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The influence of material handling and operational performance on food loss occurrence in the milk supply chain

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ABSTRACT

Food loss occurs during production, handling, and post-harvest processing. Food loss also occurs because the product is under quality and shelf-life over. In addition, the performance and knowledge of farmers also need to be improved to minimize food loss. Food loss in the milk supply chain occurs due to spills, damage, and product contamination caused by operator negligence and poor handling procedures due to the lack of material handling and operational performance. This study aims to determine the effect of material handling and operational performance on food loss in the milk supply chain. The method used is a quantitative method with a statistical test Chi-Square. The results show that most material handling cases involve manual milking and milk storage. Another cause of food loss is the high production of bacteria, which impacts milk quality. In operational performance, the primary reason is communication among farmers regarding the cleanliness and handling of cattle during production. New farmers with low experience are expected to attend training to increase production capacity and avoid bacterial contamination. Upgrading Milking equipment is also essential to reduce food loss in the milk supply chain.

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INTRODUCTION

Food loss occurs during production, either during handling or post-harvest processing. Many factors cause food loss, such as overproduction, defective products, packaging damage, poor procedures, and poor conformity. Food loss can also occur because the product does not match the quality and shelf life (Wesana et al. 2019). In the milk supply chain, the lack of knowledge and skills of dairy farmers can result in decreased production and food loss (Hidayat 2020). However, farmers need to understand this situation due to its impact on labor, infrastructure, and income (Poppi et al. 2021). Food loss also occurs due to spills, damage, and product contamination caused by operator negligence and poor handling procedures (Fatonah et al. 2020). Therefore, good material handling is needed to maintain product quality. Material handling must be designed according to the needs of its users (adjusting tasks to humans) with the application of ergonomics and anthropometry.

In Indonesia, the production of fresh milk is done manually. The manual process causes the low quality and safety of the milk produced (Rahman et al. 2013). Milk production needs a semi-automatic machine to increase milk productivity. This machine is not made for just one cow, but mostly one set of tool components is made to milk 200 cows per hour. All members are integrated and flow milk to a reservoir which will then be processed into a product. In addition, using a machine provides many advantages, such as reducing the number of bacteria by up to 75%, milk not spilling during milking, and shorter milking time. The use of machines also has an impact on reducing milk contamination by microbes. The number of dairy products will also increase, where manual milking only produces an average of eight liters of milk per day. The manual process is the most significant influence on food loss (Purnama and Pertiwi 2011).

Another dairy cow challenge is operational performance. Operational performance is a measure of farmer performance to increase knowledge, so production can increase by minimizing the occurrence of food loss (Ahmad and Yuliawati 2013). Operational performance refers to the suitability of the process and evaluation in terms of costs, customer service, delivery of goods to customers, quality of the process of goods or services on farms, the transfer or delivery of milk, frequent accidental spills, and the knowledge regarding the tools used (Hartanto et al. 2021). The quality of goods and processes are very influential on the products produced because milk is a product that is easily exposed to bacteria. It will only result in food loss in dairy products (Naufalin et al. 2019). Operational performance is produced within a certain period by referring to the standards before milking. The milk is discarded to check whether the milk is in good condition or has the disease (mastitis) by checking whether the damaged milk is mixed with good milk and knowing which cattle are affected by the disease to minimize the loss (Naufal 2018).

Moreover, material handling and operational performance are needed in food loss research. Therefore, this study aims to determine the effect of material handling and operational performance on food loss in the milk supply chain. This research was conducted in Banyumas, Central Java Province and it was chosen because this area is developing Friesian Holstein (FH) type. This cow has several advantages include higher milk production with low fat content (Setyorini et al. 2020).

METHODS

This research method used a quantitative approach. The research started by conducting problem definitions, defining research objectives, and developing research instruments. All those three activities were based on literature reviews. Furthermore, data collection was performed by conducting observations and surveys. The survey was spread questionnaires to dairy farmers in the Banyumas area who came from two villages, namely Tumiyang and Kemutug Lor. The respondents were 40 experienced dairy farmers. The data used in this study were primary data based on supply chain practices such as the milking, storage, and distribution processes. After getting the data, a Chi-Square test was performed to gain statistical analysis. The last activity was conducted with a conclusion and recommendation (Figure 1).

Moreover, the collected data were the demographics and preferences of dairy farmers for material handling and operational performance. Demographic data included the number of productive cows, stall area, morning production capacity, and afternoon production capacity. The data collection was recorded using a Likert scale with a scale range of one to seven; 1) Strongly

Disagree, 2) Moderately Disagree, 3) Disagree, 4) Neutral, 5) Moderately Agree, 6) Agree, 7) Strongly Agree. After data collection, the data were tested for feasibility, including validity, reliability, and normality tests.

Furthermore, the data were processed using the Chi-Square method to test the relationship among demographics, material handling, and operational performances. The preferences attributes of material handling and operational performance can be seen in Tables 1 and 2.

The data were tested statistically using Minitab 19 (alpha 5%). The hypothesis was set as follows (Narendra et al. 2021):

H_1: Material handling affects food loss in the fresh milk supply chain.

H_2: Operational performance affects the occurrence of food loss in the fresh milk supply chain

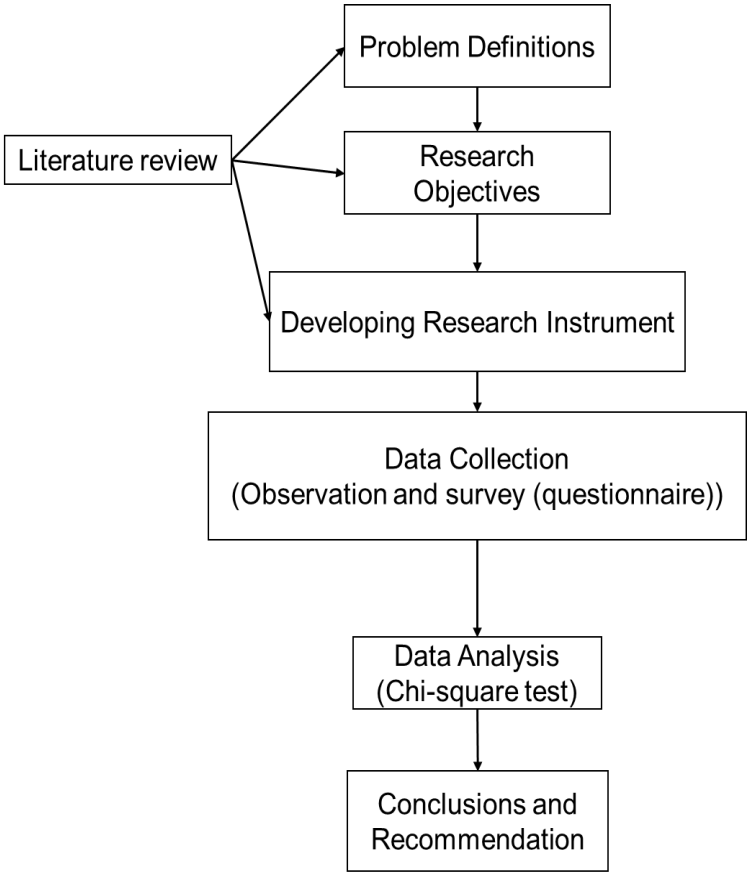

Figure 1 Research flow diagram

Table 1 Attributes of material handling

Activity	Code	Attribute
Production (Rahim and Kurniawan 2017) (Hidayat 2020)	P1	Cage cleanliness
	P2	Dirty places affect milk yield
	P3	Standards for a targeted amount of time and product quality
Harvesting (milking) (Purnama and Pertiwi 2011)	P4	Manual tools affect milk yield
	P5	Manual milking causes milk to spill
Inventory (Setiyowati 2020)	P6	Manual transfer of milk container causes milk spill
	P7	Storage of dairy products

Table 2 Attributes of operational performance

Activity	Code	Attribute
Production (Rahim and Kurniawan 2017)	P8	Milking methods
	P9	Receive socialization about the cleanliness of the cage
Harvesting (milking) (Purnama and Pertiwi 2011)	P10	Milker washes hands before milking
Inventory (Setiyowati 2020)	P11	Transfer of milk into storage causes milk to spill
	P12	Proper storage activities can reduce milk spills
	P13	Adequate storage infrastructure can reduce milk spills

RESULTS AND DISCUSSION

Respondent demographics

The demographics of the respondents can be seen in Table 3. Milk farmers came from two villages: Tumiyang with 22% and Kemutug Lor with 78%. %. The majority of productive cattle owned by farmers are one to five cattle, with a percentage of 50%. The majority of the cage area is 1 to 100 square meters with a percentage of 85%, the second with a total size of 101 to 200 square meters accounting for 12%, and the rest is 201 to 300 square meters. Milk production in the morning is mainly 1 to 20 liters by 60%. In the afternoon, the majority of the production is 1 to 20 liters with a percentage of 75%.

Validity, reliability, and normality test results

After the data is collected, the next step is to test the validity, reliability, and normality (Table 4). Finally, a validity test is used to determine the validity of the questionnaire used by researchers in measuring and obtaining research data from respondents. The validity test that has been carried out shows that P1 to P13 is declared valid with a p-value below 0.05.

Table 4 showed that P1 to P13 was reliable, with Cronbach's Alpha value of 0.7341 or greater than 0.60. The normality test here uses the standard reference value of kurtosis and skewness. The test results show a skewness value of 1.6924, and the kurtosis value is 3.035119. Therefore, the data is declared normally distributed. This result follows (Hair et al. 2012), who stated that if the value of asymmetry and kurtosis is between -2 and +2, or kurtosis is -7 and +7, then the distribution is considered normal.

Chi-Square test result

The Chi-Square test results (Tables 5 and 6) indicate that the production attribute in material handling is a factor that influences food loss in the milk supply chain. The results showed that the number of productive cows affected the cage's cleanliness (P1). The cage's cleanliness was necessary because the cows' health would affect the milking results produced in terms of quality and quantity. Furthermore, the afternoon production capacity affects manual milking (P5). This result is related to the time and method of milking, where the afternoon milk yield differs by about 50% from the morning milk yield. In addition, there are differences in milking time intervals, which were nine hours for the afternoon and 15 hours for the morning (Sari et al. 2021). In material handling, the storage of dairy products affects the afternoon production capacity (P7). The storage of dairy products affects milk quality. If it is left for too long, the bacteria produced will be excessive, damaging the milk product and only resulting in food loss.

Based on operational performance, the chi-square test results on production attributes indicate that the socialization of cage cleanliness affects production capacity (P12). Farmers' knowledge about the cage's cleanliness certainly affects the quality of care. In addition, the quality of the cleanliness of the cage also has a significant effect on the cows and dairy products produced. If these two things are not considered, it will be easy for food loss to occur. Furthermore, small things such as washing hands before milking (P13) are quality standards that must be implemented on every farm. If forgotten, it is not impossible for food loss to occur because of the bacteria produced.

Table 3 respondent demographics

User Variable		Frequency	Distribution (%)
Farmer's Address	Tumiyang	9	22
	Kemuug Lor	31	78
Cage Area (m^2)	1 - 100	34	85
	101 - 200	5	12
	201 - 300	1	3
Number of Cows (cattle)	1 - 5	20	50
	6 - 10	11	27
	11 - 15	7	17
	16 - 20	1	3
	20 - 25	1	3
Morning production (liter)	1 - 20	24	60
	21 - 40	7	17
	41 - 60	6	15
	61 - 80	2	5
	81 - 100	1	3
Afternoon Production (liter)	1 - 20	30	75
	21 - 40	9	22
	41 - 60	1	3

Table 4 validity, reliability, and normality test results

Code	Pearson correlation	P-value	Cronbach's alpha	Skewness	Kurtosis
P1	0.674	0.000	0.7341	-1.6924	3.035119
P2	0.348	0.028			
P3	0.406	0.009			
P4	0.462	0.003			
P5	0.597	0.000			
P6	0.317	0.046			
P7	0.599	0.000			
P8	0.663	0.000			
P9	0.805	0.000			
P10	0.264	0.100			
P11	0.329	0.038			
P12	0.702	0.000			
P13	0.403	0.001			

Material handling and operational performance are interrelated in the supply chain flow and the milk supply chain flow. Some activities can cause food loss, so the supply chain actors must review activities from the production process to the cooperative (Ramdani 2019). When the tools used do not meet the standards, but the knowledge of the breeder is good enough, the things that result in food loss will be controlled. On the contrary, if the tools used are qualified, but the breeder's knowledge is lacking, the results will be the same (Sutono et al. 2016). The existence of adequate material handling in the availability of proper material handling will significantly affect the yield of wasted milk by providing sophisticated equipment such as automatic milking machines (Suhartono et al. 2019).

Good storage can help farmers in reducing the occurrence of food loss. Training is also essential in operational performance for farmers. With training from the center regarding the cage's cleanliness, handling, and milking methods for cows, it is not impossible if production results will minimize food loss. Moreover, it needs attention from the government and related organizations regarding cattle issues to improve production and farmers' economic capabilities (Amam et al. 2021).

Table 5 material handling chi-square test results

Demographics		Number of productive cows	Cage Area	Morning Production Capacity	Afternoon Production Capacity
P1	Chi-Square	50.615*	58.083	77.975	52.113
	DF	30	60	72	54
P2	Chi-Square	7.582	44.420	43.214	24,522
	DF	20	40	48	36
P3	Chi-Square	13.248	48.400	46.836	64,905
	DF	30	60	72	54
P4	Chi-Square	38.267	55.25	79.642	60.914
	DF	30	60	72	54
P5	Chi-Square	58.523	119.061	111.400	118.491*
	DF	50	100	120	90
P6	Chi-Square	13,822	39,506	61.704	28.66
	DF	20	40	48	36
P7	Chi-Square	55.894*	82.913*	62.695	93.664*
	DF	30	60	72	54

Table 6 operational performance chi-square test results

Demographics		Number of productive cows	Cage Area	Morning Production Capacity	Afternoon Production Capacity
P8	Chi-Square	39.415	59.554	85.785	53.885
	DF	30	60	72	54
P9	Chi-Square	21.548	50.799	39.215	33.299
	DF	20	40	48	36
P10	Chi-Square	10.687	20.247	23.134	17.371
	DF	10	20	24	18
P11	Chi-Square	15.968	28.639	63.967	41.952
	DF	20	40	48	36
P12	Chi-Square	33.634	61.657	55.448	82.657*
	DF	30	60	72	54
P13	Chi-Square	67.446	125.146*	114.632	102.748
	DF	50	100	120	90

CONCLUSION

The study provides the cause of food loss in the milk supply chain based on material handling and operational perfromance. In material handling, the leading cause is manual milking and milk storage. The result indicates that the bacteria produced is relatively high and causes damage to dairy products. In operational performance, the leading cause is socialization among farmers

regarding the cleanliness and handling of cattle during production. New breeders with new experience are expected to attend training to increase production capacity and avoid bacterial contamination.

Furthermore, the innovation of automated milking tools is also important to reduce food loss. This discussion can be a recommendation for future research to include other factors, such as the role of cooperatives to consumers in minimizing the occurrence of food loss. In addition, future research can be done by analyzing food loss from a milk quality perspective.

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