent t-test is performed as detail below:-

Date	Brown (another brand) Sample1	Pink (goby fish band) Sample 2	X_1^2	X_2^2
05/06/19 (1)	25	46	625	2,116

06/06/19 (2)	30	38	900	1,444
07/06/19 (3)	19	55	361	3,025
Total	74	139	-	-
N	3	3	-	-
\bar{X}	24.67	46.33	-	-
Df	3-1=2	3-1=2	-	-
$\sum X^2$	-	-	1,886	6,585
$(\sum X)^2/n$	-	-	$74^2/3 =$ 1,825.33	$139^2/3 =$ 6,440.33
$\sum X^2$	-	-	1,886 -	6,585 -
$(\sum X)^2/n$	-	-	1,825.33 = 60.67	6440.33 = 144.67

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$$S^2 = (S_1^2 + S_2^2)/2 = \sum X_1^2 + \sum X_2^2 / 2(n-1)$$

$$S^2 = 60.67 + 144.67 / 2(3-1) = 51.335, Df = 4$$

$$S \bar{x}_1 - \bar{x}_2 = \sqrt{2s^2 / n} = \sqrt{2(51.335)/3} = 5.85$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{N_1} + \frac{s_2^2}{N_2}}}$$

$t = (74-139)/5.85 = -11.11$, $Df = 4$, t-table $t = 2.132$ at $\alpha = 0.05$

The decision rule is stated that if t is less than -2.132 , or greater than 2.132 , reject the null hypothesis.

Therefore, as a result, showed, it can be illustrated that the null hypothesis is rejected where it means there is a significant difference where Sample1 (other band shrimp paste). There is the probability of less than 2.5% regarding sample1 which it can see that sample 2 is significantly increasing of 1% possibility, probability of 95% of $(65) + (-2.132)5.85 = 53$ and 77 votes.

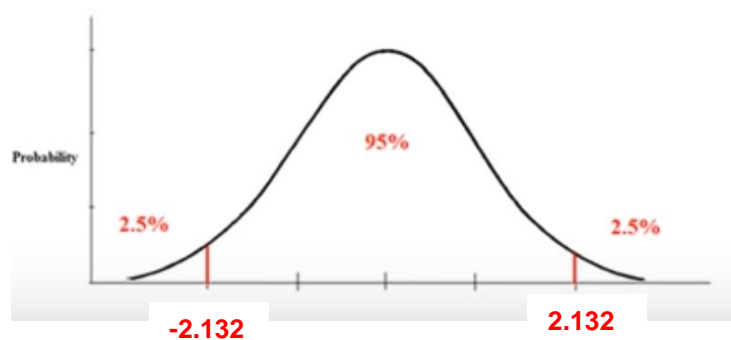


Figure 38 T-distribution graph where $\alpha = 0.05$ and $df = 4$

4.4 QFD Analysis Result

Regarding Survey results and observations via qualitative and quantitative techniques, the QFD of shrimp paste is developed, as shown below in the figure. Firstly, the centre of the housing of quality divided into two parts which are What (what is customer's requirement of selecting shrimp paste product) and how (how to develop the product to capture customer requirement). The importance of customer's need is in descending order as 1st, Taste of shrimp paste until 14th, Muslim standard. The concern of customer's requirement scoring raised from the survey. The properties of the product based on the possibility of improving quality in shrimp paste, such as the long process of drying. As a result, to improve texture and moisture content to meet with TISI 1080. Where it is need to be below 45 as our product over with 10% in moisture content, the adjust of insertion of a particular ingredient might be a consideration to improve the taste of shrimp paste, for an instant, add sugar or salt, but this would lead to unmet condition for TISI 1080 but regarding what I have research from qualitative. The sugar and msg were added into some brand of shrimp paste to reduce the cost of obtaining and maximise profit, which leads to deceiving a customer. The addition of information in the label and make it more attractive is concerned even though the customer's requirement results shown that colour and beauty of label is unnecessary for the customer to choose, but the information such as ingredient, expiry date, volume, price are related

to label improvement. The change of material packaging, the lid of packaging and remove of paraffin are correlated with each other because after removing paraffin, the packaging must be supportive in food perseverance for customer satisfaction but in fact, using the existing pp packaging is unable to keep the shrimp paste in good condition as microorganism can develop. Also using paraffin is prohibited for food and medical administration register. Therefore, the decision to change packaging by trial and error occurs. Firstly, seeking suppliers with finished goods of plastic (no need to make to order, no need to make a new mould). After, site observation around the supermarket, there are 2 possibilities types of packaging, as mentioned in section 3.4. However, as the computation of scoring system in the housing of quality of shrimp paste shown that there are 4 improving points that chose to develop regarding total score that more than one hundred or top four. Thai food and drugs standard and Thai industrial standard highlighted as Food and drugs for goby fish are low compared to competitors due to Goby fish brand did not register as food and drugs standard. Thai industrial standard is a unique point where every shrimp paste brand did not meet the requirement of TISI 1080. Thus, it is an excellent opportunity if the company success in meeting requirement of TISI 1080 so it is a market opportunity.

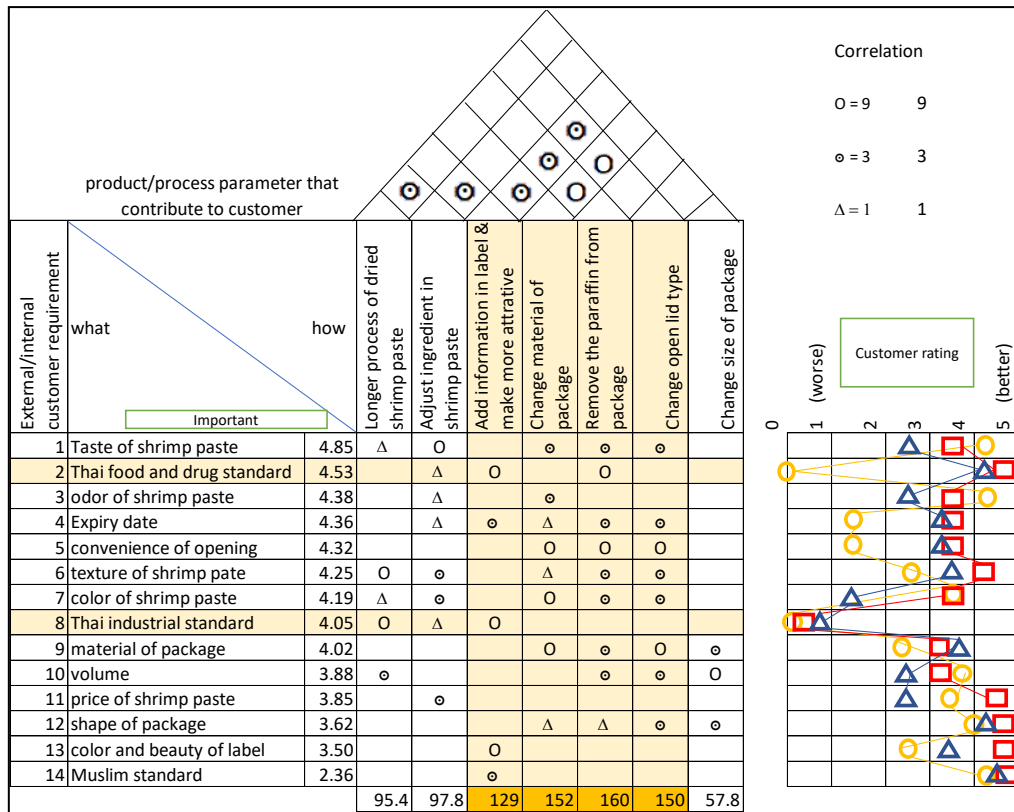


Figure 39 Quality Function deployment of shrimp paste product

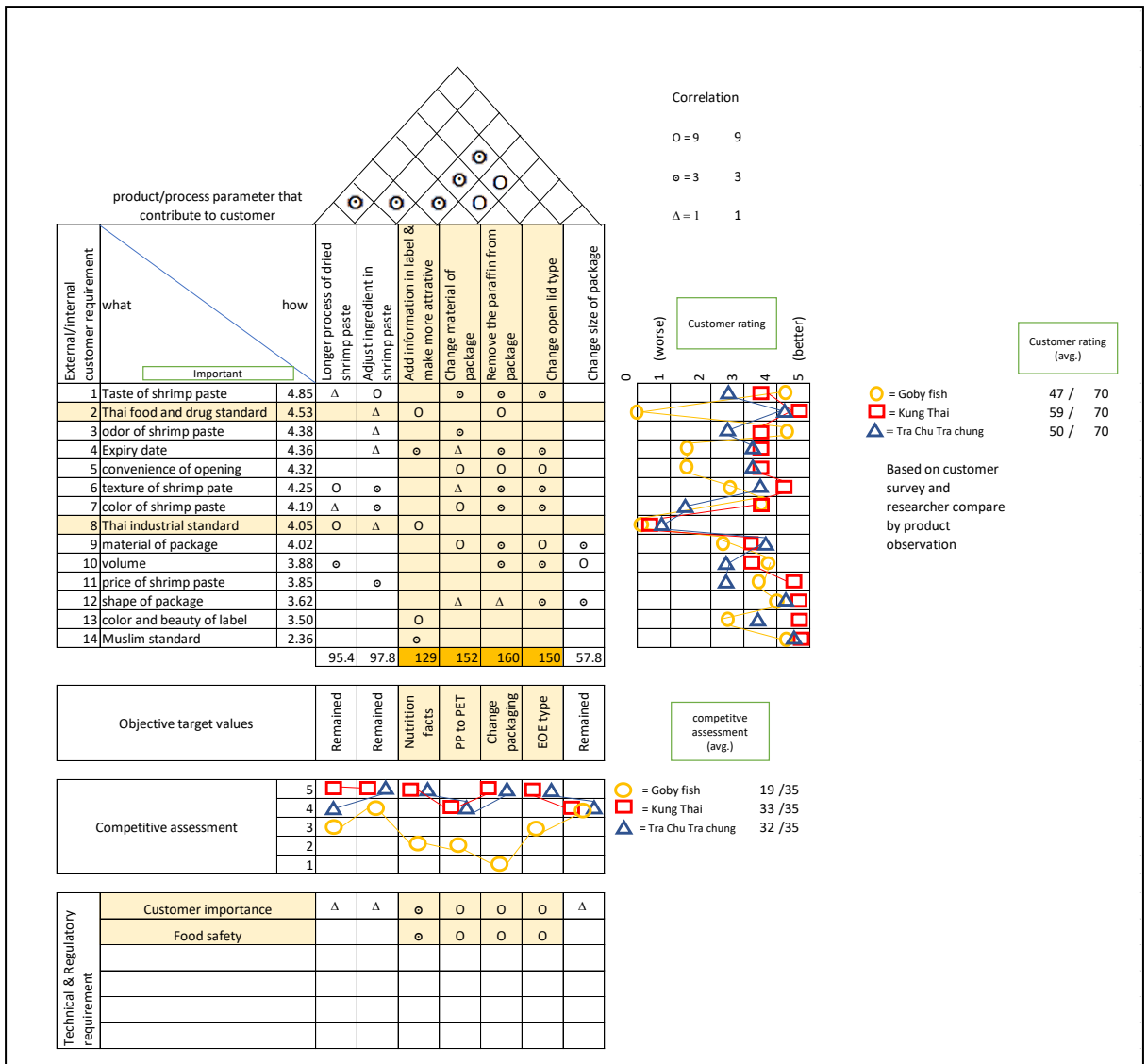


Figure 40 Full Quality Function deployment of shrimp paste product

The objective target values are set based on 4 top totals score that correlation between customer's requirement and product properties. The label improved by adding information, nutrition facts, product properties, garnish information, and expiry date. PP packaging is consideration of a change to PET is more transparent which customer can visualise easier of colour and texture of shrimp paste. It also can keep

odour inside of packaging. The removal of paraffin resulted in consideration of changing the packing. The convenience of the opening is the consideration of switching to easy open ends type.

Regarding customer rating, the average score of goby fish is the least among the other 2 brands. Therefore, there is a gap to be improved. Furthermore, competitive assessment is similarly low compared with the other 2 brands. The regulatory requirement would be customer importance and food safety, as shown at the bottom part of the housing of quality. It is related to the four technical properties.

Even though the test of shrimp paste is the most important to the customer but if adding an ingredient to shrimp paste might result negatively to the customer because the existing customer is used to the taste of goby fish shrimp paste which adding some ingredient might have a negative impact to an existing customer.

Regarding the result of an experiment by poll voting of the customer by blind tasting at a restaurant, it can guarantee that our taste of the product quite satisfies customer which no need to improve in the taste of shrimp paste.

4.5 Packaging Development

4.5.1 Trial and error result of packing

First, the experiment with packing to 2 types of packaging and compare to existing packaging. The existing bottle PP (polypropylene) with paraffin. Another two are packing testing which conducted on safety lock PP (polypropylene) and easy end open bottle PET (polyethene terephthalate). The results are shown below. The PET is selected from Gikit company (Gikit, 2019) as they met with the ISO9001 standard of quality. There is various shape for selecting packaging. The size of 180ml is selected to do in this experiment because it is the nearest size to the existing. Besides, the size of 180 is also closed to 216 grams as a result of the survey. In addition, the pet with EOE type is using the sealer machine. I ask cooperation from the company for trail for this experiment.



Figure 41 Gikit EOE sealing machine

While, Reangwa company (Reangwa, 2019) is selected for another choice of packaging as they also met with iso9000 standard and typically export product globally. However, the safety lock type of packaging has a similar size of 130ml. The first PET

was tested filled-in shrimp paste on early February of 2019. There was no spilt of shrimp paste outside of the packaging. The packing is used by hand and pushes the lid to completely close the can. The shrimp paste needs to touch the lid due to salt will not form on the top of the shrimp paste, which results in dissatisfaction of the customer.



Figure 42 packing of shrimp paste with 2 different packagings (EOE and safety lock)

Meanwhile, the safety lock type similarly tests on the same period, found that it spilt of salty water which came out of the packaging. Therefore, Blanctec water absorption paper is used for fresh food, meat, etc. which applied to the safety lock packaging. The background of this company met with European standard and ISO9000 standards (Blanctec, 2019). However, the size of the paper fixed as the smallest size is 110x75mm. However, the diameter of the opening of RW1680 is 72mm. Then I decided to fold it in half and packing.



Figure 43 The Blanctec is used with Safety lock

The result of using Blanctec to block the salty water from spilling is working, but the image of the packaging is not appropriated as it looks similar to a diaper.

The net weight of both packagings is measured with a standard scale. As described in the method, the gross weight (W_g) is subtracting to packaging weight (W_p) as a result to gain net weight (W_n).

1. PET can with EOE



Figure 44 PET Packaging weight is 31g and Gross weight is 213g

The net weight of shrimp paste can be computed as $213g - 31g = 182g$.

2. PP can with safety lock



Figure 45 PP with safety lock Packaging weight is 14 and Gross is 160g

The net weight of shrimp paste can be computed as $160\text{g} - 14\text{g} = 146\text{g}$.

The packing for testing colour and observation was done on 14 April 2019, with 6 cans for each type of packaging. That means the measurement and observation of 2 months will occur on 14 June 2019. All of 6 cans from each type of can will be measure the colour on each period. The table below illustrated the measurement of colour which value of L^* , a^* , and b^* are shown. The first sample is set to be standard as to compared with the other five samples. Therefore, the value of ΔE^*_{ab} of each sample will be compared to sample 1. The tolerance was set to be at 2.

	L*	a*	b*	ΔE^*ab	Status
1. PET w/ EOE					
sample 1	42.60	7.36	9.89	-	standard
sample 2	44.85	7.44	10.40	0.52	passed
sample 3	44.00	7.25	10.61	0.85	passed
sample 4	43.92	6.71	9.55	1.79	passed
sample 5	43.77	6.92	10.23	1.35	passed
sample 6	45.88	8.07	10.97	1.24	passed
Average	44.17	7.29	10.28	1.15	passed
2. PP w/ safety lock					
sample 1	40.06	5.89	10.75	-	standard
sample 2	39.27	5.34	11.50	1.66	passed
sample 3	39.28	5.16	11.23	1.81	passed
sample 4	38.73	5.06	10.88	2.31	failed
sample 5	44.66	6.03	9.97	4.60	failed
sample 6	40.41	4.43	11.83	2.22	failed
Average	40.40	5.32	11.03	2.52	failed
3. PP w/ paraffin					
sample 1	44.59	7.31	9.23	-	standard
sample 2	42.99	7.64	10.03	1.82	passed
sample 3	42.73	8.74	9.70	2.39	failed
sample 4	45.67	8.51	9.85	1.72	passed
sample 5	44.60	7.60	9.44	0.36	passed
sample 6	45.47	8.01	10.47	1.67	passed
Average	44.34	7.97	9.79	1.59	failed

Table 28 Color measurement results at 2 months fermentation



Figure 46 Figure CS-100 colourimeter measurement

The value of CIELAB can illustrate that PET with EOE type, and PP with Paraffin type was almost the same value that mean PET with EOE packaging can stop developing in colour. Nevertheless, PP safety lock has failed as L* reduced (darker) and trend to

reduce in a^* (more to green side). Lastly, b^* is a trend towards increasing (more to yellow side). However, the delta E^*ab can illustrate deviation of colour in each packaging type, from the result, PET with EOE passed all tolerance, which means less of deviation.

4.5.2 Label improvement

The label improvement, I will not improve the beauty of the label to attract the customer by keeping the same logo and same background colour, but I will add information. The information that needs to be included in the label is the English language, properties, nutrition fact, ingredients, how to garnish, social media address, expiry, and manufacturing date. The information on not using paraffin highlighted in red. The properties of shrimp paste are listed beside the logo. The properties are long life shelf, no contaminant matter, no food colouring, no preservative, clean and hygienic food. The nutrition facts of shrimp paste are examined and provided the information by the food laboratory of the University of Chula, as mentioned earlier. The ingredient information adjusts from 98% of shrimp and 2% of salt to 85% of shrimp and 15% of salt. The expiry and manufacturing date is included on the PE lid on the top of the can. The comparison of existing and new label is shown below. The material of both labels is a paper sticker label. The actual label cost is 0.5 baht

per piece, but the new label is 1baht per piece as it requires more area in printing.

The expiry date and manufacturing date will stamp on the top of the lid.



Figure 47 label comparison of existing and new



Figure 48 label attached to packaging comparison existing and new

4.6 Statistical Process control packing control result

The operation is shrimp paste packing into a new type of packaging (PET can with EOE). The characteristics for measurement are the length of shrimp paste to led and net weight. Frequency of measurement is 2 times, with 10 samples per time. The data are shown below in the table.



Figure 49 image of packing and measuring

	time 1			time 2		
	length (mm)	gross weight (g)	net weight (g)	length (mm)	gross weight (g)	net weight (g)
1	4	215	185	2	212	182
2	2	215	185	2	214	184
3	3	215	185	2	211	181
4	2	211	181	3	210	180
5	3	214	184	2	215	185
6	2	220	190	2	217	187
7	3	212	182	3	218	188
8	1	219	189	4	210	180
9	2	210	180	2	215	185
10	2	217	187	1	218	188
x bar	2.4	214.8	184.8	2.3	214	184
R bar	3	10	10	3	8	8

Table 29 Raw data for packing time 1 & 2 with the calculation of R-bar and X-bar

	Average	
	Length (mm)	Net weight (g)
x bar	2.35	184.4
R bar	3	9

Table 30 Table average of R-bar and X-bar

Length of lid to shrimp papste				
		x-chart		R-chart
	UCL	7.99	UCL	9.81
	LCL	-3.29	LCL	0
	CL	2.35		3

Table 31 Table length of the lid to shrimp paste

Net Weight of shrimp paste				
		x-chart		R-chart
	UCL	201.32	UCL	29.43
	LCL	167.48	LCL	0
	CL	184.4		0

Table 32 Table length and weight of shrimp paste

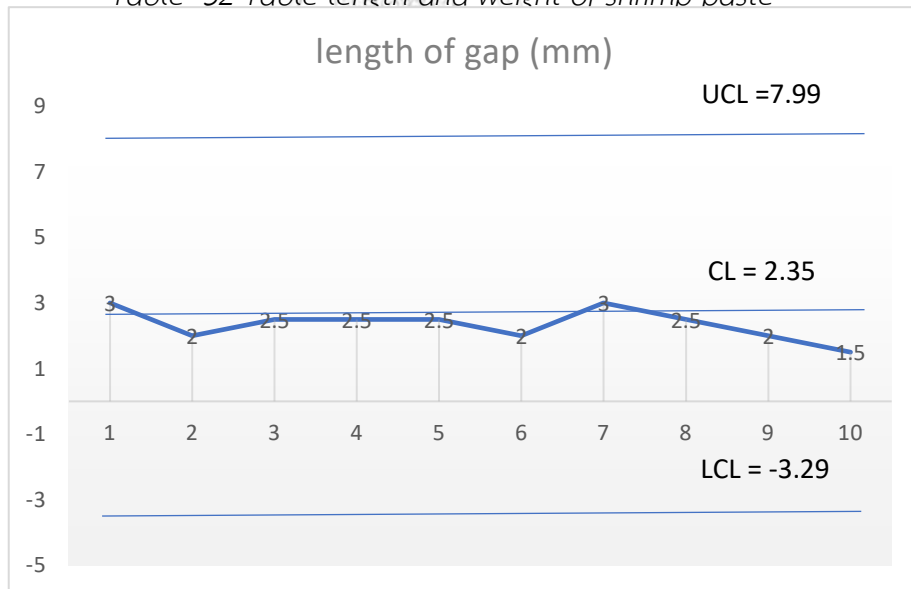


Figure 50 X-chart Length of the gap between shrimp paste and lid

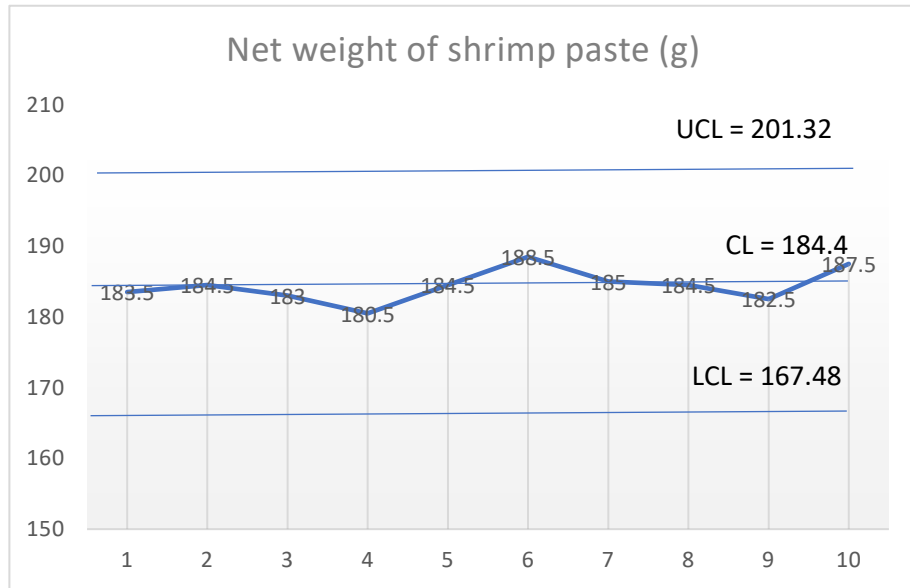


Figure 51 X-chart Net weight of shrimp paste

The result of SPC illustrated that packing quality is in acceptance range which not reach the upper and the lower limit, but there is room to be improved due to it has overweight above 180g which result of waste in resources.

4.7 Product's profit margin result

Existing packaging (135g / 580g)

The selling price

The selling price of 15.27 and 20 baht per piece for wholesaling and retailing, respectively.

(for 580g wholesale is 60 baht and retail is 80baht)

Raw material cost

The raw material of shrimp paste with transportation is obtained by 1 kg equal to 45baht. Therefore, the unit cost is 45 divided by 1,000g, which equal to 0.045 baht per gram.

Packaging cost

Primary packaging, the packaging with transportation is 3 baht per unit and label cost is 0.25baht per unit

(for 580g = 6baht + label 0.5baht)

Secondary packaging, cartons with transportation is 5 baht per 36 units, 0.13baht per unit

(for 580g = 5 baht per 12 units, 0.41baht per unit)

Paraffin cost

Whereas paraffin cost is 80baht per 1,000g. 1000g can be used for 45 of 580 gram (diameter of 10cm with an area of 78.5cm²). Therefore, 1000g can used for $45 \times 78.5 \text{cm}^2 = 3532.5 \text{cm}^2$ per 1000kg. Whereas small packaging has a diameter of 7cm. The area of small packaging is 38.47cm². So $3532.5 \text{cm}^2 / 38.47 \text{cm}^2$ will equal to 92 pieces of a small package. The unit cost of paraffin for the small package is $80/92 = 0.87 \text{baht}$. (for 580g = $80/45 = 1.78 \text{baht}$ per unit)

Gas cost

The gas was used for 3 months per 15kg of gas which cost 2,000 baht. The production line able to contribute with a capacity of 500 dozen of big size (6,000 pieces) and 100 three dozen (3,600 pieces) of small size. 15kg can use for paraffin big size = $133 \times 3 = 400 \text{kg}$ and small size $39 \times 3 = 117 \text{kg}$, totally melting paraffin 517kg per 3 months with use of 15kg of gas. The unit cost of gas expense can be calculated by

2000 divided by 517kg, which equal to 3.87 per kg. If 1 kg can contribute 92 pieces of small size. Therefore, the unit cost is 3.87 divided by 92 pieces which equal to a unit cost of gas per 1 small size, which equal to 0.04 baht. (for 580g 3.87baht per kg of paraffin can contribute 45 pieces, equal to $3.87/45 = 0.086$ baht)

Water and electricity cost

The meter was installed separately for shrimp paste factory, usually one month, electricity cost is 1,000 baht and water is 1,000 baht. Electricity cost is from fan and lighting. Water is from washing equipment and cleaning places in the factory. Regarding the capacity of 500 dozen of big size (6,000 pieces) and 100 three dozen (3,600 pieces). If weight into kilograms, the total will equal 3,480kg and 486kg = 3,966kg which calculate into percentage big size is 87.7% whereas the small size is 12.3%. If compute for 2,000 multiply by 12.3% is equal to 246baht per 3,600 pieces. Therefore, the unit price for electricity and water for small size is 0.068baht per piece. (for 580g, 2000baht multiple by 87.7% equal to 1,754 and divided by 6000 which equal to 0.29baht per unit)

Worker cost

There are 2 workers in a factory, one worker who is head worker pay with a fixed cost of 12,000 baht per month. Another worker pays on what she did or pays by performance. The work separated into two main jobs. The first job is to separate raw material into plastic boxes and separate the volatile matter of the raw material and put 60kg of shrimp paste in the box. The second task is packing shrimp paste into

packaging with a label for secondary packaging and input into the paper box for tertiary packaging (big size with dozen of secondary packaging and small size with 36 of secondary packaging). There are 20 working days, and each task was done for 10 days. Normally, task1 is done with 1 day of 6-7 boxes for 1 box worker will get pay around 50baht. If 7 boxes per day were done in 10days will be the amount of 3500 baht. As percentage for small packaging is equal to 3500 multiples by 12.3% which equates to 430.5 need to add the fixed cost of labour 1 assume to do half of this job which is 6000baht multiple by 12.3% which equates to 738baht. As a result of task 1, a total of 1,168.5baht (for small packaging only). 1,168.5 divided by 3,600 pieces will equal to 0.32 worker cost per unit of task 1.

Task2 is done with a month of big size 6000pieces and small size 3600pieces. If 10 days of working in 1 month. These workers were packing shrimp paste, tertiary packaging for big size costs 12baht per packaging. The small size costs 10 baht per packaging. 500 of dozen big size is 6,000 baht per month, and 100 of three dozen of small size is 1,000 baht. Total of pay rate for packing of worker is 7,000 baht per month. 7,000 is multiple by 12.3%, which is 861 baht and worker 1, which is fixed cost by 12.3% of 6,000baht is 738 baht. As a result of task 2, a total of 1599baht (for small packaging only). 1599 divided by 3,600 pieces will equal to 0.44 worker cost per unit of task 2

Task1 and task2 will equal to $0.32+0.44 = 0.74$ baht for the total labour cost per unit

(for 580g, Task1 $(3500 \times 87.3\% + 6000 \times 87.3\%) / 6000 = (3055.5+5238) / 6000 = 1.38$

baht

Task2 $(7000 \times 87.3\% + 6000 \times 87.3\%) / 6000 = (6111+5238) / 6000 = 1.89$

baht

Total labour cost per unit is $1.38 + 1.89 = 3.27$ baht)

New packaging (180g & 700g)

The selling price

The selling price new packaging for 180g is 25 and 30 baht per piece for wholesaling and retailing respectively.

The selling price new packaging for 700g is 80 and 90 baht per piece for wholesaling and retailing respectively.

Raw material cost

The raw material of shrimp paste with transportation is obtained by 1 kg equal to 45baht. Therefore, the unit cost is 45 divided by 1,000g, which equal to 0.045 baht per gram.

Packaging cost

The packaging of E.O.E. with transportation is 6.45 baht per unit and label cost is 1baht per unit whereas 12.81 baht per unit of 700grams and label cost of 2 baht.

Machine running cost

It is a seamer machine with the power of 200W and voltage of 200V 1 P. If the assume of productivity is the same as existing. Therefore, 6000 units of big size and 3600 units of small size per month. The machine speed capability of can seamer is 10seconds per can. Therefore, 9600 units per month. The time spends for can seamer will be $9600\text{units} \times 10\text{seconds} = 96,000 \text{ seconds} = 1,600 \text{ minutes} = 26.6 \text{ hours} = 3.33 \text{ working days (8 hours non-stop)}$.

In order to compute, the formulation is from MEA of Thailand (Metropolitan Electrical Authority)

Rate of unit is 4.4217baht if use more than 400 unit per month

$(\text{Power (watt)} \times \text{number of machine}) / 1000 \times \text{hour of using in one day} = \text{unit per day}$

$(200 \times 1 / 1000) \times 8 = 1.6 \text{ unit per day} \times 3.33\text{days} = 5.238 \text{ units per month} = 5.238 \times$

$4.4217 \text{ baht} =$

$23.16 \text{ baht per month} \times \text{by } 12.3\% \text{ for small packaging} = 2.84 \text{ baht} / 3600 =$

$0.0008\text{baht per unit}$

$23.16 \text{ baht per month} \times \text{by } 87.3\% \text{ for big packaging} = 20.22 \text{ baht} / 6000 = 0.0034\text{baht}$

per unit

Water and electricity cost

Assume the water and electricity of the factory is similar to the existing packaging

Worker cost

Assume that the worker cost remains the same since they need to process of dispatch from bags into boxes and packing. However, the process of melting paraffin is cut out of the production process.

Table of Product's profit margin calculation		Product A (existing) 135g	Product B (new) 180g	Price increase	
Selling price (wholesale / retail)		15.27 / 20 baht	20 / 30 baht	WH=30.97 %	RT= 50%
Obtainin g price	Raw material cost w/ transport	0.045x135 = 6.075	0.045x180 = 8.1	135g = 11.79baht 1g=	180g=16.49bah t 1g =
	Packaging & label cost w/ transport	3baht + 0.25 +0.13 baht	6.45+1+0.1 3 baht	0.0873baht 1kg = 87.3baht	0.0916baht 1kg = 91.6baht
	Paraffin	0.87baht	-		

	Expense cost (machine/gas)	0.04baht	0.0008baht		
	Expense cost (water/electricity)	0.068baht	0.068baht		
	Expense cost (worker)	0.74baht	0.74baht		
	Total of obtaining cost	11.79bah t	16.49baht	% diff = (91.6-87.3 / 87.3) *100 = 4.92%	
	Gross profit margin (selling price – obtaining price)	3.48 / 8.21 baht	3.51 / 13.51 baht		
	Profit margin % (gross profit / selling price)	22.79% / 41.05%	17.55% / 45.03%		

Table 33 calculation of the product's profit margin comparison between existing packaging 135g and new packaging 180g

Regarding the comparison of existing and new packaging, the unit price is steady at 0.11g/b for a unit price for wholesaling, but the selling price is raised due to increase

in the volume of more than 40g. However, the profit gross margin is decreasing by around 5%, but the price for the retailer is increasing by around 4%.

Table of Product's profit margin calculation		Product A (existing) 580g	Product B (new) 700g (GKPE700)	Price increase	
Selling price (wholesale / retail)		60 / 80 baht	80 / 90 baht	WH=33.33%	RT=12.5%
Obtaining price	Raw material cost w/ transport	0.045x580 = 26.1	0.045x700 = 31.5	580g=38.44baht 1g =	700g=50.28baht 1g=0.0718baht
	Packaging & label cost w/ transport	6baht + 0.5 + 0.41baht	12.81+2 + 0.41baht	0.06627baht	
	Paraffin	1.78baht	-	1kg =	1kg= 71.83baht
	Expense cost (machine/gas)	0.086baht	0.0034baht	66.27baht	
	Expense cost (water/electricity)	0.29baht	0.29baht		
	Expense cost (worker)	3.27baht	3.27baht		

	Total of obtaining cost	38.44	50.28	% diff = $(71.83-66.27 / 66.27)$ *100 = 8.39%
Gross profit margin (selling price – obtaining price)		21.56 / 41.56	29.72 / 39.72	
Profit margin % (gross profit / selling price)		35.93% / 47.54%	37.15% / 44.13%	

Table 34 calculation of the product's profit margin comparison between existing packaging 580g and new packaging 700g

According to unit price of existing and new, it has raised from 0.10b/g to 0.11b/g for wholesaling, the profit margin percentage for wholesaling is increasing by around 1 percentage but the retailing price, result decreasing of 3 percentage for profit margin.

4.8 Schedule plan

ID	Description	workspk	Schedule		MATERIAL		MANPOWER		2019												2020					Remarks			
			Start	Finish	Unit	cost/unit	Unit	cost/day	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP		OCT	NOV	DEC
1	Shrimp paste quality enhance	548	2-Apr-19	30-Dec-20																									
1.1	Packaging Improvement	103	2-Apr-19	30-Jul-19																									
	Packaging design	84	2-Apr-19	8-Jul-19																									
	-Shrimp paste properties analysis	32	2-Apr-19	30-Apr-19																									
	-Survey (Quantitative and Qualitative)	14	15-May-19	30-May-19																									
	-QFD analysis	26	1-Jun-19	1-Jul-19																									
	-Packaging trial and error	52	12-Apr-19	11-Jun-19																									
	Test at 1 month	4	11-Jun-19	14-Jun-19																									
	-Packaging selection	7	1-Jul-19	8-Jul-19																									
	-label improvement	52	12-Apr-19	11-Jun-19																									
1.2	Seamer Machine investment	13	16-Jul-19	30-Jul-19	2	25,000	50,000	0	0																				
2	Food and drug administration (future)	105	1-Aug-19	30-Nov-19																									
2.1	Preparation	59	1-Aug-19	8-Oct-19																									
	Factory renovation	13	1-Aug-19	8-Oct-19																									
	Wair	15	16-Aug-19	15-Aug-19	16	2,500	40,000	5	500																				
	Wair	13	16-Aug-19	30-Aug-19	60	500	30,000	5	500																				
	Tile	7	31-Aug-19	2-Sep-19	140	150	21,000	5	500																				
	Tile	3	8-Sep-19	11-Sep-19	80	200	16,000	5	500																				
	Ceiling	3	11-Sep-19	13-Sep-19	1	10,000	10,000	1	500																				
	Stainless doors	14	14-Sep-19	30-Sep-19	200	250	50,000	5	500																				
	Net to protect insects	7	1-Oct-19	8-Oct-19	2	5,000	10,000																						
	- Equipment	7	1-Oct-19	8-Oct-19	4	2,500	10,000																						
	stainless tables	7	1-Oct-19	8-Oct-19	4	2,500	10,000																						
	stainless chairs	7	1-Oct-19	8-Oct-19	4	2,500	10,000																						
	stainless locker (for personal belonging and clothes)	7	1-Oct-19	8-Oct-19	4	10,000	40,000																						
	stainless racks (for storing cans and lids)	7	1-Oct-19	8-Oct-19	4	10,000	40,000																						
2.2	Food and drugs administration document submission	27	9-Oct-19	8-Nov-19																									
	- Submission SB1 (fee)	7	9-Oct-19	16-Oct-19	1	10,000	10,000																						
	- Audit	7	16-Oct-19	23-Oct-19																									
	- Submission SB1	13	23-Oct-19	6-Nov-19																									
	- Submission SB5 (fee)	7	6-Nov-19	13-Nov-19	1	10,000	10,000																						
	- Received FD code	16	13-Nov-19	30-Nov-19																									
3	Modern trade (future)	359	1-Dec-19	30-Dec-20																									
	- Sourcing for modern trade partner (lobis, big c and makro)	26	1-Dec-19	31-Dec-19																									
	- Presentation to modern trade partner	27	7-Jan-20	6-Feb-20																									
	- Blank loan	27	6-Feb-20	7-Mar-20	1	-2,000,000	-2,000,000																						
	- Agreement on business deal (first pay for vendor list)	26	7-Mar-20	6-Apr-20	1	1,000,000	1,000,000																						
	- Start implement of 1st modern trade partner (3 month probation)	78	13-Apr-20	12-Jul-20																									
	- Hire worker	26	7-Mar-20	6-Apr-20																									
	Driver (salary)	27	13-Apr-20	13-May-20	1	350	350																						
	Worker (salary)	16	7-Mar-20	6-Apr-20	2	350	700																						
	- Monitoring and evaluation	221	6-Apr-20	30-Dec-20																									

Table 35 Schedule plan for shrimp paste quality enhancement

The preparation of Food and drugs administration and Modern trade will be explained later in Future work. The packaging

improvement has a duration between 2nd April until 30th July 2019

4.9 Financial analysis result

4.9.1 Breakeven point analysis

The breakeven point illustrates in the below details, this included future work to register for Food and drug administration which invest in renovation cost. This case will be divided into 2 situations, whereas first situation conduct continues selling with the same distributors (a unit price that excludes modern trade). The second situation is included in modern trade correlated cost. Therefore, as a result, the outcomes should be able to investigate the possibility of modern trade entrance.

Formula

Total revenue = price x number of units ($TR = P * X$), (revenue function)

Total cost = variable cost x number of units + total fixed cost ($TC = VC * X + FC$),
(cost function)

BEP, $TR = TC$

$$PX = VC * X + FC$$

$$BEPX = FC / (P - VC) \quad , \text{ where } p = \text{price}$$

Case1.1 (No modern trade with new packaging 700g new price)

Fixed cost	Cost (THB)
- Renovation cost	293,500
- Equipment cost	70,000
- Machinery cost	50,000
- Document fee	20,000
Total fixed cost (FC)	433,500
Variable cost (per unit 700g.) (VC)	50.28
Wholesaling Price (700g.) (P)	80.00
Breakeven point in units [FC / (P - VC)]	433,500 / (80-50.28)
	14,587units
	(20,107x700)/1000 = 10,210kg

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Case1.2 (No modern trade with new packaging 180g new price)

Fixed cost	Cost (THB)
- Renovation cost	293,500
- Equipment cost	70,000
- Machinery cost	50,000
- Document fee	20,000

Total fixed cost (FC)	433,500
Variable cost (per unit 180g.) (VC)	16.49
Wholesaling Price (180g.) (P)	25
Breakeven point in units [FC / (P - VC)]	$433,500 / (25 - 16.49)$ 50,941units $(50,941 \times 180) / 1000 = 9,169\text{kg}$

Table 36 Breakeven units calculation with traditional trade on 700g and 180g

Based on the calculation of breakeven point, both case 1.1 and 1.2, is shown that the smaller size of 180g would use lesser resources to contribute to the breakeven point with 9,169kg and 50,941 units. Regarding previous selling information, around 25,000kg was sole per year. Therefore, half of the year, it might be able to contribute 10,000kg which cover the revenue investing for Food and Drug Administration registration preparation.

Case 2.1 (Modern trade with new packaging 700g new price)

Fixed cost		Cost (THB)
Food and Drug		
- Renovation cost		293,500
- Equipment cost		70,000
- Machinery cost		50,000
- Document fee		20,000
Modern trade		
- Account opening		
- Interest rate (10% per year)		1,000,000
Total fixed cost (FC)		200,000
		1,633,500
Variable cost (per unit 700g.) (VC)	$50.28+(120*0.37)$	94.68
Modern trade charged (37% from selling price)		
Retailing Price for modern trade (700g.) (P)		120.00

Breakeven point in units $[FC / (P - VC)]$	$1,633,500 / (120-94.68)$ 64,515units $(64,515*700)/1000 = 45,161\text{kg}$
--	---

Case 2.2 (Modern trade with new packaging 180g new price)

Fixed cost		Cost (THB)
Food and Drug		
- Renovation cost		293,500
- Equipment cost		70,000
- Machinery cost		50,000
- Document fee		20,000
Modern trade		
- Account opening		
- Interest rate (10% per year)		1,000,000
Total fixed cost (FC)		200,000
		1,633,500
Variable cost (per unit 180g.) (VC)	$16.49+(40*0.37)$	31.29

Modern trade charged (37% from selling price)	
Retailing Price for modern trade (180g.) (P)	40.00
Breakeven point in units [FC / (P - VC)]	1,633,500 / (40-31.29) 187,544units (187,544*180)/1000 = 33,758kg

Table 37 Breakeven units calculation with modern trade on 700g and 180g

According to breakeven point calculation in case 2.1 and 2.2, the smaller packaging 180g would use fewer resources compared to the 700g size. There are significant differences between shrimp paste weight around 10,000kg that will contribute to total revenue. The modern trade will charge around 37% of the selling price. Therefore, the selling price for modern trade needs to be adjusted to be more expensive than the regular price. As a consequence, to cover the cost of modern trade that included (GP, DC and rebate costs see further in a future chapter).

4.9.2 Cash flow forecasting

If assuming of entrancing modern trade with 1,000 branches, the minimum finished goods that will need to contribute to modern trade's distribution centre is dozen of 180g per branch — the total of good finished need to be 12,000 units. The production capacity of 1month is 500 dozens of significant size (6,000 units) and 100 of 3times dozens (3,600 units). Regarding changing procedure of exclude melting paraffin process. The production could be reached to 12,000 units in 1 month period but the actual traditional trading, the company need to maintain, therefore, the 12,000 units, the company might need to pay for overtime period for the worker because modern trade is an unforeseen sale, so it not necessary to hire new worker yet. However, the credit term with deal with modern trade usually will pay within 3 months period because it is paid based on sale volume with consignment term. Therefore, the company needs to have healthy cash flow as a consequence to absorb 3 months of the total cost.

The 187,544 units are the amount that needs to be sold to reach the revenue cost. 187,544 units divided by 12,000 units equal to 15.62 times, a total of 33,758kg. Regarding previous, current sale is approximately 30,000 kg per year in the south area of Thailand. Therefore, it is possible to reach 33,758kg in one year of modern trade since modern trade is distributed in all location in Thailand.

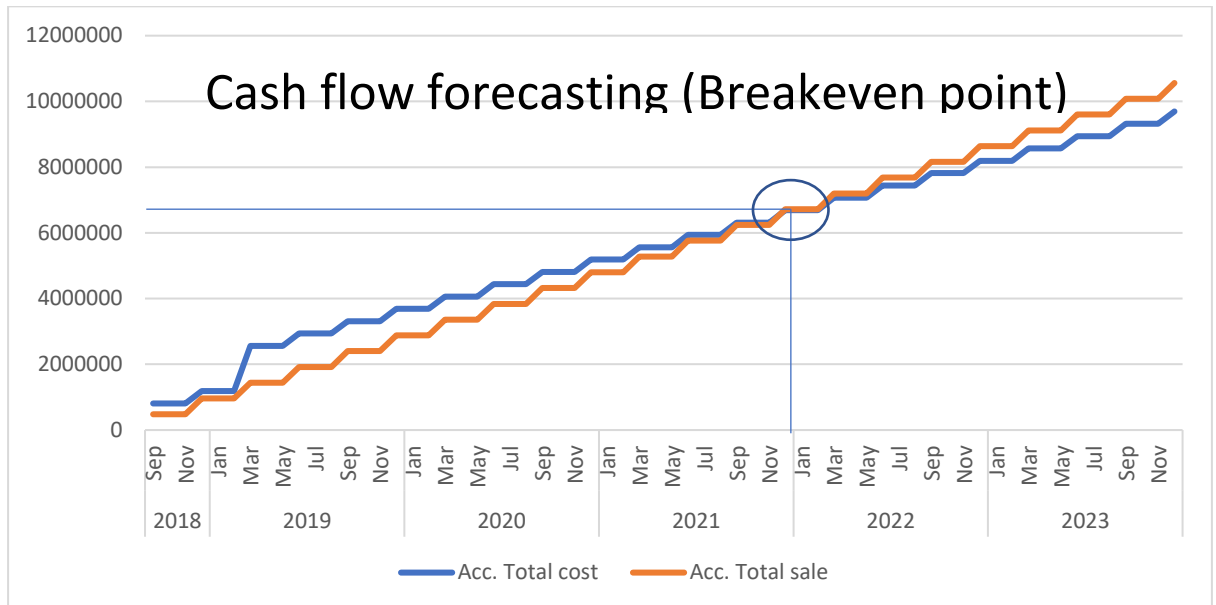


Figure 52 cash flow forecasting breakeven point

The above graph includes 10% of interest payment for 2 million baht bank loan. The assumption of production volume is 12,000 units per 3 months and sale volume of 100% of 12,000 units. The assumption is included only new packaging that sold in modern trade platform. Thus, the traditional trade is not taken into this account for the calculation of breakeven point. Referring to the graph above it is a 3 year R.O.I (return of investment). For more details, the balance sheet account is shown in the appendix section.

Chapter 5 Discussion

The discussion separates mainly into 2 parts, part 1 is related to shrimp paste quality, and part 2 is relevant to packaging.

5.1 Shrimp paste quality

The properties of shrimp paste between Goby fish shrimp paste and literature of other shrimp pastes which compared correlate to TISI-1080-2535 standard.



Shrimp paste	Ash (not dissolve in acid) (%)	NaCL (%)	pH	Aw	Moisture (%)	Protein (%)	Fat (%)	Nitrogen
TISI-1080-2535	<= 0.5	>=36	6.5 – 7.8	N/A	<=45	-	-	>=58
SK avg (30samples)	16.75	11.95	6.73	0.73	43.33	-	-	23
KK avg (14 samples)	24.09	21.78	7.35	0.72	41.86	22.29	1.23	61.64
MB	19.15	14.94	7.56	0.73	47.92	30.38	0.63	-
KS	13.95	12.87	8.50	0.77	21.13	56.59	0.82	-

PS (4samples)	avg -	14.40	7.47	0.72	53.90	14.41	1.10	-
IT	29.12	16.75	7.53	-	37.41	25.42	6.11	-
GF	0.45	37.12	7.46	0.72	51.60	22.03	2.16	-

Table 38 Comparison of shrimp paste properties with TISI-1080-2535

The ash which not dissolve in acid is incomparable due to other shrimp paste the only % of total ash available. However, Goby fish shrimp paste passed the standard which below than 0.50. Interestingly, NaCl percentage of Goby fish shrimp paste is outstanding, whereas others failed to pass the measure. PH of Southern shrimp paste is low resulted from input of flour and sugar as mentioned earlier. It also reflects with nitrogen to be below the standard. The parameter of moisture content is the only parameter that goby fish shrimp paste failed to pass in this table. In order to solve this issue is to prolonger of the drying process.

Lists of testing	TISI 1080-2535	Lab results
Total Plate count	Less than 1×10^5 CFU/g	9,200CFU/g
Coliforms	< 3MPN/g	< 3MPN/g
S. aureus	Not detected in 0.1g	Not detected in 0.1g
C. perfringens	Not detected in 0.01g	Not detected in 0.01g

Salmonella spp.	Not detected in 25g	Not detected in 25g
Yeast & Mold	<50CFU/g	100 CFU/g

Table 39 Hygienic lab result

Another parameter that failed from the standard is Yeast & mould, this might have resulted from overfermentation. In order to avoid this problem, the shrimp paste should not be kept over 6 months.

5.2 Packaging

The paraffin is used in existing packaging. It aimed to be removed consequently to be able to register the Food and Drug Administration (FDA). This would be affected by the increase in quality standard. The customer also gives this factor as second prioritises of selecting the shrimp paste product which research data from FMEA and QFD. If gaining FDA, it results in gaining of company reputation and increase product value. The packaging that was selected is Easy open ends with PET material. The benefits from this are that customer able to see the shrimp paste colour clearly because PP material is lower transparent visualise.

Regarding the research of colour observation of 3 types of packaging, which are PP with paraffin, PP with safety lock and PET with E.O.E.

The results of 2 months fermentation shown that PET with E.O.E. and PP with paraffin has a similar result which this means the new packaging can be a substitute for paraffin as it can the perseverance of shrimp paste colour.

The drawback from changing packaging is that it is more expensive, which resulted in raised price. However, the total expense cost for packaging by kilogram of shrimp paste to Thai baht is around 5 – 10 percentages. The new price will rise by 10 -50 percentages; therefore, this should be able to cover the cost. The label is developed to capture customer by attraction and additional information. After the packaging is developed, there is an excellent opportunity that the product can spread into the modern trade market. Even though there are 3 years of return in investment, but the company can expand its market. The price of modern trade is shown below to compare with others. It is not over the market price, which should be able to compete with others.

The logo of Chulalongkorn University, featuring a central emblem with a crown and a sunburst, surrounded by a circular border with Thai text.

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Price list	Tra Rueng Bai	Tra Kung Thai	Tra Chu Tra Chung	Goby fish
90g		13 (0.14b/g)	20 (0.22b/g)	
135g				20 (0.15b/g)
175g	34 (0.19b/g)			
180g				40 (0.22b/g)
185g			40 (0.22b/g)	
200g		25 (0.12b/g)		
400g	64 (0.16b/g)	45 (0.11b/g)	77 (0.19b/g)	
500g	70 (0.14b/g)			
575g			107(0.19b/g)	
580g				80 (0.14b/g)
700g				120 (0.17b/g)
1000g		110 (0.11b/g)		

Table 40 Market price comparison with modern trade



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Chapter 6 Conclusion

Regarding the study of chemical and physical properties of shrimp paste, the standard of TISI-1080-2535 has mostly met the condition, except for yeast & mould and moisture content. The worker who packed the shrimp paste before the examination. They confessed that they did put in salty water into the shrimp paste before packing as a result of easier packing with the containment because they did not get used to the new packaging. These might be the results where those two parameters are over the condition. In order to ensure to solve this problem, the drying process is extended to prevent over in percentage of moisture content.

Furthermore, the stock of raw material must not exceed 6 months period to prevent yeast and mould from developing. Referring to other shrimp pastes parameter that was in the literature review, their condition mostly did not meet because they put in sugar and flour to reduce their cost. However, referring to QFD results, the TISI standard has not attracted the customer from choosing the product, and all the competitors in the shrimp paste industry were not received TISI standard. Therefore this might be an excellent opportunity to gain this standard. However, that might be considered in the future.

Besides, the selection of appropriate packaging is one of the quality enhancement in this dissertation. This research found that paraffin oil was prohibited for the food industry, so this thesis contributes a possibility of appropriate packaging which

matches to shrimp paste. There were QFD and FMEA involved in developing the packaging. The packaging was selected from QFD, which was mainly based on customer's satisfaction and technical parameter that correlated with shrimp paste. Rigid packaging is assumed to be used. The plastic packaging with a completely closed end is selected as packaging for the shrimp paste. Regarding the glass for packaging is not suitable for bulk transportation because it is easily damaged. Even though it might look transparent, but it is heavier than plastic, which as a consequence, it effects increasing of cost for transportation. Moreover, the glass material is also more expensive than plastic. Therefore, glass is not an option. Furthermore, steel or aluminium can is unable to suit with shrimp paste since it reacts with salt to form corrosion. The shrimp paste product is rich in salt. Nevertheless, if using high specification of steel can that resisted salt, it may affect very high cost. However, based on the literature review, there are 3 types of commercial packaging which, according to the product, there were only 2 commercial packagings, which are primary packaging and secondary packaging. I was not planned to develop on secondary packaging (carton) since it is used for protection in transportation when delivery in bulk. The primary is developed so that it can attract customer on the shelf.

The shrimp paste was packed into 2 possible types of packaging to compare with the original product with paraffin. The result of colour measurement was satisfied as PET plastic with EOE opening is remained the colour as same as the paraffin. Therefore, it

can slowly stop microorganism from developing. Nevertheless, 2 months might not be sure, it needs to continue monitoring. The taste of shrimp paste is recommended from the customer that it is the most crucial factor from choosing the product. Therefore, the blind test has been conducted, which was conducted at the local restaurant. The result was positive, which is further studied on t-test, which the result is rejected the null hypothesis, which means that goby fish sample has a higher probability of increasing of the vote against other brands. There was a developing in primary packagings such as label that included nutrition facts, expiry date, and manufacture date. All of the above, development is highly aiming for Food and drug registration but in one condition that the company was not ready is that the place, because it needs to be renovated as mention in future work appendix A. The SPC, was the plot in packing control to check their quality in packing. The result is satisfied with no result reached an upper and lower limit. However, the study of this has shown the possibility of making a new packaging compared to the existing in term of finance. The gross profit of existing and new packaging was a slight difference. The increasing expense cost for changing from existing to new packaging resulted that around 5 to 10 percentages, which the new price is set to be around 12 – 50 percentages. This means the new price will be able to cover the cost of obtaining. Therefore, it can remain with the same group of customers who buy the product at the wholesaling price. The study of modern trade is also included in future work. The

calculation of the return of investment is around 3 years. The ends of this thesis, the owner of the goby fish will be able to decide whether to choose to change packaging or remain existing.





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Appendix A *Future work*

As I mentioned earlier in the previous chapter. That the purpose is to able to pass qualification from the Food and Drug Administration of Thailand. Food and Drug Administration of Thailand is followed by GMP standard. This chapter will review the stand of GMP (good manufacturing practice) and how to register the Food and Drug Administration of Thailand. In addition, the information related to modern trade in a convenience store should be review. Even though the reviews of charging cost in modern trade are limited, but there is an interview based on experience after they enter the modern trade of business. Those data are used to compute in the previous chapter.

7.1 GMP standard

GMP standard is globally used in cosmetic, drug and food manufacturing. The terminology is shown in the law of the United States of America in the Code of Federal Regulation title no. 21, part 110. If compared internationally, it appears as a standard of food among countries FAO/WHO (codex) which terminology of General Principles of Food hygiene. Therefore, this standard aims for standardised the manufacturing processes to meet with customer's safety. Which primarily focused on prevent, protect or take any risk that consuming the product is hazardous to the consumer. Then GMP is applied to worldwide including Thailand. GMP included the place of manufacturing, structural of building, manufacturing process and meet

quality in each manufacturing processes which start from manufacturing planning, raw material control, on the process of manufacturing, storage, quality control and distribute. Sanitation and hygiene. GMP is a general standard which leads to another quality standard such as HACCP (Hazards Analysis and Critical control points) and ISO 9000. Thai's law is strictly to follow the GMP standard. Presently, 4 of Thai's law is related to GMP, which are Notification of the ministry of public health no. 193 the year 2000, no. 239 the year 2001, no. 220 the year 2001, no. 298 the year 2006 and no. 342 the year 2012. (Deeprasertwong, 2016) .

Even though in the notification of ministry of public health is excluded shrimp paste from follow GMP standard but 2 of shrimp paste in the market received GMP. Therefore, following GMP will also build trust in the consumer.

GMP consists of 6 requirements which are (FDA, 2000) :-

1. The construction and layout of the food premises
2. Machine and equipment for manufacturing
3. Production control
4. Sanitary
5. Maintenance and clean
6. Personal hygiene

All of these requirements are aims for the safety of the consumer. However, the GMP standard is applied for Food and drug administration registration.

7.2 Food and Drugs Administration of Thailand standard

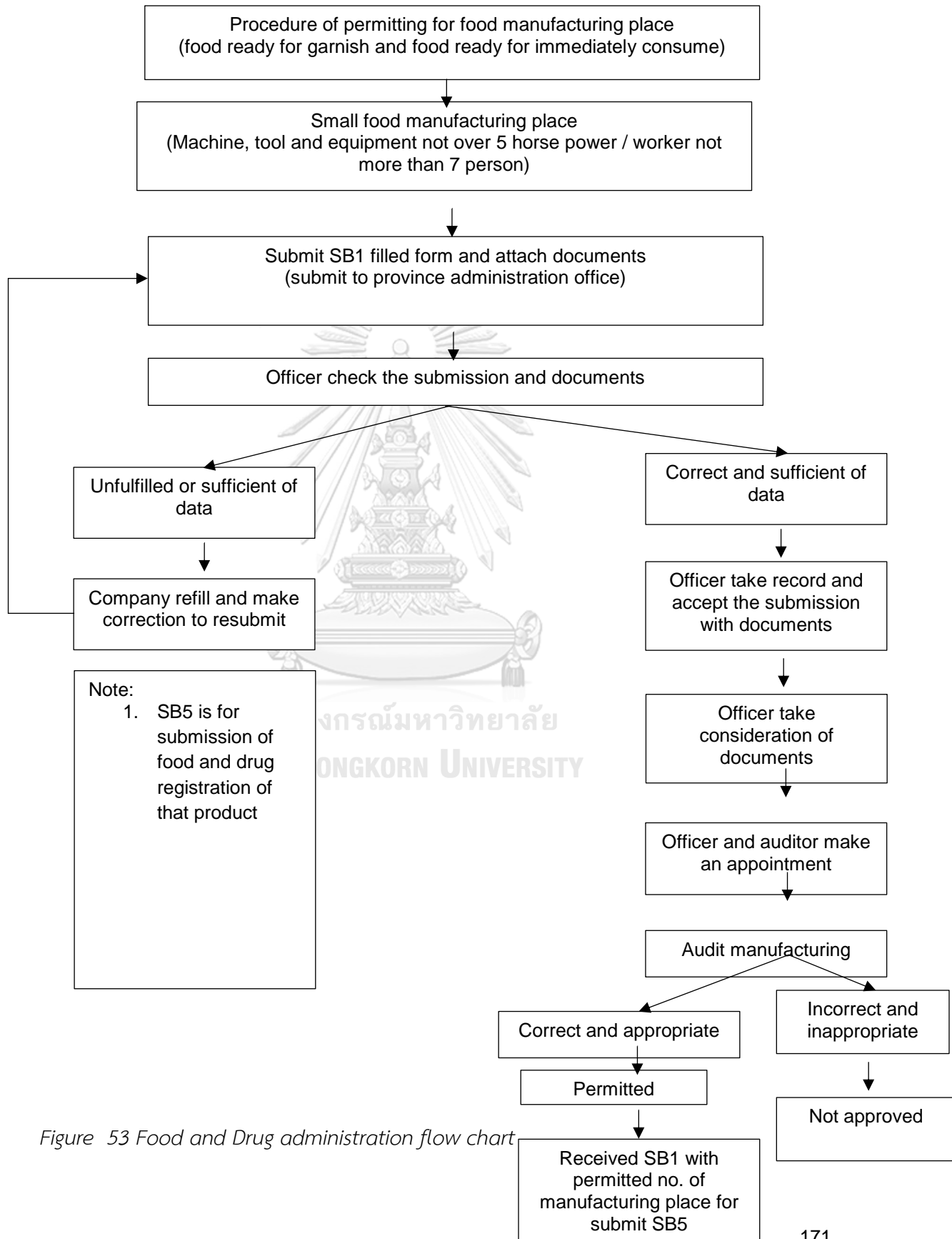


Figure 53 Food and Drug administration flow chart

According to regulation to the registration of food and drug administration, the company must register according to SB1 form. Which the requirement is shown below in no. 6.2.1 to 6.2.3. There is also discussion about future work that related to the goby fish shrimp paste company.

7.2.1 Identification of company

1. Copy of House registration document of the person
2. Copy I.D. card
3. Copy of commercial registration
4. Copy of land
5. Power of authority
6. Copy of House registration document of manufacturing place

4.3.1 Manufacturing place plan (see in appendix)

1. Location plan
2. Site plan
3. Side elevation plan
4. Front elevation plan
5. Floor plan (included line of process, machine, equipment)

4.3.2 Detail related to food manufacturing

1. Source of water usage
2. Food genus
3. Ingredient
4. Type of packaging
5. Production process
6. Amount of production
7. List of machines and electrical machines (electrical/horsepower)
8. Cleaning of machine and packaging process
9. Method of eliminating garbage
10. Number of works (separate into male and female)

7.3 Place and facilities of Goby fish company

There are 2 buildings of Goby fish company, the first building is used for packing and the second building is used for storage. The first building was once acted as packing and storage but then the second building was built since 2010 because the damage of concrete pit in first building but then the first building didn't renovate at all. Which the company tried to keep their empty packaging both primary and secondary packaging above the pit. In order to explain more precise, the photo and plan are shown below.

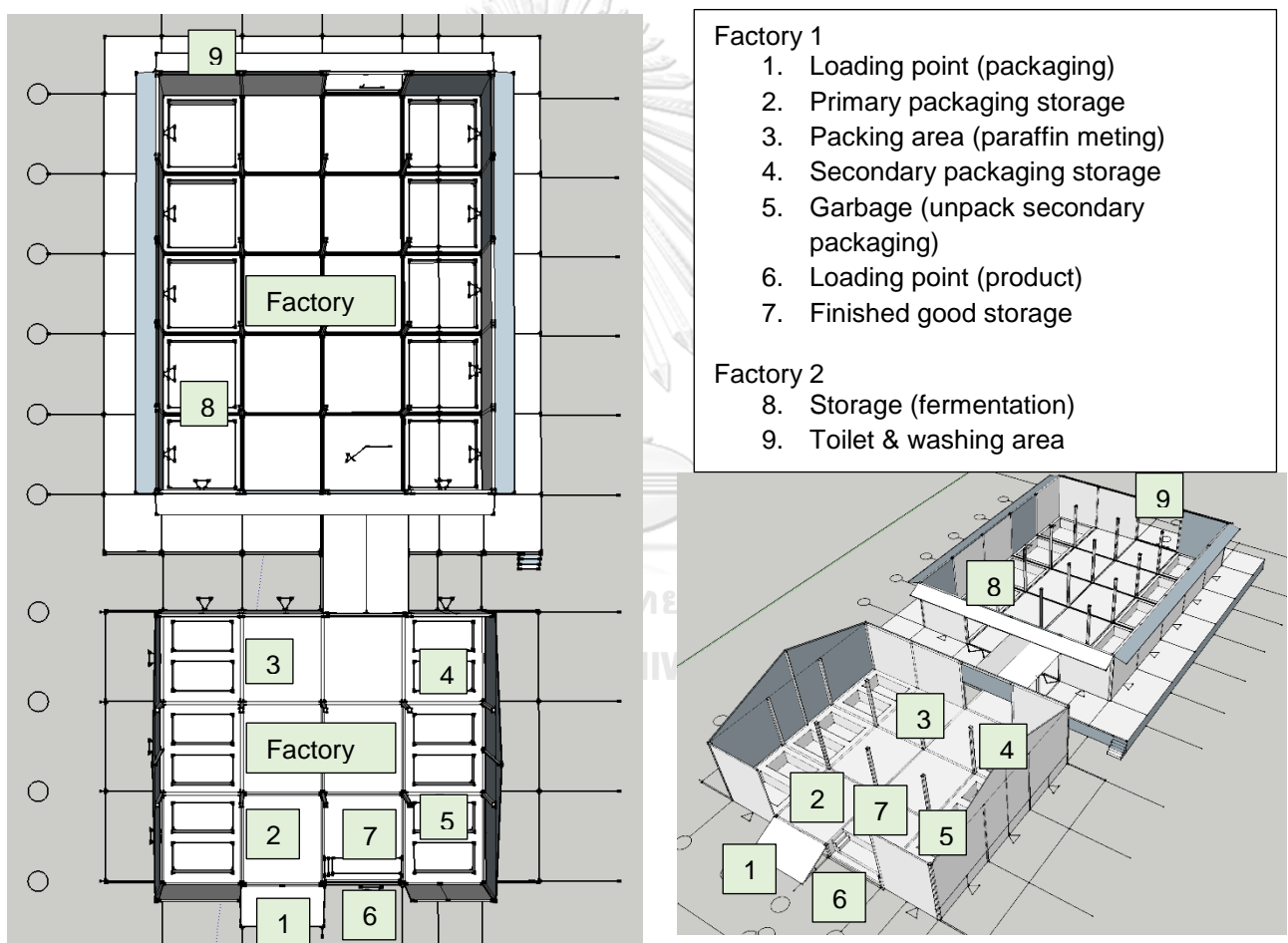


Figure 54 Layout plan of Goby shrimp paste factory



Figure 55 Front view photo of goby shrimp paste factory





Figure 56 Figure Primary packaging storage and Packing area (paraffin meting)



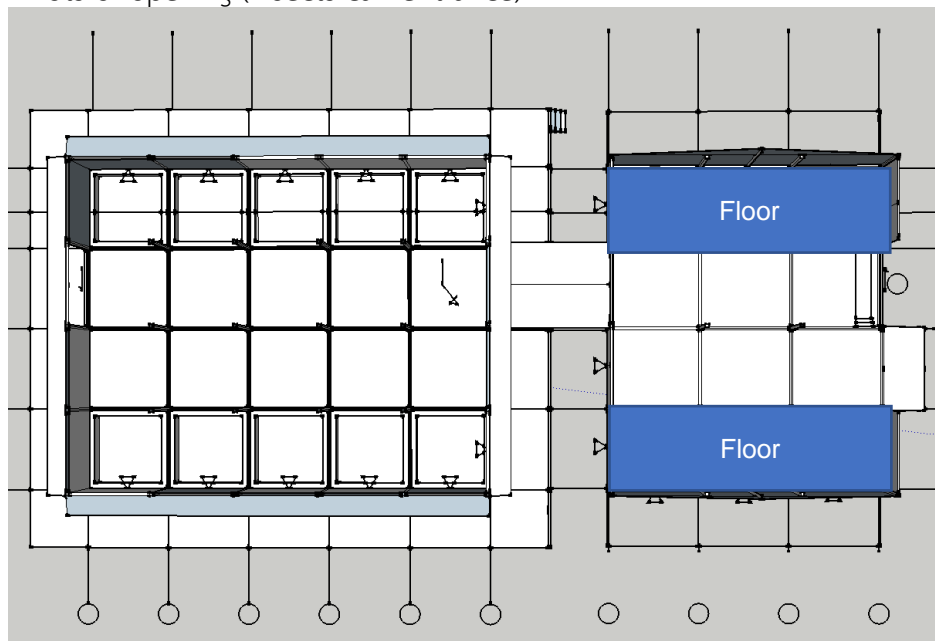
Figure 57 Garbage (unpack secondary packaging) and Secondary packaging storage



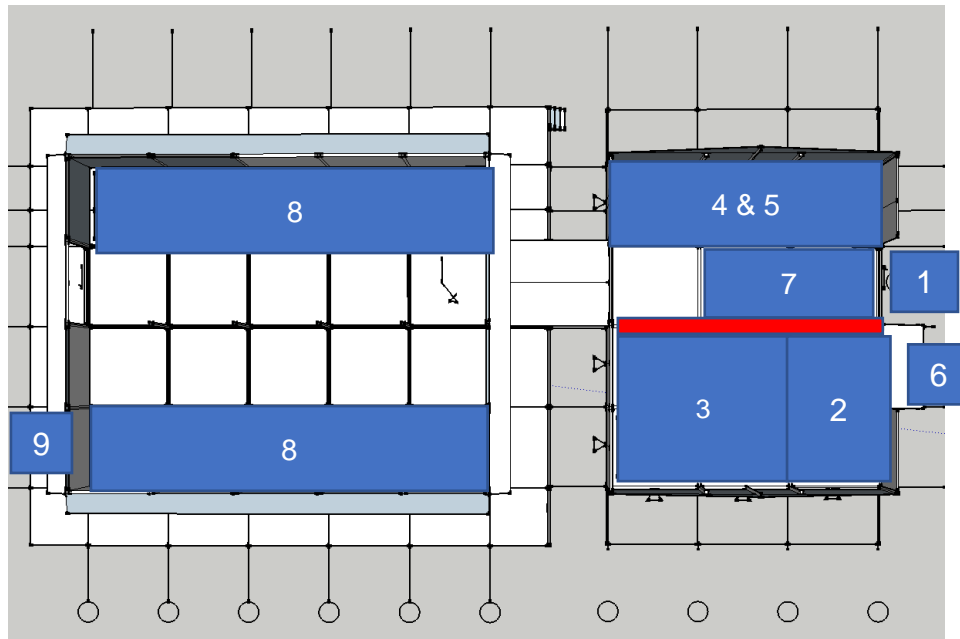
Figure 58 Finished good storage and Storage (fermentation)

As you can see from the photo, there are many points to be improved. There is a list of improvement that plans to improve.

1. Unused space (pit)
2. No standard rack for storage packaging
3. Sitting on a short bench is not appropriate for ergonomic and hygiene (near the floor)
4. Lots of opening (insects can entrance)



1. The unused pit needs to be poured with concrete to form the same level floor as a consequence to use maximum space and avoid an accident from worker falling.



2. The wall must be added to form a room of packing and plastic storage, but the paper packaging must be stored separately as it could be damaged from evaporating of salt.

The storage rack should be added and unpack of all plastic to the rack to avoid packaging from damage with the previous of 5 levels of packaging (over capacity)

3. The stainless chair, table, dress for the worker should be included
4. The net should be installed in every opening.

Regarding all of this improvement of shop floor should be able to meet GMP standard and be able to register for food and drug administration. However, the machine of sealing packaging should be included in the packing room as a consequence of stop using paraffin wax.

7.4 Modern trade

The traditional trade is what the goby fish company's main strategy for selling the product. Goby fish only sell with same amount goods to the same distributor as wholesaling. This is unable to find a new market and develop in the sale. Modern trade is widely accepted in the present day as people change their behaviour in shopping since the city is developed, the convenience stores are open in many provinces in the country. However, the behaviour of people still developed to align with technology. That is the online shopping that has increased every single day, but how the customer will buy the product if they do not recognise the product. Therefore, modern trade is the primary channel where it can be introducing to a new market and increase in the sale but the cost of obtaining the product to sell on the shelf at a convenience store is significantly higher because there is a price to pay to store. This section will mention about the price of obtaining the product into the modern trade. However, modern trade information of entrance the convenience store is minimal as it is confidential information. Nevertheless, there is an interview of entrance modern trade by sharing their own experience. The video clip is posted on Youtube, AjarnRath channel. The poster was posted on 12 May 2017. There are 2 companies who are the interviewees. The group of NEC CEFE club is interviewer whose name is Kritsanee Thoto. The 2 companies are Bangkok banana and Sengheng Tofu. Miss Thitinan Charoenwongreut (Marketing and sale manager) representative of Bangkok banana with newbie of 3 modern trade of stores and Mr. Patcharathanasit

Maethawacharaphanitch (business development manager) representative of Sengheng Tofu with more than 15 modern trade of stores. Firstly, they said that change of mind occurs after the entrance of modern trade. They did not mention about their profitability or loss, but they did mention that they need to put more efforts into modern trade but surely they able to gain a new group of customer. Interestingly, he did mention that entrance of modern trade, and you need to continuous improvement in term of quality, brand and especially sale to be aligned with those modern trade store as they are always continuous improvement. Modern trade they want to business partner with a growing business; otherwise, they will unaccepting the product to be on the shelf. In order to register and be a business partnership, they need to present their product through modern trade store's management. They need to contact modern trade store sale department and need that sale department to make an appointment. Usually, they share the experience of waiting time from 1day to 1 year. The condition of pricing will offer during the product presentation. Furthermore, there are 2 ways of selling the product, 1. Consignment and 2. Credit (completely bought), (Charoenwongreut & Maethawacharaphanitch, 2017)

The important of modern trade is to compute whether the investment is worth to take. Therefore, the cost of obtaining is the critical point in this where they had explained. First, the cost that occurs is

1. Initial Open Account (1 time only) vary from 10,000 – 1,000,000 baht depend on brand image and those modern trade stores
2. Managing of SKU (stock keeping unit) typically around 1-4SKU/5,000baht and 5-10SKU/10,000 baht (per year)
3. GP (gross profit), usually charged 30% to 50% of the price depend on categories of product and each modern trade store.
4. DC (distribution centre), usually charged 5% from the price which deducted of GP
5. The rebate usually charged 5% from the price which deducted of GP (not all modern trade)
6. Promotion, depending on seasonal and each modern trade store (1 free 1, discount) 2weeks to 1 month

Unit price obtaining for modern trade if 100.-	100.-
GP 30%	70.-
DC 5% from 70.-	66.5.-
Rebate 5% from 70.-	63.-
Price to pay to modern trade	(37.-) or 37%

Table 41 100baht unit price obtaining from modern trade

Appendix B Questionnaire

The questionnaires take about 5 mins. Please make these sign in the blank boxes ✓

or X

1. Gender Male Female

2. Age less than 18 18 – 30 31 – 40 41 – 50 51 – 60 more than 60

3. Have you regularly bought Thai brand shrimp paste as choices provided below?

(please select only one)

Goby fish brand  Klong Kone  TraChu 
 TraKung Thai  Tra Rueng bai 
 other please specific..... Never bought

4. What is your purposes of buying shrimp paste?

Food Ingredients Thai shrimp paste sauce Curry Other

please specific.....

5. In what scale to measures of product selecting?

Food and medical standard	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Industry standard	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Muslim standard	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Colorful/attractive of label	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Shape of package	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Material of package	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Convenience of opening	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Taste of shrimp paste	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Color of shrimp paste	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Odor of shrimp paste	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Texture of shrimp paste	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Price of shrimp paste	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Expiry date	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
Volume	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

6. Regarding to what have you chose in no.1, please identify each value of the shrimp paste you chose?

Sufficient of information on label	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
------------------------------------	----------------------------	----------------------------	----------------------------	----------------------------	----------------------------

- | | | | | | |
|------------------------------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| Appropriate shape of package | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Durability of package | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Convenience of opening | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Taste of shrimp paste | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Color of shrimp paste | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Odor of shrimp paste | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Texture of shrimp paste | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Appropriate of price | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Appropriate of volume | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |
| Long life shelf | <input type="checkbox"/> 5 | <input type="checkbox"/> 4 | <input type="checkbox"/> 3 | <input type="checkbox"/> 2 | <input type="checkbox"/> 1 |

7. Usually how often did you consume shrimp paste?

- Less than 1 time per week
 Less than 4 times per week
 More than 10 times per week

8. Usually how much you use shrimp paste for 1 time of your cooking?

- 1 spoon per time
 2 spoon per time
 More than 1 spoon per time
- more than 10 spoon per time
 Never cook by my self

9. Usually a 0.5 kg of shrimp paste, how long have to take to consume or use?

more than 1 year less than 6 months less than 1 month less than 7 days

10. Usually after used of shrimp paste, the spare will be store in?

Refrigerator Ambient temperature near cooking area other

please specific.....



Appendix C Test Report

Food Research and Testing Laboratory Faculty of Science Chulalongkorn University Floor 16 th Mahamakut Building Phayathai Road, Pathumwan, Bangkok 10330, Thailand		Report No. : C 0402/19 Issued Date : 7 May 2019 Sample ID : 191477 Page 1 of a total of 2 pages
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----- begin report -----

Test Report For Nutrition Labeling

Client Name : Thippimol Panich
 Client Address : 32 moo 11 Chumphon-Ranong Road, Wangpai, Mueng, Chumphon 86000

Sample Description : Shrimp paste
 / brown paste packed in plastic jar sealed, 7 jars, weight 3,000 g.
 Serving Size : 1 TBS (18 g) Servings Per Container : About 11

Sampling by : Client
 Date Sample Received : 29 March 2019
 Date Analyzed : 1 April 2019

Test Results

Test Items	Per 100 g	Per serving 1 TBS (18 g)	% Daily value	Test Method
Calories (kcal)	111.80	15	-	Method of Analysis for Nutrition Labeling. Virginia : AOAC International ; 1993, p. 106.
Total fat (g)	2.16	0	0	In-house method based on AOAC (2016) 922.06
Protein (g) N x 6.25	22.03	4	-	In-house method T 058 based on AOAC (2016) 981.10
Total Carbohydrate (g)	1.06	0	0	Method of Analysis for Nutrition Labeling. Virginia : AOAC International ; 1993, p. 8.
Sugars (g) ^A	Not detected	0	-	In-house method T 082 based on AOAC (2016) 982.14
Sodium (mg)**	7186.61	1290	54	In-house method based on AOAC (2016) 984.27
Ash (g)	23.15	-	-	AOAC (2016) 938.08
Moisture (g)	51.60	-	-	AOAC (2016) 950.46 (b)

Remark : ** = Sub contract

A = Limit of detection Sugars = 0.10 g/100g

----- end report -----

 (Phayoohong, Wilai) Technician Manager, Chemical Laboratory	 (Tantratian, Sumate Assoc. Prof. Dr.) Deputy Director	Approved By  (Kokpol, Sirirat Prof.Dr.) Director
--	---	--

The above results are only valid for the analyzed sample(s) as indicated in this report. This report must not be used for advertising purposes and cannot be reproduced (except in full) without the written approval of the laboratory.

F-QM-006/R02



-----begin report-----

Test Report For Nutrition Labeling (Continue)

Nutrition labeling for

Sample name : Shrimp paste

Net weight : 190 g

Nutrition Information		
Serving size : 1 TBS (18 g)		
Serving (s) per container : About 11		
Amount per serving		
Total energy 15 kcal		
		Percent Thai RDI*
Total fat	0 g	0 %
Protein	4 g	
Total carbohydrate	0 g	0 %
Sugars	0 g	
Sodium	1290 mg	54 %
* Percent Thai Recommended Daily Intakes for population over 6 years of age are based on a 2,000 kcal diet.		

Food Research and Testing Laboratory
 Faculty of Science Chulalongkorn University
 Floor 16th Mahamakut Building Phayathai Road,
 Pathumwan, Bangkok 10330, Thailand



Report No. : M 0181/19
 Issued Date : 8 May 2019
 Sample ID : 191477
 Page 1 of a total of 2 pages

----- begin report -----

Test Report

Client Name : Thippimol Panich
 Client Address : 32 moo 11 Chumphon-Ranong Road, Wangpai, Mueng, Chumphon 86000

Sample Description : Shrimp paste / brown paste packed in plastic jar sealed, 7 jars, weight 3,000 g.

Sampling by : Client
 Date Sample Received : 29 March 2019
 Date Analyzed : 1 April 2019

Test Results

Test items	Test Results	Test Method	Limit of Detection
Total Plate Count	9,200 CFU/g	FDA BAM, Online, 2001 (Chapter 3)	-
Coliforms	< 3 MPN/g	FDA BAM, Online, 2017 (Chapter 4)	-
<i>S. aureus</i>	Not detected in 0.1 g	In-house method based on ISO 6888-3 : 2003	-
<i>C. perfringens</i>	Not detected in 0.01 g	In-house method based on FDA BAM, Online, 2001 (Chapter 16)	-
<i>Salmonella</i> spp.	Not detected in 25 g	ISO 6579 -1 : 2017	-
Yeast & Mold	100 CFU/g	FDA BAM, Online, 2001 (Chapter 18)	-
Acid insoluble ash (on dry basis)	0.43 g/100g	AOAC (2016) 941.12 (B)	-
pH	7.46	TISL 1080 - 1992	-
Benzoic acid	Not detected	In-house method T 029 based on Bull. Dept.	1.00 mg/kg
Sorbic acid	Not detected	Med. No. 4, Vol. 40, 1998, p.461-469	1.00 mg/kg

The above results are only valid for the analyzed sample(s) as indicated in this report. This report must not be used for advertising purposes and cannot be reproduced (except in full) without the written approval of the laboratory.

F-QM-0832082



----- begin report -----

Test Report (continue)

Test Results (continue)

Test Items	Test Results	Test Method	Limit of Detection
Synthetic Food Color**			
Tartrazine	Not detected	In-house method based on TIS 696-1987 by HPLC	1.00 mg/kg
Brilliant Blue	Not detected		1.00 mg/kg
Sunset Yellow	Not detected		1.00 mg/kg
Allura Red	Not detected		1.00 mg/kg
Carmoisine	Not detected		1.00 mg/kg
Ponceau 4R	Not detected		1.00 mg/kg
Erythrosine	Not detected		1.00 mg/kg
Quinoline Yellow	Not detected		1.00 mg/kg
Amaranth	Not detected		1.00 mg/kg
Fast Green	Not detected		1.00 mg/kg
Cadmium (Cd)**	0.037 mg/kg	In-house method based on AOAC (2016), 999.10	-
Lead (Pb)**	<0.050 mg/kg	In-house method based on AOAC (2016), 986.15	-
Mercury (Hg)**	Not detected	In-house method based on AOAC (2016), 974.14	0.010 mg/kg
NaCl (on dry basis)	37.12 g/100g	In-house method based on AOAC (2016), 937.09	-
Water Activity (a _w)	0.72	In-house method based on AOAC (2016) 978.18	-

Remark : ** = Sub contract

----- end report -----

Approved By

(Kaprom, Ajima)

Technician Manager,

Microbiological Laboratory

(Tantratian, Sumate Assoc. Prof. Dr)

Deputy Director

(Kokpol, Sirirat Prof. Dr)

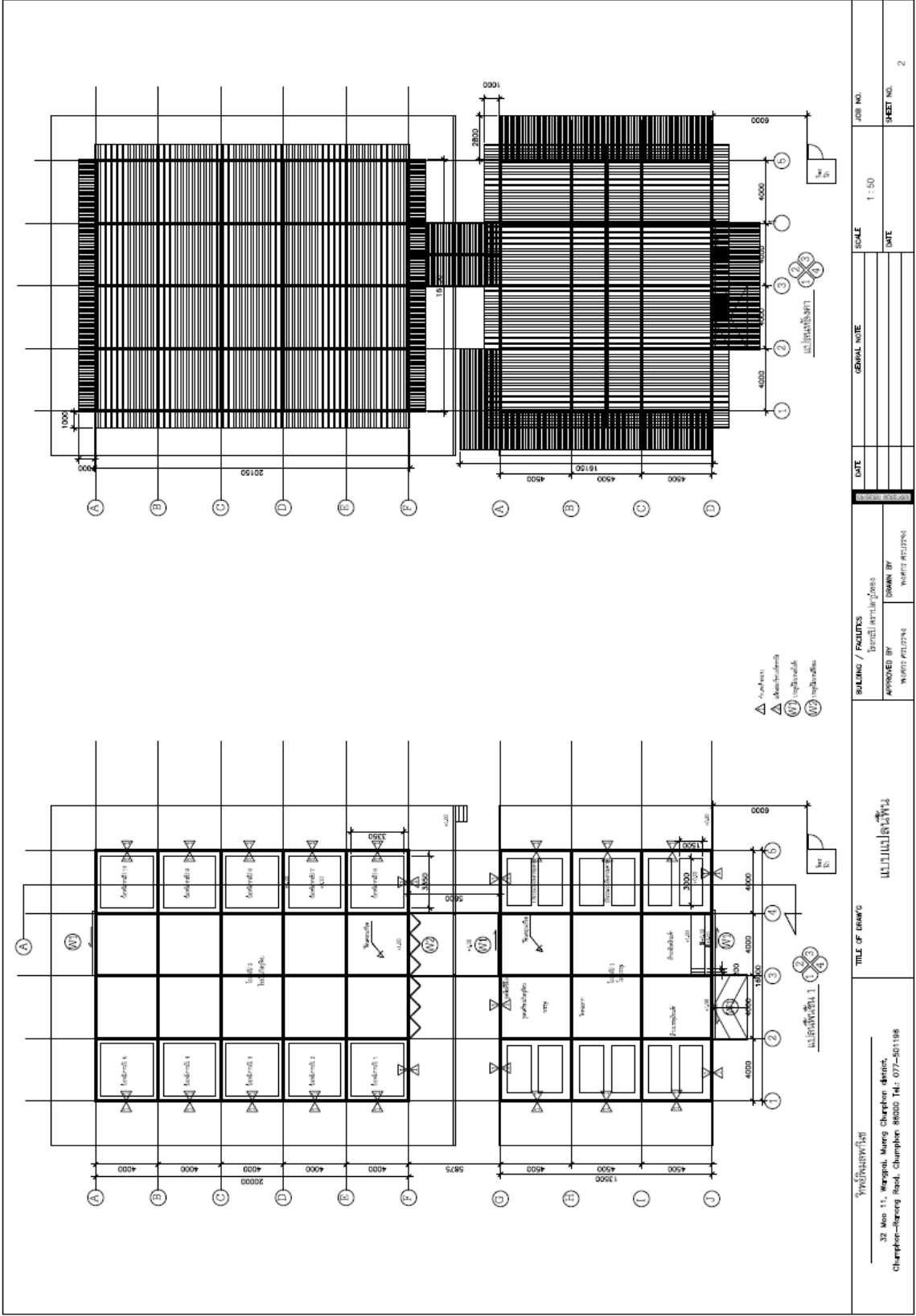
Director

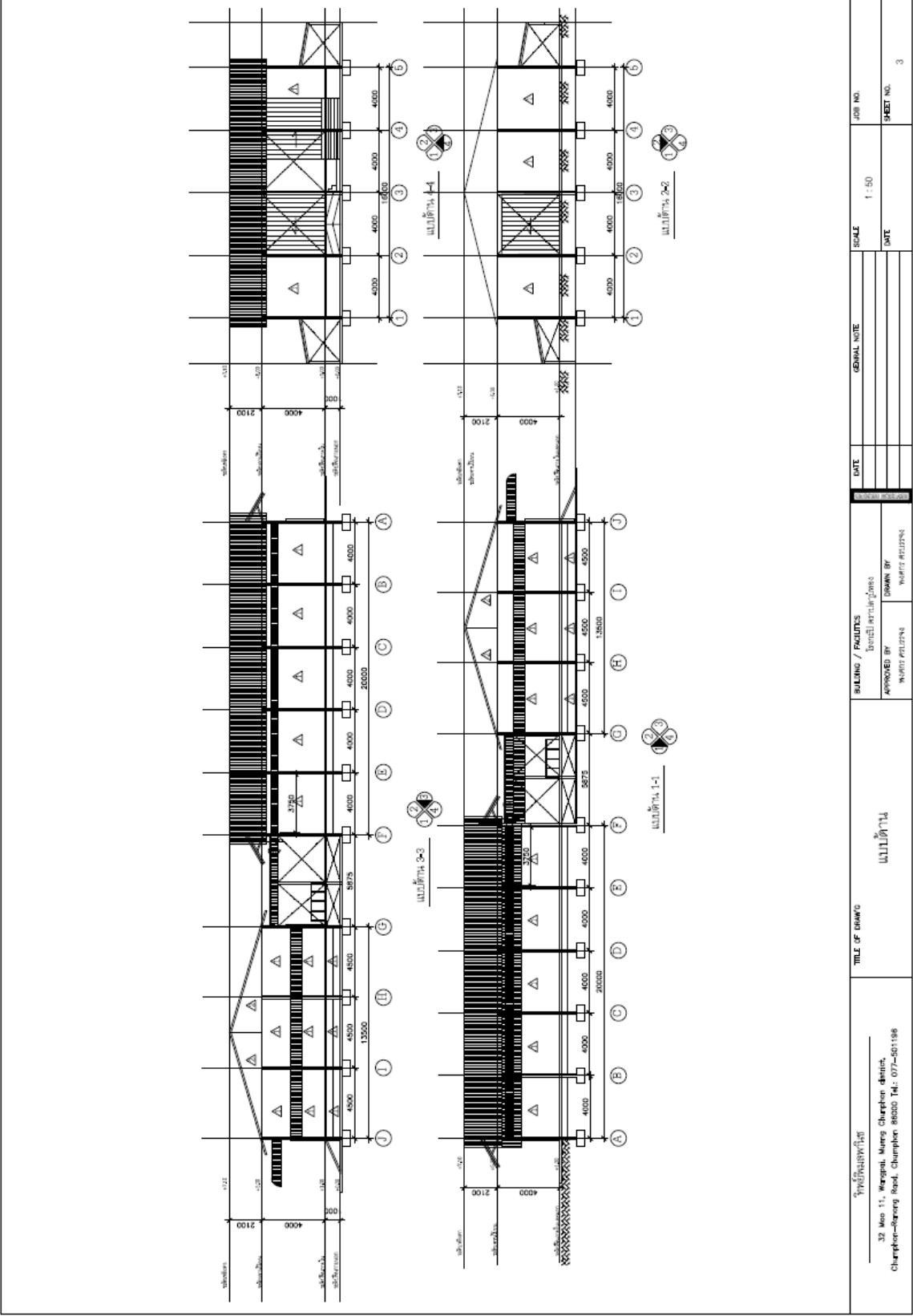
The above results are only valid for the analyzed sample(s) as indicated in this report. This report must not be used for advertising purposes and cannot be reproduced (except in full) without the written approval of the laboratory.

Appendix D Financial information

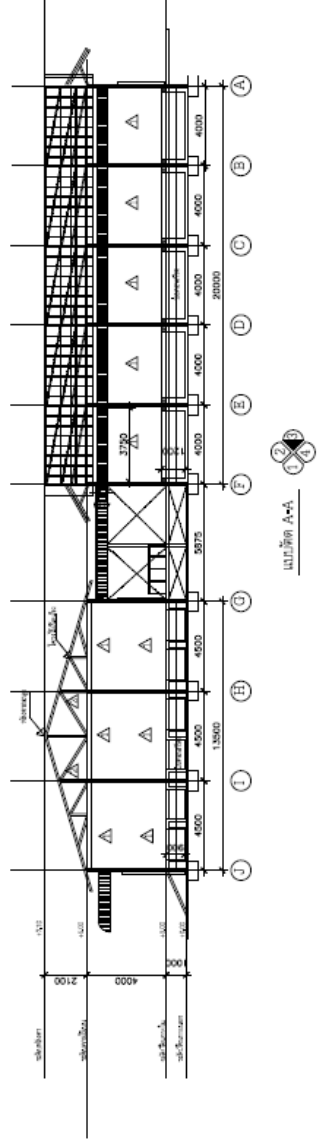
	2018												Balance Sheet
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
Assets													
Current Assets													
Cash	255,390	397,430	671,880	874,465	699,295	768,235	1,100,625	739,575	537,965	168,550	37,930	539,030	
Accounts receivable	343,000	398,000	415,000	514,500	271,000	453,000	343,000	415,000	343,000	514,500	631,000	470,000	
(B)	400	400	500	600	300	400	400	500	400	600	800	500	
(S)	100	200	100	150	100	300	100	100	100	150	100	200	
(S) new	3,270	3,756	3,966	4,905	2,574	4,242	3,270	3,966	3,270	4,905	6,054	4,452	
Inventory	882,300	685,700	525,300	813,250	772,500	509,000	918,800	1,198,900	1,607,700	1,816,400	1,450,400	1,185,100	
Prepaid expenses	-	-	-	-	-	-	-	-	-	-	-	-	
Short-term investments	-	-	-	-	-	-	-	-	-	-	-	-	
Total current assets	1,480,690	1,461,130	1,612,180	2,202,215	1,742,795	1,725,235	2,362,425	2,353,475	2,488,665	2,499,450	2,119,330	2,194,130	
Fixed (Long-Term) Assets													
Long-term investments	-	-	-	-	-	-	-	-	-	-	-	-	
Property, plant, and equipment	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	1,600,000	
(Less accumulated depreciation)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	
Intangible assets	-	-	-	-	-	-	-	-	-	-	-	-	
Total fixed assets	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	
Other Assets													
Deferred income tax	-	-	-	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	-	-	-	-	-	
Total Other Assets													
Total Assets	3,048,690	3,029,130	3,180,180	3,770,215	3,310,795	3,293,235	3,950,425	3,921,475	4,056,665	4,067,450	3,687,350	3,762,130	
Liabilities and Owner's Equity													
Current Liabilities													
Accounts payable (shrimp paste)	151,500	72,000	151,500	652,000	152,750	71,000	652,500	572,000	651,500	572,750	73,500	72,500	
Interest rate	-	-	-	-	-	-	-	-	-	-	-	-	
Income taxes payable	24,010	27,860	29,050	36,015	18,970	31,710	24,010	29,950	24,010	36,015	44,170	32,900	
Accrued salaries and wages	20,600	21,600	22,500	24,900	18,700	22,600	20,600	22,500	20,600	24,900	28,200	23,500	
Unearned revenue	-	-	-	-	-	-	-	-	-	-	-	-	
Current portion of long-term debt	-	-	-	-	-	-	-	-	-	-	-	-	
Total current liabilities	196,110	121,460	203,050	712,915	190,420	125,310	697,110	623,550	696,110	633,665	145,870	128,900	
Long-Term Liabilities													
Long-term debt	-	-	-	-	-	-	-	-	-	-	-	-	
Deferred income tax	-	-	-	-	-	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	-	-	-	-	-	
Total long-term liabilities													
Owner's Equity													
Owner's investment	1,284,580	1,339,670	1,409,130	1,489,300	1,552,375	1,598,925	1,665,315	1,729,925	1,792,555	1,865,785	1,973,460	2,065,230	
Retained earnings	-	-	-	-	-	-	-	-	-	-	-	-	
Other	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	1,568,000	
Total owner's equity	2,852,580	2,907,670	2,977,130	3,057,300	3,120,375	3,167,925	3,233,315	3,297,925	3,360,555	3,433,785	3,541,460	3,633,230	
Total Liabilities and Owner's Equity	3,048,690	3,029,130	3,180,180	3,770,215	3,310,795	3,293,235	3,950,425	3,921,475	4,056,665	4,067,450	3,687,350	3,762,130	
Common Financial Ratios													
Debt Ratio (Total Liabilities / Total Assets)	0.06	0.04	0.06	0.19	0.06	0.04	0.18	0.16	0.17	0.16	0.04	0.03	
Current Ratio (Current Assets / Current Liabilities)	7.55	12.03	7.94	3.09	9.15	13.77	3.39	3.77	3.58	3.94	14.53	17.02	
Working Capital (Current Assets - Current Liabilities)	1,284,580	1,339,670	1,409,130	1,489,300	1,552,375	1,598,925	1,665,315	1,729,925	1,792,555	1,865,785	1,973,460	2,065,230	
Asset-to-Equity Ratio (Total Assets / Owner's Equity)	1.07	1.04	1.07	1.33	1.06	1.04	1.22	1.19	1.21	1.18	1.04	1.04	
Debt-to-Equity Ratio (Total Liabilities / Owner's Equity)	0.07	0.04	0.07	0.23	0.06	0.04	0.22	0.19	0.21	0.18	0.04	0.04	

	2019												Balance Sheet
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
FORECASTING													
Tippimol Panich													
Assets													
Current Assets													
Cash	891,920	1,033,960	1,308,410	1,510,495	1,334,575	1,400,265	1,736,155	1,109,355	690,995	321,580	190,960	692,060	
Accounts receivable	343,000	398,000	415,000	514,500	271,000	453,000	343,000	415,000	343,000	514,500	631,000	470,000	
(B)	400	400	500	600	300	400	400	500	400	600	800	500	
(S)	100	200	100	150	100	300	100	100	100	150	100	200	
(S) new													
Inventory	3,270	3,756	3,966	4,905	2,574	4,242	3,270	3,966	3,270	4,905	6,054	4,452	
Prepaid expenses	1,093,900	877,300	737,400	1,026,100	983,600	721,600	1,130,400	1,410,500	1,819,300	2,028,000	1,662,000	1,396,700	
Short-term investments													
Total current assets	2,328,820	2,309,260	2,460,810	3,051,095	2,589,175	2,574,865	3,209,555	2,934,855	2,853,295	2,864,080	2,483,960	2,558,760	
Fixed (Long-Term) Assets								266,750					
Long-term investments													
Property, plant, and equipment	1,600,001	1,600,002	1,600,003	1,600,004	1,600,005	1,600,006	1,600,007	1,600,008	1,600,009	1,600,010	1,600,011	1,600,012	
(Less accumulated depreciation)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	(32,000)	
Intangible assets													
Total fixed assets	1,568,001	1,568,002	1,568,003	1,568,004	1,568,005	1,568,006	1,568,007	1,834,758	1,568,009	1,568,010	1,568,011	1,568,012	
Other Assets													
Deferred income tax													
Other													
Total Other Assets													
Total Assets	3,896,821	3,877,262	4,028,813	4,619,099	4,157,180	4,142,871	4,777,562	4,769,613	4,421,304	4,432,090	4,051,971	4,126,772	
Liabilities and Owner's Equity													
Current Liabilities													
Accounts payable (shrimp paste)	151,500	72,000	152,000	652,750	151,000	72,500	651,500	572,000	651,500	572,750	73,500	72,500	
Interest rate													
Income taxes payable	24,010	27,860	29,950	36,015	18,970	31,710	24,010	29,950	24,010	36,015	44,170	32,900	
Accrued salaries and wages	20,600	21,600	22,500	24,500	18,700	22,600	20,600	22,500	20,600	24,500	28,200	23,500	
Unearned revenue													
Current portion of long-term debt													
Total current liabilities	196,110	121,460	203,550	713,665	188,670	126,810	696,110	623,550	696,110	633,665	145,870	128,900	
Long-Term Liabilities													
Long-term debt													
Deferred income tax													
Other													
Total long-term liabilities													
Owner's Equity													
Owner's investment	2,132,710	2,187,800	2,257,260	2,337,430	2,400,505	2,448,055	2,513,445	2,578,055	2,373,935	2,230,415	2,336,090	2,429,860	
Retained earnings													
Other	1,568,001	1,568,002	1,568,003	1,568,004	1,568,005	1,568,006	1,568,007	1,568,008	1,784,759	1,568,010	1,568,011	1,568,012	
Total owner's equity	3,700,711	3,755,802	3,825,263	3,905,434	3,968,510	4,016,061	4,081,452	4,146,063	4,158,694	3,798,425	3,906,101	3,997,872	
Total Liabilities and Owner's Equity	3,896,821	3,877,262	4,028,813	4,619,099	4,157,180	4,142,871	4,777,562	4,769,613	4,854,804	4,432,090	4,051,971	4,126,772	
Common Financial Ratios													
Debt Ratio (Total Liabilities / Total Assets)	0.05	0.03	0.05	0.15	0.05	0.03	0.15	0.13	0.16	0.14	0.04	0.03	
Current Ratio (Current Assets / Current Liabilities)	11.88	19.01	12.09	4.28	13.72	20.30	4.61	4.71	4.10	4.52	17.03	19.85	
Working Capital (Current Assets - Current Liabilities)	2,132,710	2,187,800	2,257,260	2,337,430	2,400,505	2,448,055	2,513,445	2,578,055	2,157,185	2,230,415	2,336,090	2,429,860	
Assets-to-Equity Ratio (Total Assets / Owner's Equity)	1.05	1.03	1.05	1.18	1.05	1.03	1.17	1.15	1.06	1.17	1.04	1.03	
Debt-to-Equity Ratio (Total Liabilities / Owner's Equity)	0.05	0.03	0.05	0.18	0.05	0.03	0.17	0.15	0.17	0.17	0.04	0.03	





32 Mei 11, Margono, Mungur, Churapion, district, Churapion-Rarang Road, Churapion 86000 Tel.: 077-501188	TITLE OF DRAWING BANGUNAN		BUILDING / FACILITIES BONDOLLE/LOKASI		DATE	GENERAL NOTE	SCALE 1:50	JOB NO.
	APPROVED BY NURDI PRATIKA		DRAWN BY WALITA PRATIKA		DATE	GENERAL NOTE	SCALE 1:50	SHEET NO. 3



32, Jln. 11, Mangrove, Muang Chumphen District, Chumphon-Batang Road, Chumphon 86000 Tel: 077-501196	TITLE OF DRAWING วิทยาลัยอาชีวศึกษา MUANG CHUMPHEN		BUILDING / FACILITIES วิทยาลัยอาชีวศึกษา MUANG CHUMPHEN		APPROVED BY อนุมัติ MUANG CHUMPHEN		DATE / /		GENERAL NOTE		SCALE 1 : 50	JOB NO.
											DATE	SHEET NO. 4

Appendix F C.O.A of aluminum lid



Gikit Company Limited

99/17 Moo 2 Tambon Tha Sao, Krathum Baen, Samut Sakhon 74110

99/17 หมู่ 2 ตำบลท่าเสา, อำเภอกระทุ่มแบน, จังหวัดสมุทรสาคร, 74110

Tel : 034-460-979 , Mobile: 081-905-4582 , 089-500-2486 Fax : 034-460 929

E-mail : gikit@windowslive.com E-mail : gikitthailand@yahoo.com www.gikit-pack.com

CERTIFICATE OF ANALYSIS (C.O.A)

Customer Name :

Categories :

Aluminium lid (for cover EOE#307)

Model ID :

AL#307 ฟาอลูมิเนียมชนิดพิเศษสำหรับอาหาร

Size :

Ø 93.20 x 3.8 MM

Materials :

Aluminium Sheet Jiangmen Betterlid Material Inc.

Packing of Delivery :

100 PCS/ ROW 2000 PCS/ BOX

Delivery Date :

No.	Description	Unit	The Standard	MAX.	MIN.	AVG.
1	Net weight	G	5. 2± 0.2	5.40	5.00	5.20
2	Height	MM	3.8 ± 0.1	3.90	3.70	3.80
3	Width	MM	93.20± 0.2	93.40	93.00	93.20
4	Internal diameter	MM	82.30±0.2	82.50	82.10	82.30



Lot No.

Records : 25/5/2019

Examiner : Mr. Kittichai Jankasem

REFERENCES



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

VITA



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY