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DEVELOPMENT OF A PRODUCT QUALITY INDEX FOR THE VALUE CHAIN OF THE DAIRY INDUSTRY: A CASE STUDY IN MONARAGALA DISTRICT, SRI LANKA

Wickrama PSSL[1], Sandika AL[1*], Jayamanne VS[2]

[1]Department of Agricultural Economics, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

[2]Department of Food Science and Technology, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka

ABSTRACT

Value chain management is immensely important to the management of a network of interconnected businesses involved in the eventual provision of the highest quality product and service packages required by end customers. Dairy and dairy products are highly attached by microorganisms and products are damaged due to inappropriate methods of packing, storage and transportation. Insufficient information flow; low productivity, low GDP contribution from the dairy sector; poor processing capacity and lack of chilling centers are other major handicaps. Therefore, this study aimed: to assess the different quality maintenance practices for developing a Product Quality Index (PQI) for a dairy product and to make suggestions for improving quality through the quality index of the dairy value chain. *Wellawaya* Divisional Secretariat (DS) division was purposively selected out of 11 DS divisions of the district for the study since dairy production is the main occupation in that area. Stratified random sampling method was used to select 20 small scales, 10 medium scales, and 10 large scale farmers while the purposive sampling method was used to select, 10 collectors, 10 processors, 15 marketers and 15 consumers. Primary data were collected using a pre-tested structured questionnaire through a field survey. The PQI was developed for this study which is varied from 1 to 100 values. The result showed that all the practices in the *Wellawaya* area were shown medium standard based upon the mean marks. Animal nutrition management (6.0) was the best practice and farmer level hygienic and quality practices (3.45) were the practices with lower marks in the area. PQI of locally produced different dairy products were compared with the most popular dairy brand available on the market. According to the newly developed PQI value for this study, locally produce curd and yoghurts marks were varied from 29.5% to 64.6% and the PQI of the most popular branded curd and yoghurt products was 77.8%. So, locally produced curd and yoghurt products which are produced at the *Wellawaya* belong to medium and low-quality levels whereas the quality of the branded dairy products was high. In conclusion, it can be sid that Hence we concluded that the quality standard of locally produced dairy products were low as compared to branded dairy products. Therefore, it's important to train actors in the value chain to develop products with high-quality practices and suggests expanding the PQI value as an indicator for the quality of the dairy value chain.

Keywords: Dairy farmers, dairy product, product quality index and value chain actors

INTRODUCTION

Value chain defines a set of activities that a firm operating in a specific industry performs to deliver valuable products (Webber and Labaste 2009). In the dairy industry, different value chain actors can be identified as input suppliers, milk producers, milk processors, marketers and consumers. Also, there can be identified the different value-added product as curd, yoghurt, pasteurized milk, ice cream and milk toffee (Webber and Labaste 2009).

The farm animals sector of Sri Lanka recorded 6.3% growth in 2016 including 0.6% performance and the cattle population has been extended by 11% while the buffalo population improved by 12% in 2016

*Corresponding author: sandika@agecon.ruh.ac.lk

comparatively 2015. Also, the aggregate milk production into 2016 has expanded with the aid of 13% compared in imitation of 2015. Formal milk collection has accelerated by 6% in 2016, which reflects the inadequacy of improvement regarding milk processing capacity within the country. This may lead to serious consequences in the coming years as the increased production has to be captured within the formal milk market to ensure the stability of the industry (DAPH 2016).

Different quality practices and important techniques are used worldwide to support farmers to produce protected, quality milk and milk items to fulfill the desires of the sustenance business and customers' requirements (FAO 2013). The point is to guarantee that the milk is created at the farm level by healthy animals under acceptable conditions for animals and in balance with the environment. Milk contains various supplements and it makes a significant contribution to meeting the body's necessities for Calcium (Ca), Magnesium (Mg), Selenium (Se), Riboflavin, Vitamin B12. Furthermore, Pantothenic acid (Vitamin B5) (FAO 2013). This regular variety of dairy animals' eating methodologies effect the variation of milk properties, for example, taste, color, fat substance and etc. (Nethagi *et al.* 2014). According to the study of Biasato *et al*. (2019), animal health and welfare mainly affect to the milk and milk product quality variation. Other than the variation of environmental elements and cows' diets are also effect into milk properties. Also, stress's condition deal with nutrition, reproduction, and the environment was affected dairy yield as well as composition (Harding 1995). Different hygienic conditions in the environment and equipment mainly cause contamination of milk and milk products by bacteria and other microorganisms. It mainly affects the final dairy product quality. There can be identified conflicting pressures on dairy farmers. Milk should be clean but liberated from hints of cleansers. Milk should be from healthy dairy animals, yet ought not to contain residues of anti-toxins (Harding 1995). According to the Marchand *et al*. (2012), different microorganism as bacteria can adhere and aggregate with milk on the different surface during transportation and storage. Further packing materials affect to nutritive value, economic value and food stability of different dairy and other products (Wong *et al*. 2014).

Based on the above-discussed reasons, quality variation and different quality practices in each step of the value chain should be considered when producing quality milk products. Accommodation of high-quality local production in the market chain has become a challenge. There is limited data on hygienic practices throughout the dairy supply chain in Sri Lanka and no evidence of the existence of standard milking procedures. A recent study in Sri Lanka identified that many actors do not properly follow necessary quality management practices in the dairy value chain. This practice can lead to the spread of contagious pathogens. The milk supply chain is an important source for the transmission of milk-borne pathogens to people, as can be effectively defiled amid draining and taking care of (Addo *et al.* 2011; Pal 2012). Poor or improper treatment of value chain practices significantly affect both general wellbeing and financial limitations in this way requiring hygienic and quality maintaining practices (Zewdu 2015). Because of that, the development of infrastructures such as milk collecting networks, facilities for value addition and further processing and quality assurance will be required for the smooth growth of the dairy industry and dairy product quality. Therefore, this study mainly focuses on the achievement of the above different criteria. The objectives of the study on this background were: to analyze the different quality maintenance practices for developing a quality index for dairy value chain products, to develop a Product Quality Index (PQI) and to make suggestions for improving quality through the quality index of the dairy value

chain. The findings of the study will be useful to make appropriate strategies to improve the hygiene and quality of the dairy product of the local products via PQI. The next section explains the methodology of this study followed by the results of the study.

MATERIALS AND METHODS

This part of the article explains the study area, sample size, sampling technique, data analysis and dairy product index development steps. This study was conducted in the *Monaragala* district. *Wellawaya* DS division was purposively selected for this study among eleven DS divisions of *Monaragala* district by considering the large number of cattle raring farmers in the area as compared to other DS divisions. The target population is the total group of individuals from which the sample was drawn. All actors of the dairy value chain were considered the target population of the study. The survey was directed to the dairy value chain approach starting from input supplier, farmer, collector, processor, wholesaler and retailer to consumer in *Wellawaya* DS division.

Out of the different sampling techniques stratified random sampling method was used to select 20 small scales, 10 medium scales, and 10 large scale farmers from the target population. Farmers list of the *Wellawaya* veterinary office and *Milco* collecting center was used as a sampling frame to select dairy farmers. Apart from that, ten input suppliers, ten collectors, ten processors, fifteen marketers (as five wholesalers and ten retailers) and fifteen consumers were selected by using the purposive sampling method for the study.

Data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. Both primary data and secondary data were collected for this study. Six different pre-tested structured questionnaires were used for primary data collection from each dairy value chain actors. Secondary data were collected by using literature review as books, journal articles, newspapers, and websites.

Collected data was first tabulated by using MS Excel and SPSS software packages. Both descriptive and inferential analyses were undertaken on the data using computer packages. The data were analyzed descriptively in terms of percentage, pie chart and bar chart. Further Wilcoxon sign rank test were applied for the analysis of data.

The development of Product Quality Index (PQI) was an important objective of the study. A quality index was developed to evaluate a different type of locally produced dairy products by comparing the popular branded products. The main three value chain actors of the dairy value chain as farmer level, collector level and processor level were used to develop

$$Main\ criteria\ value = \left(\frac{\sum marks\ of\ practise\ sub\ criterion}{\sum marks\ of\ main\ criteria}\right) * 10 \ldots\ldots\ldots\ldots (i)$$

$$Product\ Quality\ Index\ (PQI) = \frac{(20\ Y1) + (10\ Y2) + (15\ Y3) + (5\ Y4) + (10\ Y5) + (5\ Y6) + (10\ Y7) + (05\ Y8) + (10\ Y9) + (10\ Y10)}{10} \% \ldots\ldots\ldots (ii)$$

$$SNF\ percentage = \left(\frac{CLR}{4}\right) + 0.22F + 0.72 \ldots\ldots\ldots\ldots (iii)$$

CLR = Corrected Lactometer Reading F = Fat content in milk

Table 1: Main criteria at different value chain actors' level

Farmer level	**Maximum Marks**
Animal nutrition management	0-10
Animal health control and milking	0-10
Farmer level hygienic and quality management	0-10
Farmer level transportation and storage	0-10
Collector level	
Collector level hygienic and quality management	0-10
Collector level transportation and storage	0-10
Processor level	
Processor hygienic management	0-10
Processor level transportation and storage	0-10
Processing and quality management	0-10
Packing	0-10

the quality index. Ten main criteria were taken into account for developing the PQI of the dairy products because the quality of the final dairy product depends on the hygiene and quality of the raw milk which is required to maintain the quality from farmer level, collector, processor to the ultimate end user. Ten criteria that are relevant to the hygiene and quality maintenance of the milk as raw materials for all levels were taken into account as follows (see annex i).

Marks were given to each main criterion by developing sub-criteria (see annex i) for each main criterion. It means each main criterion pointed out as Y_1 to Y_{10}, has several sub-criteria. All criteria were measured using a scale from 0 (very poor condition) to 10 (excellent condition). The final value for the main criterion was calculated by adopting the equation (i).

Categorization of the criterion was done based upon the criterion value. Less than 3.0 marks for a criterion was indicated as low-quality practices whereas the value greater more than 7 for the main criterion was indicated as high-quality practices. When the value 3.1 - 6.9 range was shown moderate-quality practices. Based on the study done by Paraffin *et al.* (2018), a weighted value was given for each criterion to calculate PQI. As indicates in Table 01, based on the impact of the relevant criteria for the quality of the final product weighted value was assigned to criteria.

Y_1, Y_2, Y_3, Y_4, Y_5, Y_6, Y_7, Y_8, Y_9 and Y_{10} indicate criteria value for each criterion. The formula (ii) was adopted to develop the Product Quality Index (PQI).

PQI value varied from 1 to 100 and categorization was done by considering the value. When the PQI is less than 30, it indicates that the product quality is low whereas the PQI value for medium quality products is between 31 to 69. PQI value for a high-quality product is greater than 70%.

A lab experiment was done to check the actual hygiene and quality of the ultimate products of the studied value chain to check the validity and reliability of PQI. Experimental data collection was done based on the sample selection and laboratory tests were done through the milk sample collection through the entire value chain. Milk samples were collected from three main different levels that include ten milk samples from farmer level, ten milk samples from processor level and ten yoghurt/curd sample from processor level in *Wellawaya* DS division by using the purposive sampling method.

Milk quality parameters were measured by identifying different quality variations through the dairy value chain. Fat percentage, SNF percentage, Specific gravity and pH were determined by using the standard method at three main different levels of milk

Table 2: Assigned weight value for each criterion

Criteria	Weight	Criteria	Weight
Animal nutrition management (Y_1)	20%	Collector level transportation and storage (Y_6)	05%
Animal health control and milking (Y_2)	10%	Processor hygienic management (Y_7)	10%
Farmer level hygienic and quality management (Y_3)	15%	Processor level transportation and storage (Y_8)	05%
Farmer level transportation and storage (Y_4)	05%	Processing and quality management (Y_9)	10%
Collector level hygienic and quality management (Y_5)	10%	Packing (Y_{10})	10%

Table 3: Assigned weight value for each criterion

Main criteria	Minimum value	Maximum value	Mean value
Animal nutrition management (Y1)	4.0	8.0	6.0
Animal health control and milking (Y2)	2.0	8.0	5.0
Farmer level hygienic and quality management (Y3)	2.0	4.9	3.45
Farmer level transportation and storage (Y4)	4.0	6.4	5.2
Collector level hygienic and quality management (Y5)	2.14	5.0	3.57
Collector level transportation and storage (Y6)	3.07	6.15	4.61
Processor hygienic management (Y7)	2.3	6.15	4.23
Processor level transportation and storage (Y8)	3.6	6.42	5.01
Processing and quality management (Y9)	2.85	5.7	4.28
Packing (Y10)	4.0	6.8	5.5

value chain. Laboratory tests were carried out by *Wellawaya Milco* milk collection center laboratory and the Animal Science laboratory Department of Animal Science, Faculty of Agriculture University of Ruhuna to determine value variation of Fat percentage, SNF percentage, Specific gravity and pH.

Fat percentages were determined by using standard Gerber methods. Specific gravities were determined according to the standard lactometer reading methods. pH values were calculated by using a pH meter and SNF percentages were identified by using equation (iii).

RESULTS AND DISCUSSION

As explained in the methodology, when the criteria value less than 3.0 is indicating low-quality practices, whereas the value is greater than 7, the criteria indicate high- quality practices. If the value is in between the 3.1 - 6.9 range indicates the moderate quality practices. The result of the study clearly illustrates in Table 3, that, minimum possible marks were distributed from 2.0 to 4.0. Maximum possible marks were distributed from 4.9 to 8.0 while mean marks were distributed from 3.45 to 6.0 for the main criteria of PQI. Farmers properly practice animal nutrition management practices (6.0) and processors properly practice packing (5.5) activities than other practices within the dairy value chain of *Wellawaya* DS division. Also, farmer level (Y3) and collector level (Y7) hygienic and quality management practices were shown the lowest value. All of the practices in the *Wellawaya* DS division are medium standard practices on mean marks of

For minimum marks

$$Product\ \ Quality\ Index\ (PQI) = \frac{(20*4)+(10*2)+(15*2)+(5*4)+(10*2.14)+(05*3.07)+(10*2.3)+(05*3.6)+(10*2.85)+(10*4.0)}{10}\%$$

For maximum marks

$$Product\ Quality\ \ Index\ (PQI) = \frac{(20*8)+(10*8)+(15*4.9)+(5*6.4)+(10*5)+(05*6.15)+(10*6.15)+(05*6.42)+(10*5.7)+(10*7.0)}{10}\%$$

For mean marks

$$Product\ Quality\ Index\ (PQI) = \frac{(20*6.0)+(10*5)+(15*3.45)+(5*5.2)+(10*3.57)+(05*4.61)+(10*4.23)+(05*5)+(10*4.3)+(10*5.5)}{10}\%$$

Figure 1: PQI value on minimum marks, maximum and mean marks of each practice

each criterion. According to the maximum marks, only Animal nutrition management (Y1) and Animal health control and milking (Y2) practices were shown high standard in dairy value chain Table 03: Marks distribution for each main criteria in *Wellawaya* DS division yoghurt/curd production.

Marks of main quality activities were applied to the PQI equation to calculate the PQI value for *Wellawaya* DS division curd production. PQI value on minimum marks, maximum and mean marks of each practice is shown in Fig. 1.

PQI value for curd was distributed from 29.5% to 64.6% while the mean PQI value was 47.05%. According to the results, it can be interpreted that the quality of the yoghurt/ curds in Wellawaya DS division is low to medium.

Relevant values for the main criteria for yoghurt/curd production in the popular large scale dairy company were shown in Table 03. Processor level hygienic, processor level transportation and storage and packing activities were high and maximum value was reported this activity. It was greater than 8.5 and a minimum value (5.0) was reported for farmer-level hygienic and quality practices. Values for other criteria were in between that maximum and moderate range.

An attempt was made to calculate the PQI value for the branded product and it was 77.82%. According to the categorization, product quality is high. This value is significantly higher than the PQI of locally produced products.

Following Table 05 illustrates the comparison of the average values of the main ten criteria. Hygiene and quality maintains at a different level of the locally produced dairy products are low as compared to the branded products. Table 5, clearly illustrates that farmer-level hygienic and quality management, transportation and storage practices were poor

Table 4: Values for the main criterion in popular dairy company yoghurt/curd production

Main criteria	Possible value
Animal nutrition management (Y1)	8
Animal health control and milking (Y2)	8
Farmer level hygienic and quality management (Y3)	5
Farmer level transportation and storage (Y4)	7.15
Collector level hygienic and quality management (Y5)	7.5
Collector level transportation and storage (Y6)	7.7
Processor hygienic management (Y7)	8.5
Processor level transportation and storage (Y8)	9
Processing and quality management (Y9)	8.4
Packing (Y10)	10

Table 5: Possible marks distribution for each main criterion in both level productions

Main criteria	Mean value for locally produced products at *Wellawaya*	Possible value for popular dairy companies products
Animal nutrition management (Y1)	5.73	8.46*
Animal health control and milking (Y2)	7.00	7.00
Farmer level hygienic and quality management (Y3)	3.58	3.58
Farmer level transportation and storage (Y4)	3.64	4.00
Collector level hygienic and quality management (Y5)	3.94	7.24*
Collector level transportation and storage (Y6)	3.72	7.58*
Processor hygienic management (Y7)	4.75	9.20*
Processor level transportation and storage (Y8)	2.99	8.63*
Processing and quality management (Y9)	6.64	8.23*
Packing (Y10)	4.15	9.00*

in both value chain. This should be taken into account by the relevant authorities need to take appropriate measures to correct it. All other criteria of the popular company were better than the value chain of local products.

Standard level of fat % is 3.1-3.3 (cow) and 5.3-9.0 (Buffalo) while SNF%, specific gravity (g/ml) and pH value for both cow and buffalo are 8.7, .032-1.035 and 4.5 (Max.), respectively ((FOA 2013; Weerasekara *et al*. 2010).

When considering the quality variation at the farmer level, the fat percentage of ten milk samples were varied within the 3.8%-5.0% range and the mean fat percentage of the milk sample was 4.34%. SNF percentages of ten milk samples were varied within the 8.34-

9.1% range while the mean SNF percentage was 8.69%. Also, specific gravity contents were varied within the 1.028-1.030 g/ml range and the mean specific gravity of ten milk samples was 1.028 g/ml. According to the mean value, it can be determined that there were no standard specific gravity range and SNF percentage according to FOA and California standard. Further, there were no required levels of fat percentage comparatively standard buffalo milk fat percentage.

At the collector level fat percentage of ten milk samples were varied within the 3.7%-5.2% range and the mean fat percentage of the milk sample was 4.31%. SNF percentage of ten milk samples were varied within the 8.05-9.1% range while the mean SNF percentage was 8.45%. Also, specific gravity contents were varied within the 1.025-1.029 g/ml range and the mean specific gravity of ten milk samples was 1.027 g/ml. According to the mean value, it can be determined that there were no standard specific gravity range and SNF percentage. Further, there can be identified there were no necessary levels of fat percentage of Wellawaya village-level milk products comparatively standard buffalo milk Fat percentage.

Further, processor level pH values of ten samples were varied within the 4.7-4.84 range and the mean pH value of curd samples was 4.76. It can be determined that there were no standard pH values in all analyzed locally produced yogurt and curd samples. According to the results, it was shown fat percentage and SNF percentage were slightly decreased through the dairy value chain and therefore, the qualities of the locally produced products were decreasing. However, all the parameters for branded products were aligned with the standards. Actual quality of the product is alien to the PQI. It is therefore, PQI can be used as an indicator of the quality of dairy products.

Further, these findings are confirmed by the study done by Smit (2003). According to findings, breed and animal husbandry practices, farmer level hygienic practices, pasteurization & sterilization technologies and availability of quality maintains equipment mainly affect the final dairy product quality and safety (Smit 2003).

The study attempted to recognize the discrepancy of hygiene and quality maintains of studied value chains. Focus group discussion was made with all actors of two value chains to identify the possible reasons and make appropriate measures. They pointed out that socio-economic and environmental conditions are favorable to dairy sector development in the area. However, based on the discussion, it can be said that poor and insufficient knowledge of the farmers, collectors and other actors on best practices were the main reason. Further, farmers' poor knowledge and practice on animal health practices, best animal welfare practices and best animal nutrition practices were significantly affected. Further, lack of appropriate transport and storage facilities were also a significant issue of the area which affects the quality. On the other hand, the dairy company with the popular brand name are conducting training programs for their farmers and implementing regular monitoring system to maintain hygiene and quality. It is Therefore, holistic awareness and training programms in this regard need to be conducted in the area. Further, appropriate containers, transportation methods and quality and appropriate storage facilities should be introduced to all actors of the supply chain.

According to the consumers' point of view, packing material quality, the convenience of buying and the price of the product was significant than other characters. Therefore, the quality of packing material, the convenience of buying and the price need to be considered by the local produces too for the development of their business.

CONCLUSION

PQI is aligned with the quality of the product. Therefore, PQI can be used as an indicator of the quality of dairy products. According to the newly developed product quality index, the PQI value of Wellawaya DS division yoghurt/curd was varied from 29.5% to 64.6%. PQI of yoghurt of the reputed company was 77.82%. In this context, it can be concluded that there was no highest quality locally produced yoghurt and curds in Wellawaya DS division while higher quality yoghurt products can obtaining from the reputed company. Low marks of activities as farmer level hygienic and quality management, collector level hygienic and quality management, processor hygienic management and processing and quality management were caused to low marks of PQI and a low level of product quality.

Though the socio-economic and environmental conditions are favorable to dairy industry development there were not sufficient knowledge, best milking practices, best animal health practices, best animal welfare practices and best animal nutrition practices at the farmers' level. It can be suggested that further research and examination on PQI is needed to identify the wide range applicability of PQI to select the best quality product from the market and further improvement is required to increase the scope of PQI.

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Annex i

Farmer level	Sub criterion	Response	Marks
Animal nutritional management (Y1)	Feed types	Grain supplement	04
		Hay	03
(Nethagi *et al*. 2014)		Pasture and forage	02
		Concentrate	01
	Availability of minerals	Yes	01
		No	00
	Types of water	River	02
		Well	01
		Lake	01
	Preventing animal from eating toxic plants	Adopted	01
		Not adopted	00
	Adaptation to check the quality of feeds/minerals and water	Adopted	01
		Not adopted	00
	Feeding amount per day/time duration		02
Animal health control and milking management (Y2)	Regular health checkup	Adopted	01
		Not adopted	00
	Veterinary advice (Frequency)	Follow	01
(Biasato *et al*. 2019: Harding 1995)		Not follow	00
	Method of milking	Machine	02
		Hand	01
	Time interval between milking	12hr<	02
		12hr>	01
	Dry cow therapy	Follow	01
		Not Follow	00
	Straining of milk	Practiced	01
		Not practiced	00
	Immediate care of the sick animal	01 day>	02
		01-02 day	01
		03day<	00
Farmer level hygienic and quality management (Y3)	Cleaning of milkman before engage with dairy-related practices	Disinfection use	02
		Normal water	01
(Wong *et a*l. 2014: Smit 2003)		No wash	00
	Cleaning of the animal before milking	Entire animal	03
		Back of animal	02
		Udder	01

Annex i: ***continued***

	Cleaning of animal shed	Twice a day	03
		Once a day	02
		Other	01
	Cleaning of utensils	Sterilized	02
		No sterilized	00
	Chemical use	Adopted	00
		Not adopted	01
	SLSI standard	Follow	01
		Not follow	00
	Milk quality measuring equipment	Have	01
		Not have	00
	Wastage disposal method	Compost	02
		Biogas	02
		Other	01
		No best method	00
Farmer level transportation and storage (Y4) (Wong *et al*. 2014)	Transportation/ storage	Not done	10
	Transportation start from milking	01hr>	03
		01-02	02
		02<	01
	Time duration of transportation	01>	03
		01-02	02
		02<	01
	Equipment of transportation	Sterilized sealed	03
		Sterilized	02
		Sealed	02
		Normal	01
	Storage equipment	De freezer	03
		Icebox	02
		Other	01
	Equipment of storage	Sterilized	01
		Not sterilized	00
	Transportation vehicle	Vehicle with freezer	01
		Normal	00
Collector level hygienic and quality management (Y5) (Wong *et al*. 2014: Marchand *et al*. 2012)	Nature of collecting center	Well design	01
		Not well design	00
	Cleaning of collection center	Twice per day	02
		Once per day	01
		Other	00
	Hygiene of milk collector	Disinfection use	02
		Normal water	01
		No wash	00
	Type of collection equipment	Sterilized	01
		Not sterilized	00
	Ventilation of place	High	01
		Low	00
	Sorting of milk on different grade	Adopted	01
		Not adopted	00
	Chemical usage	Yes	00
		No	01
	Follow SLSI standard	Yes	01
		No	00
	Milk quality measuring facilities	pH	01
		Density	01
		Fat content	01
		No facilities	00

Annex i: ***continued***

	Milk quality maintain facilities	pH	01
		Density	01
		Fat content	01
		No facilities	00
Collector level transportation and storage (Y6)	Milk collection period	30min>	03
		30min-1 hour	02
(*Wong et al. 2014: Marchand et al. 2012*)		1 hour<	01
	Transportation time duration	01hr>	03
		01-02	02
		02<	01
	Transportation equipment	Sterilized sealed	03
		Sterilized	02
		Sealed	02
		Normal	01
	Storage equipment	De freezer	03
		Icebox	02
		Other	01
	Transportation vehicle	Vehicle with freezer	01
		Normal	00
Processor level hygienic management (Y7)	Nature of processing place	Well establish	03
		Normally arranged	02
(Biasato *et al*. 2019: Harding,1995)		Not well arranged	01
	Cleaning of processing place	Twice per day	03
		Once per day	02
		Other	01
	Cleaning of processor	Disinfection use	02
		Normal water	01
		No wash	00
	Nature of processing equipment	Sterilized	01
		Not sterilized	00
	Cleaning of the equipment	Disinfection use	02
		Normal water	01
		No wash	00
	Cover the body during processing	Hat	01
		Apron	01
		Gloves	01
		Not cover	00
Processor level transportation and storage (Y8)	Transportation/ storage	Not done	10
	Transportation start after milking/ processing	01hr>	03
		01-02	02
(Biasato *et al*. 2019: Harding 1995)		02<	01
	Time duration of transportation of milk/product	01>	03
		01-02	02
		02<	01
	Equipment of transportation milk/product	Sterilized sealed	03
		Sterilized	02
		Sealed	02
		Normal	01

Annex i: ***continued***

	Storage equipment of milk/product	De freezer	03
		Icebox	02
		Other	01
	Equipment of storage milk/product	Sterilized	01
		Not sterilized	00
	Transportation vehicle milk/product	Vehicle with freezer	01
		Normal	00
Processing and quality management (Y9)	Methods of processing	Blanching	01
		Pasteurization	01
(Biasato *et al.* 2009: Harding 1995)		Sterilization	01
		UHT	02
		Other	01
	Artificial ingredients	Not use	01
		Use	00
	Type of equipment	Clay	03
		Aluminum	02
		Other	00
	Shelf life of products	02 day>	03
		02-05	02
		05day<	01
	SLSI standard	Follow	01
		Not follow	00
	Milk quality measurement facilities	Have	01
		Not have	00
	Type of water use to process	Filtered	02
		Well	00
		River	00
		Lake	00
	Maintain quality standard	pH	01
		Fat	01
		Solid	01
		Microorganism	01
Packing (Y10)	Packing place	Well established	01
		Not well established	00
(Karatapanis *et al*. 2006)	Packing method	Vacuum	02
		Modified atmos-phere	02
		Microwave	02
		Other	01
	Packing material	Paper	02
		Plastic	02
		Glass	03
		Clay	03
		Other	01
	Equipment	Sterilized	01
		Not sterilized	00
	Packing start after processing	At the same time	03
		1hour>	02
		1hour<	01