Setting Priority for Improvement of Yogurt Production Process Using Quality Function Deployment (QFD) on Household Industry (IRT) X, Sumedang

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Abstract

This study aims to determine the priority of the yogurt production process improvement by the household industry (Industri Rumah Tangga = IRT) X, so that the products according to the needs and expectations of consumers. This is done by applying the method of Quality Function Deployment (QFD) which aims to find the gap between the needs and expectations of consumers by way of an industry to fulfill it from the side of the two basic components of technology: techno-ware and human-ware. The competency gap is analyzed through: (1) the relation between the requirements of the yogurt product and the production process; (2) the importance weight of both of them based on techno-ware and human-ware aspects; and (3) assessment of competency level and (4) assessment of industrial competency level based on techno-ware and human-ware aspects. The study involved 203 respondents in obtaining information about the needs and expectations of consumers in yogurt products (yogurt product requirements). Depth analysis of the yogurt production process was done by direct observation and interviews. Assessment of product requirements and production process in the form of a matrix involving 4 experts. Product requirements based on the results of this study were (1) the benefits of yogurt to help facilitate the digestive system; (2) the legality of (management of legality, halal certification, food safety in form of the acquisition of a number MD); (3) volume per pack of 250 ml; (4) price per pack was IDR 6,001 - 9,000; (5) type is strawberry flavor; (6) degree of acidity is medium; (7) smooth texture; (8) viscosity is medium; (9) type of packaging is plastic bottles; (10) the information listed on the packaging consists of the manufacture of packaging labels, expiration date, legality, brand, composition, nutritional value information, net weight, description of taste, production code, and manufacturers; and (11) additional pieces of fruit. The results of this study indicate that the company need to complete or replace some of the production facilities, improve the ability of workers, and improve the hygiene of workers and production facilities. A major reshuffle is necessary to eliminate the gaps in the following sequence of actions: (1) complete and / or replace some facilities of yogurt production processes adapted to financial circumstances; (2) provide guidance and monitoring of workers to perform all activities in the process of producing yogurt correctly; (3) adding to the completeness of workers with hygiene equipment; And (4) place the production facility in accordance with the sequence of processes.

Keywords: *Quality Function Deployment, human-ware, techno-ware, household industry, yogurt*

1. INTRODUCTION

The growth rate of the food and beverage industry has fluctuated. According to the Ministry of Industry of the Republic of Indonesia, the magnitude of the rate of growth in food and beverage industry from 2011 to 2015 was 10.98% sequentially; 10.3%; 4.1%; 9.5%; and 7.5%. It shows that the rate of growth in the food and beverage industry require special attention in order to be able to continue to increase its growth rate (Kementerian Perindustrian Republik Indonesia, 2016).

Food and beverage industry included in the category of agricultural products industry because of using raw materials derived from agricultural products. One of them is a dairy processing industry. Many domestic industries engaged in the processing of milk, one of which is IRT-X in Sumedang District. IRT-X managed by the company in the form of *Commanditer Venootschap (CV).* The company was previously engaged in the dairy farm, then expanded its business in the form of domestic industry which produces pasteurized milk and yogurt. The company is still in the stage of developing the yoghurt industry. The number of workers involved in the yoghurt production process is 2 person who are graduates of high school level. Milk produced by the company is sold in the form of fresh milk and is used as a raw material to be processed into

pasteurized milk and yogurt.

One improvement efforts can be done to increase the growth rate of the industrial sector is improving product quality. The quality of a product is one of the factors that affect the product can be accepted or not by the consumer (Agyekum, et.al.,2015).

According to Boeing in Goetsch and Davis (2006), the definition of quality is "Providing our customers with products and services that consistently meet their needs and expectation s of customers". Therefore, the industry should be able to produce quality products in order to be accepted by consumers.

The production process is a factor that greatly affects the quality of the product (Lombard, et.al., 2014). In the production process, a lot of things can happen and it can make the quality of the product does not meet expectations, therefore the process needs to be improved. One method that can be used to determine the parts of the process which needs to be improved so that the results meet the needs and expectations of consumers is Quality Function Deployment (QFD). According Uselac in Goetsch and Davis

(2006), "QFD is practice for designing your processes in response to customer needs". IRT-X as an industry that was still in the development stage can use QFD method to produce the products according to the needs and expectations of consumers. In the production process, the company has used a relatively simple technology. The use of this type of technology is believed to greatly affect the quality of the resulting product. The application of technology in the development of IRT-X is regarded as essential.

2. OBJECT AND METHODS

A complete technology assessment actually looks at four technological components: techno-ware, human-ware, info-ware, and orga-ware. Use of QFD method in determining the priority of production process improvement on IRT X was restricted assessed from the two basic components of technology, namely techno-ware and human-ware. Techno-ware is a tool and machine used in the production process, while human-ware is a person involved in the production process (Nazaruddin, 2008).

This study has used the method as a procedure arranged in the QFD method. Stages of activity in the application of the QFD method are as follows (Cohen, 1995):

1. Identify customer needs and expectations by providing questionnaires to respondents to obtain the requirements of yogurt products. Respondents are students of the Faculty of Agro-Industrial Technology, Universitas Padjadjaran who once consumed a yogurt drink. Distribution and processing of questionnaire results using type form application online.
2. Identify technical requirements by interviewing IRT representative regarding the production process of yogurt;
3. Assessment of the matrix of the relationship between the yogurt product requirements and the yogurt production process (correlative matrix) by giving value to any yogurt product requirements associated with the yogurt production process;
4. Assessing the importance of weight using the Analytical Hierarchy Process (AHP) method by assigning value to all yogurt product requirements and yogurt production processes based on their importance;
5. Assessment of competency level from techno-ware and human-ware aspects by giving value to yogurt production process that has relationship with every requirement of yogurt product based on two basic components of technology that is techno-ware and human-ware;
6. Calculation of planning matrix to obtain normalized weight value on every requirement of yogurt product based on techno-ware and human-ware aspects; and
7. Technical matrix calculation to obtain percentage gap value in each yogurt production process based on techno-ware and human-ware aspects.

2.1 Data Collection Methods and Samples

The data collection method consists of four ways: Nonparticipant Observation (O), Interview (I), Questionnaire (Q), and Calculation (C), while the sampling method consists of two ways: Incidental Sampling (IS) and Sampling Purposive (SP). Methods of data collection and sampling are presented in Table 1.

Table 1. Data Collection and Sampling Methods

Activitiy	Data Collection Methods			Sampling Methods		
	O	I	Q	C	SI	SP
Identify customer needs and expectations		√	√	√	√	
Identification of production process	√	√				
Assessment of correlation matrices		√	√	√		√
Assessment of importance weights using the AHP method		√	√	√		√
Assessment of competency level from techno-ware and human-ware aspects		√	√	√		√
Calculation of planning matrix				√		
Technical matrix counting				√		

2.2 Steps to Implement QFD

1) Identify customer needs and expectations. This step is done by giving questionnaires to respondents to obtain the requirements of yogurt products. Distribution and processing of questionnaire results using type form application online.
2) Identification of production process. This step is done by interviewing IRT representative regarding the production process of yogurt. This production process usually has a relationship with the needs and expectations of customers.
3) Assess the matrix of the relationship between the yogurt product requirements and the yogurt production process (correlation matrix). This step is done by assigning the value to any yogurt product requirements that are related to the yogurt production process. There are four value only to represent the level of the relationship. A value of 0 indicates no relationship, 1 indicates a weak, 3 indicates a medium, and 9 indicates a strong relationship.
4) Assessment of importance level weights using Analytical Hierarchy Process (AHP) method. The weight of importance consists of two, namely the importance of the yogurt product and the importance of the yogurt production. This step is done by giving value to all yogurt product requirements and yogurt production process based on its importance. The results of the assessment processed using the open application like the expert choice to obtain the weight of importance level. The assessment uses a fundamental scale of absolute numbers according to Saaty (2008), as presented in Table 2.

Table 2. Fundamental Scale of Absolute Numbers

Level of Interest	**Definition**
1	Equal importance
2	Weak or slight
3	Moderate importance
4	Moderate plus
5	Strong importance
6	Strong plus
7	Very strong or demonstrate importance
8	Very, very strong
9	Extreme importance
Reciprocal	If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value when compared with i
1.1-1.9	When activities are very close a decimal is added to 1 to show their difference as appropriate

(Source: Saaty, 2008)

The calculation result is said to be consistent if the value of Consistency Ratio (CR) is less than 10%.

5) Assessment of competency level from techno-ware and human-ware aspects. The level of competence consists of two things, namely the level of competence requirements and the level of industrial competence.
6) The level of competency requirements is an assessment based on the standards that should be met, while the level of industry competence is an assessment based on the actual state of the industry. This step is done by valuing the yogurt production process that has a relationship with each product requirement based on the components of techno-ware and human-ware. The procedure for determining the score of technology components according to Nazaruddin (2008) is presented in Table 3.

Table 3. Suggested Score Determination Procedures for Technology Components

No	Ability of Engineering Facilities	The Human Ability of the Company Members	Score
1.	Facilities manual	Ability to operate	1 - 2 - 3
2.	The facilities are power sourced	Ability to repair	2 - 3 - 4
3.	General function facility	Ability to adapt	3 - 4 - 5
4.	Special function facilities	Ability to innovate	4 - 5 - 6
5.	Automatic facilities	Ability to set-up	5 - 6 - 7
6.	Computer based facility	Ability to reproduce	6 - 7 - 8
7.	Integrated facilities	Ability to improve	7 – 8 - 9

(Source: Nazaruddin, 2008)

7) Values that have been awarded at the competency level of requirements based on techno-ware (TS) and human-ware (KS) aspects and the values given at the level of industry competence based on techno-ware (TI) and human-ware (KI) aspects multiplied by the importance of yogurt production. Then the multiplication is summed per product requirements to obtain: (1) requirement competence of techno-ware aspect (ATS); (2) industry's competence of techno-ware aspect (ATI); (3) requirement competence of human-ware aspect (AKS); and (4) industry's competence of techno-ware aspect (AKI) values used in the sixth step.
   • Improvement ratio is how much improvement the industry should make to meet customer needs and expectations. The value of improvement ratio is obtained from the division between ATS (goal) with ATI and AKS (goal) with AKI.
   • Interest point is a value given to know how much influence the industry's ability to meet customer needs and expectations. A value of 1.2 is given if the ATS and AKS values are greater than the ATI and AKI value and a value of 1.5 is given if the ATS and AKS values are less than the ATI and AKI values. The value of 1.2 shows the effect of medium and value 1.5 indicating strong influence (Cohen, 1995).
   • Weight is a weight to meet the competence requirements on each yogurt product requirement based on techno-ware and human-ware aspects. The weight value is obtained from the multiplication of ATS and AKS, improvement ratio, and interest point.
   • Normalized weight is the normalization of each weight value. Normalized weight value obtained from the division between each weight value with the total weight value.
8) Calculation of technical matrix. This step is done to obtain percentage gap value in each process of yogurt production based on techno-ware and human-ware aspects. To obtain a percentage gap, contribution value, contribution normalization, value of technology standard, human resource standard score, industrial technology value, industrial HR value, and gap or surplus are required.
   • Contribution value is the result of multiplication of normalized weight value with correlation matrix value then multiplied by weight of importance level of product requirement, and then summed per yogurt production process.
   • Normalization of contribution is the result of the division between the value of the contribution to the total value of the contribution.
   • The value of technology standards is the result of multiplication between the value of the contribution with the sum of the value given at the competency level requirements of techno-ware aspects for each production process on each product requirements
   • The value of the human resource standard is the result of multiplication between the value of the contribution and the sum of the value given at the competence level of the requirements of the human-ware aspects for each production process on each product requirement.
   • The value of industrial technology is the result of the multiplication of the value of the contribution with the sum of the value given at the level of industrial competence from the techno-ware aspect for each production process on each product requirements.
   • The value of the human resources of the industry is the product of the multiplication of the contribution value and the sum of value given to the level of industrial competence from the human-ware aspect for each production process on each product requirement
   • Gap or surplus is the result of a reduction between the value of technology standards and the value of industrial technology (from the techno-ware aspect) as well as the result of the reduction between the value of human resource

standard and the value of industrial human resources (from the human-ware aspect).

• Percentage gap is a gap of industry competence to achieve competency requirements. This is related to the relationship between yogurt product requirements and yogurt production process, the weight of importance both based on techno-ware and human-ware aspects, and the assessment of the competency level of the requirements and the assessment of the level of industry competence based on techno-ware and human-ware aspects. The percentage gap obtained from the division between gap or surplus value with the standard value of technology and the standard value of human resources.

3. RESULTS AND DISCUSSION

3.1. Customer Needs and Expectations

Based on the results of filling questionnaires by 203 respondents (students of Faculty of Agro-industrial Technology, Universitas Padjadjaran), obtained 22 secondary requirements of yogurt products, namely: (1) the benefits of yogurt to help smooth the digestive system; (2) legal stewardship; (3) halal certification; (4) food safety in the form of acquisition of MD number; (5) volume per pack of 250 ml; (6) price per packing IDR 6,001 – 9,000; (7) strawberry flavor; (8) moderate acidity; (9) fine texture; (10) moderate viscosity; (11) kinds of plastic bottle packaging; (12) Information on packaging labels; (13) expiration date; (14) legality; (15) brand, (16) composition; (17) nutrition facts information; (18) net weight; (19) taste statement; (20) production code; (21) producers; and (22) additional (topping) pieces of fruit.

3.2 Production Process

Based on observations and interviews with the owner of IRT X and two workers in the yogurt production process, 13 activities in the production process were obtained. Here are 13 activities in the process of producing yogurt, namely: (A) Raw (fresh) milk feeding; (B) heating (pasteurization) to reach the temperature of 75 - 80 ℃; (C) pouring milk into milk can; (D) cooling to a temperature of 40 ℃; (E) adding yogurt seeds to milk; (F) stirring of milk; (G) incubation with 37℃ temperature for ± 8 hours; (H) yogurt screening; (I) addition of liquid sugar, coloring, and flavorings into yogurt; (J) mixing yogurt using mixer; (K) ordering packaging materials and yogurt packaging labels; (L) topping and pouring yogurt into the package; and (M) packaging.

There are a number of things in the production process that should be noted. Raw (fresh) milk was stored for up to 14 d at 4°C and pasteurized on days 1, 3, 4, 7, 9 and 14. Precautions were taken to eliminate post-pasteurization contamination (Ravanis and Lewis, 1995). The incubation that produces L. acidophilus and Bifidobacterium spp needs to be done at 37 ° C, with a maximum time of 6 hours (Mortazavian, et.al.,2006). As the importance of making food processes sustainable increases, losses due to cleaning will become more significant, and the need to optimise cleaning will become more important (Fryer, et.al.,2013). Although the use of plastic in packaging has largely increased, consumer research consistently indicates that consumers attach a high quality perception to glass packaged products (Balzarotti, et.al. 2015).

3.3. Correlation Matrix

The correlation matrix is structured to link product requirements to production processes in the context of how they are accomplished. Based on the results of the assessment given by four experts as respondents, then calculated the average value, obtained a number of relationships in the level of strong, moderate, weak, and no relationship. One example of a strong level relationship is the relationship between the requirements of a moderate acidity yogurt product and the activity of adding yogurt seeds to the milk. According to Surajudin et. al. (2008), yogurt seeds serve to break down lactose (sugar) milk into lactic acid so that the yogurt produced has a sour taste. While the example of a medium relationship is the relationship between product requirements yogurt price per packing IDR 6,001 - 9000 with pasteurization process to reach a temperature of 75- 80 ℃. The cost of equipment and fuel used in pasteurization process will affect the selling value of yogurt per pack. An example of a weak relationship is the relationship between the requirements of a fine texture yogurt product with topping and pouring yogurt into the package. Usually the toppings added to the yogurt are small pieces, so the texture of yogurt will be slightly affected by the topping. For example, there is no relationship that occurs is between the requirements of plastic bottle type yogurt products with yogurt screening activities. The use of plastic bottles to pack yogurt is not affected by the yogurt filtering process. The correlation matrix is presented in Table 4.

Table 4. Correlation Matrix of the Mean Value of Relationship between Product Requirements and Production Process

Product Requirement	Production Process												
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
Benefits of yogurt :													
To help smooth the digestive system	7	8	5	5	7	5	5	5	7	5	5	5	6
Legality:													
Legality management	6	4	3	4	5	5	5	5	5	3	6	4	4
LPPOM MUI: Halal	8	5	4	5	9	6	8	6	9	4	3	6	4
BPOM: MD Number	6	8	6	8	9	8	9	8	8	6	3	6	8
Volume per pack: 250 ml	2	1	1	1	1	0	1	1	2	1	8	6	9
Price per pack: IDR 6,001 – 9,000	8	3	1	2	3	1	4	2	9	3	9	7	5
Flavor type: Strawberry	0	0	0	0	0	0	0	0	9	2	2	4	3
Acidity level: Medium	3	3	0	3	9	4	8	0	6	3	0	3	1
Texture: Smooth	6	5	0	3	7	2	7	8	2	5	0	1	0
Viscosity: Medium	9	5	0	3	6	3	7	3	3	2	0	1	0
Package type: Plastic bottles	0	0	0	0	0	0	0	0	0	0	9	3	5
Information on packaging labels:													
Create a packaging label	5	5	2	2	3	2	3	3	3	3	8	3	5
Expired date	8	7	3	4	8	2	6	3	6	3	5	3	8
Legality	5	5	5	5	5	5	5	5	5	5	9	5	8
Brand	3	0	0	0	0	0	0	0	0	0	7	0	3
Composition	9	2	0	0	8	0	1	0	9	2	5	5	3
Information on nutritional value	9	5	0	2	6	3	3	1	9	3	5	5	1
Net weight	4	0	3	0	1	0	0	2	3	0	9	5	5
Description of flavor	0	0	0	0	0	0	0	0	9	3	7	3	4
production code	7	7	5	5	5	3	5	3	4	3	4	5	6
Producer	5	3	3	3	3	3	3	3	3	3	5	3	5
Topping: Fruit pieces	0	0	0	0	0	0	0	0	4	2	2	8	2

Information:

***A**: Fresh milk feeding*
***B**: Pasteurization to temperature 75- 80 ℃*
***C**: Pour milk into milk can*
***D**: Cooling to 40 ℃*
***E**: Adding yogurt seeds to milk*
***F**: Stirring milk*
***G**: Incubate at 37 ℃ for ± 8 hours*
***H**: Screening yogurt*
***I**: Adding liquid sugar, coloring, and flavorings to the yogurt*
***A**: Stirring yogurt using a mixer*
***K**: Ordering packaging materials and yogurt packaging labels*
***L**: Topping and pouring yogurt into the package*
***M**: Packaging*

3.4 Weighted Interest Rate Using AHP Method

Based on the results of the assessment given by four respondents as experts with each area of expertise are: (1) yogurt production technology, (2) food hygiene and microbiology, (3) system and management in agro-industry, and (4) quality management, then analyzed using one of the open applications, then obtained the importance level weight for each yogurt product requirements and yogurt production process. All product requirements and yogurt production processes are assessed on the basis of their importance. The importance weight of yogurt product requirements and yogurt production process can be seen in Table 5 and 6.

Table 5. Interest Rate Weighing Yogurt Product Requirements

No	Product Requirements	Weight
1	Benefits of yogurt: To help smooth the digestive system	0.054
2	Legality: Legality management	0.085
3	Legality: LPPOM MUI: Halal	0.123
4	Legality: BPOM: MD Number	0.160
5	Volume per pack: 250 ml	0.024
6	Price per pack: IDR 6,001 - 9,000	0.041
7	Flavor type: Strawberry	0.015
8	Acidity: Medium	0.041
9	Texture: Smooth	0.032
10	Viscosity: Moderate	0.032
11	Package type: Plastic bottle	0.015
12	Label information: Packaging Labels	0.027
13	Label information: Expiration date	0.063
14	Label information: Legality	0.056
15	Label information: Brands	0.016
16	Label information: Composition	0.066
17	Label information: Nutrition facts	0.050
18	Label information: Net weight	0.031

No	Product Requirements	Weight
19	Label information: Description of flavor	0.023
20	Label information: Production code	0.017
21	Label information: Manufacturer	0.018
22	Supplement (topping): Pieces of fruit	0.010

Table 6. Weighing the Interests of Each Production Process

No	Process Production	Weight
1	Taking raw materials (fresh milk)	0.140
2	Heating (pasteurization) to reach a temperature of 75- 80 ℃	0.145
3	Pouring milk into milk can	0.023
4	Cooling up to 40 ℃	0.125
5	Adding yogurt seeds into milk	0.108
6	Stirring milk	0.073
7	Incubating at 37 ℃ for ± 8 hours	0.125
8	Filtering yogurt	0.056
9	Adding liquid sugar, coloring, and flavorings into yogurt	0.061
10	Stirring yogurt using a mixer	0.035
11	Order packaging materials and yogurt packaging labels	0.047
12	Topping and pouring yogurt into the package	0.033
13	Packaging	0.030

3.5 Level of Competence from Techno-ware and Human-ware Aspects

Based on the results of the assessment given by three experts then calculated the average value, then obtained the value of ATS, ATI, AKS, and AKI per product requirements. These values are used in step six. The amount of ATS, ATI, AKS, and AKI values is determined by how many activities in the production process are related to each product requirement and how much value is given for each activity in the production process. The values of ATS, ATI, AKS, and AKI can be seen in Tables 7 and 8.

3.6 Planning Matrix

The value of improvement ratio, interest point, weight, and normalized weight are obtained from calculation result based on techno-ware and human-ware aspects. The high value of the improvement ratio indicates that the improvements that the industry must make to meet the needs and expectations of customers are getting bigger and vice versa. The value of the interest point of 1.2 indicates that the effect of the industry's ability to meet customer needs and expectations is the medium. The high weight value indicates that the effort done to meet the competency requirements is greater and vice versa. Normalized weight values will be used in the last step. The calculation result of planning matrix based on techno-ware and human-ware aspects can be seen in Table 7 and 8.

Table 7. Planning Matrix Calculation Results Based on Techno-ware Aspect

No	Product Requirements	ATS	ATI	*Goal*	*Improvement Ratio*	*Interest Point*	*Weight*	*Normalized Weight*
1	Benefits of yogurt: To help smooth the digestive system	4.45	1.79	4.45	2.49	1.2	13.30	0.06
2	Legality: Legality management	4.42	1.79	4.42	2.47	1.2	13.08	0.06
3	Legality: LPPOM MUI: Halal	5.54	1.79	5.54	3.10	1.2	20.58	0.10
4	Legality: BPOM: MD Number	5.67	1.79	5.67	3.17	1.2	21.55	0.10
5	Volume per pack: 250 ml	3.52	2.37	3.52	1.49	1.2	6.27	0.03
6	Price per pack: IDR 6,001 - 9,000	4.87	1.79	4.87	2.72	1.2	15.89	0.07
7	Flavor type: Strawberry	0.73	0.37	0.73	1.98	1.2	1.73	0.01
8	Acidity: Medium	3.68	1.66	3.68	2.22	1.2	9.80	0.05
9	Texture: Smooth	3.82	1.63	3.82	2.34	1.2	10.71	0.05
10	Viscosity: Moderate	4.09	1.63	4.09	2.51	1.2	12.31	0.06
11	Package type: Plastic bottle	0.40	0.20	0.40	2.01	1.2	0.97	0.00
12	Label information: Packaging Labels	4.28	1.79	4.28	2.39	1.2	12.26	0.06
13	Label information: Expiration date	4.36	1.79	4.36	2.43	1.2	12.72	0.06
14	Label information: Legality	4.11	1.79	4.11	2.30	1.2	11.32	0.05
15	Label information: Brands	0.65	0.45	0.65	1.45	1.2	1.13	0.01
16	Label information: Composition	3.11	1.83	3.11	1.69	1.2	6.31	0.03
17	Label information: Nutrition facts	4.22	1.77	4.22	2.39	1.2	12.10	0.06
18	Label information: Net weight	1.90	0.81	1.90	2.35	1.2	5.35	0.02
19	Label information: Description of flavor	0.80	0.37	0.80	2.19	1.2	2.11	0.01
20	Label information: Production code	4.22	1.79	4.22	2.36	1.2	11.92	0.06
21	Label information: Manufacturer	4.26	1.79	4.26	2.38	1.2	12.17	0.06
22	Supplement (topping): Pieces of fruit	0.67	0.37	0.67	1.84	1.2	1.48	0.01
						Sum	215.07	1.00

Table 8. Results of Planning Matrix Calculation Based on Human-ware Aspects

No	Product Requirements	AKS	AKI	*Goal*	*Improvement Ratio*	*Interest Point*	*Weight*	*Normalized Weight*
1	Benefits of yogurt: To help smooth the digestive system	3.16	1.69	3.16	1.87	1.2	7.09	0.05
2	Legality: Legality management	4.11	1.69	4.11	2.43	1.2	11.96	0.08
3	Legality: LPPOM MUI: Halal	3.93	1.69	3.93	2.32	1.2	10.93	0.08
4	Legality: BPOM: MD Number	4.06	1.69	4.06	2.40	1.2	11.67	0.08
5	Volume per pack: 250 ml	2.66	2.40	2.66	1.11	1.2	3.53	0.02
6	Price per pack: IDR 6,001 - 9,000	3.30	1.69	3.30	1.95	1.2	7.72	0.05
7	Flavor type: Strawberry	0.59	0.40	0.59	1.50	1.2	1.07	0.01
8	Acidity: Medium	2.88	1.57	2.88	1.84	1.2	6.34	0.04
9	Texture: Smooth	3.01	1.57	3.01	1.92	1.2	6.94	0.05
10	Viscosity: Moderate	3.28	1.57	3.28	2.10	1.2	8.26	0.06
11	Package type: Plastic bottle	0.41	0.20	0.41	2.04	1.2	1.01	0.01
12	Label information: Packaging Labels	3.62	1.69	3.62	2.14	1.2	9.29	0.06
13	Label information: Expiration date	3.64	1.69	3.64	2.15	1.2	9.41	0.07
14	Label information: Legality	3.51	1.69	3.51	2.07	1.2	8.72	0.06
15	Label information: Brands	0.59	0.42	0.59	1.41	1.2	0.99	0.01
16	Label information: Composition	2.75	1.87	2.75	1.47	1.2	4.85	0.03
17	Label information: Nutrition facts	3.44	1.67	3.44	2.06	1.2	8.50	0.06
18	Label information: Net weight	1.66	0.84	1.66	1.98	1.2	3.95	0.03
19	Label information: Description of flavor	0.78	0.40	0.78	1.98	1.2	1.86	0.01
20	Label information: Production code	3.57	1.69	3.57	2.11	1.2	9.03	0.06
21	Label information: Manufacturer	3.57	1.69	3.57	2.11	1.2	9.01	0.06
22	Supplement (topping): Pieces of fruit	0.66	0.40	0.66	1.67	1.2	1.32	0.01
						Sum	143.43	1.00

3.7 Technical Matrix

The percentage gap of each activity in the yogurt production process is obtained from the calculation results based on techno-ware and human-ware aspects. The competence gap from the techno-ware aspect occurs in all activities in the production process, while the competence gap from the human-ware aspect occurs in 12 activities of 13 activities in the production process. The result of technical matrix calculation based on techno-ware and human-ware aspects can be seen in Table 9 and Table 10 respectively.

Table 9. Technical Matrix Calculation Results Based on Techno-ware

	Competence of Techno-ware Aspects												
Production process	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
Contribution Value	0.40	0.32	0.21	0.28	0.43	0.29	0.39	0.30	0.42	0.24	0.27	0.30	0.31
Contribution Normalization	0.10	0.08	0.05	0.07	0.10	0.07	0.09	0.07	0.10	0.06	0.06	0.07	0.07
Value of HR Standard	26.69	27.85	9.31	20.32	29.96	17.88	34.18	19.49	31.99	19.96	14.46	23.39	25.42
Value of Industrial HR	14.34	16.00	2.96	8.63	7.38	8.21	8.54	5.10	8.42	13.71	5.09	6.99	24.80
Gap / Surplus	12.35	11.84	6.35	11.69	22.58	9.67	25.63	14.39	23.57	6.25	9.37	16.41	0.62
%Gap	46%	43%	68%	58%	75%	54%	75%	74%	74%	31%	65%	70%	2%

Description:

***A**: Taking raw materials (fresh milk)*
***B**: Heating (pasteurization) to reach a temperature of 75 - 80 ℃*
***C**: Pouring milk into milk can*
***D**: Cooling up to 40 ℃*
***E**: Adding yogurt seeds into milk*
***F**: Stirring milk*
***G**: Incubating at 37 ℃ for ± 8 hours*
***H**:Filtering yogurt*
***I** : Adding liquid sugar, coloring, and flavorings into yogurt*
***J**: Stirring yogurt using a mixer*
***K**: Order packaging materials and yogurt packaging labels*
***L**: Topping and pouring yogurt into the package*
***M**: Packaging*

Table 10. Technical Matrix Calculation Results Based on Human-ware Aspects

	Competence of Human-ware Aspects												
Production process	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**
Contribution Value	0.37	0.29	0.19	0.25	0.40	0.27	0.35	0.27	0.39	0.22	0.26	0.28	0.29
Contribution Normalization	0.10	0.08	0.05	0.07	0.10	0.07	0.09	0.07	0.10	0.06	0.07	0.07	0.07
Value of HR Standard	20.56	18.27	6.55	13.87	24.68	12.77	22.23	13.34	27.73	15.20	15.24	19.90	20.93
Value of Industrial HR	7.10	10.61	2.70	7.82	13.53	3.72	12.70	4.63	15.41	8.81	4.99	12.16	22.94
Gap / Surplus	13.46	7.66	3.85	6.05	11.14	9.04	9.53	8.71	12.33	6.39	10.25	7.74	-2.01
%Gap	65%	42%	59%	44%	45%	71%	43%	65%	44%	42%	67%	39%	-10%

Description:

***A**: Taking raw materials (fresh milk)*
***B**: Heating (pasteurization) to reach a temperature of 75 - 80 ℃*
***C**: Pouring milk into milk can*
***D**: Cooling up to 40 ℃*
***E**: Adding yogurt seeds into milk*
***F**: Stirring milk*
***G**: Incubating at 37 ℃ for ± 8 hours*
***H**:Filtering yogurt*
***I** : Adding liquid sugar, coloring, and flavorings into yogurt*
***J**: Stirring yogurt using a mixer*
***K**: Order packaging materials and yogurt packaging labels*
***L**: Topping and pouring yogurt into the package*
***M**: Packaging*

Based on Table 9, most of the competency gaps of the techno-ware aspects caused by the production process facilities used are incomplete and less precise. There are two activities in the production process where the production process facility is incomplete, obtaining the highest percentage gap, i.e. the addition of yogurt seed into milk (activity E) and incubation activity at 37 ^{o}C for ± 8 hours (activity G). The yogurt seedling activity is not equipped with the use of measuring cups. The use of measuring cups is very important to produce accurate yogurt seed size. In incubation activities are not equipped with the use of heating lamps. Manually incubation activities should be accompanied by the use of heating lamps to keep the incubation temperature 37 ^{o}C more stable. Position and type of lamps greatly affect the stability of the incubation process (Gómez-López, et.al., 2005). One of the activities in the production process where the production process facility is less precise is the activity of pouring milk into milk can (activity C). In the event, the use of plastic bucket for pouring milk is considered inappropriate because the milk is still hot (milk after pasteurized), so it is feared that the harmful chemicals in the bucket will react if direct contact with milk in a hot state. Plastic buckets can be replaced with stainless steel bucket.

Based on Table 10, activities undertaken by workers in the production process are relatively simple, so the ability of workers is considered sufficient. However, the competence gap from the human-ware aspects is caused by workers not complete themselves with hygiene equipment such as masks, hairnet (head cover), and gloves and workers do not wash hands with soap before performing activities in the production process.

The main difficulties encountered for the implementation of food safety system were related to the implementation of actions established in the flow chart and to the need for constant training/adherence of the workers to the system. Despite this, the implementation of the food safety system was shown to be challenging, but feasible to be reached by small-scale food industries (Cusato, et.al., 2013).

CONCLUSION

Based on the results of the analysis, it can be concluded that IRT X assessed not yet meet the requirements to produce yogurt in accordance with the needs and expectations of consumers. It was shown by the gap of industrial competence to achieve a number of requirements. The competency gap is analyzed through: (1) the relation between the requirements of the yogurt product and the production process; (2) the importance weight of both of them based on techno-ware and human-ware aspects; and (3) assessment of competency level and (4) assessment of industrial competency level based on techno-ware and human-ware aspects. IRT X requires a major overhaul to eliminate the gap by the following actions: (1) completing and/or replacing some facilities of yogurt production processes tailored to financial circumstances; (2) providing guidance and monitoring of workers in order to perform all

activities in the yogurt production process properly; (3) adding to the completeness of the worker with hygiene equipment; and (4) placing the production facility in accordance with the sequence of the process.

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