An Optimization of Product Recall Cost for Frozen Milkfish in Traceability System

Aditia Ginantaka, Taufik Djatna, and Yandra Arkeman

***Abstract*—Traceability system is the trace process for give the information about the source of product through the mechanism of product supply chain if there is any complaint or food safety incident. One of the output information from traceability system is gives the list of retailer or distribution center whom sells the frozen Milkfish product with the defect indication or has been contamination. The company should doing the recall product for avoids the same complaints at the last consumer. The purpose of this paper is to optimize the cost of recall product base on a few variable was found in the mechanism business process in Frozen MilkFish Product. Business process analysis with BPMN was done for identification the cost item at every stakeholder and support data at cost recall product in traceability system. Base on the relief of analyze result, we found that the dynamic of cost recall product was influenced by the transportation cost. The range of the chance contamination is the important thing before we do the recall product. The cost optimization is concern for minimize the transportation cost and the time for finishing the recall project.**

***Index Terms*—Contamination, food safety, supply chain, transportation cost.**

I. Introduction

One of the important issues from food product trade is Food Safety Issue. If there is any indication of the contamination from the food product and not safe for consumed, it must recalled from the consumer through the mechanism of the business process. Base on the data information from U.S. Food and Drug Administration and Department of Agriculture, the food and beverage industry, there are 30 product was recalled from the market every week. European Union's Rapid Alert System for Food and Feed (RASSF) also analyzed that every week there are any 22 product was recalled at Europe. Product recall due to safety hazards entail societal cost, such as property damage, injury and sometimes death [1].

Traceability system can be used for trace product moving strip in supply chain system. This system could be effective if there is any defect product issue with its capability in give information about the first location when the product was flawed, so it can be found the factor from its. Traceability system is also report about product distribution at next sphere supply chain, like retailer or distribution centre (DC).

Manuscript received December 20, 2014; revised March 12, 2015.

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Product recall can define as the removal from the market or replacement of a product that was found to be potentially unsafe after reaching the hand of consumers [2]. Moments of detection time from the broken product is the important thing in make the cost of recall product [3]. The purpose of this paper is for identify the cost variable that influence the recall cost, make the cost attribute which very influence the dynamic of recall product, and the last is for make the recall strategy to minimize the recall cost. In this paper, we proposed a new method to recall cost analysis to predict and calculate all cost attribute, which influence the recall cost.

II. Recall Cost

A. Supply Chain Model

The model of supply chain product from frozen milkfish start from breeding unit until the retailer or restaurant (Fig. 1). The model of supply chain which can cause contamination, start from the harvesting process until the consumer get the frozen milkfish. The step before harvesting process is not determined because it is far from contamination. Specific procedure to find the contamination source can be found at SNI 01-4110.1-2006. Hygiene aspect and cold chain mechanism must be maintained to avoid the contamination of Milkfish product.

B. Calculation of Recall Cost

The calculation of the direct recall cost is from a few cost component stars at internal cost until external cost. The identification result of the recall cost component is shown in Table I. Generally, the calculation is followed below [3]:

$$Min\ NCr = ACr + RRr \quad (1)$$

where the *NCr* is net cost from recall, *ACr* is additional cost, *RRr* is reduced returns [3],

$$ACr = \sum_i \mathrm{T}_i .d_i + \sum_i (D_i + R_i).\mathrm{Q}_i + \sum_j I_j + \sum_k L_k .t_k + MA \quad (2)$$

Additional cost is function cost that depends on another cost, both from the internal or external process. Base on business process analyze at BPMN, we know the result of cost identification that was shown at Table I. While MA is determined by the goverment regulation that should doing the announcement through mass media about the product recall. The calculation formula is below [3]:

$$MA = PR + (pr_{ad}.\mathrm{Ads}) + \mathrm{other} \quad (3)$$

DOI: 10.7763/IJIMT.2015.V6.587

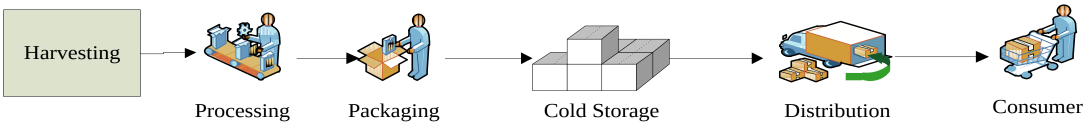


Fig. 1. The Milkfish production chain [4].

While *RRr* is substitution cost for product that had been bought by retailer, with formula below [3]:

$$RR_r = pr_{retailer}.Q_{retailer} \quad (4)$$

TABLE I: IDENTIFICATION RESULT FOR EACH VARIABLE COST PER BATCH 50000 KG PRODUCT

Variable	Description	Value (IDR)
T_i	Transportation cost and warehouse Cost (Rp/Km)	800
D_i	Throwing Cost of Fish Packaging (Rp/Kg)	750
R	Reuse cost for Feed's Fish (Rp/Kg)	500
I_i	Inspection Cost	3.000.000
L_k	Extra cost of the employer (Rp/Hour)	11.500
PR	Cost of the Public Relation Specialist	4.200.000
Pr_{ad}	Advertising Cost	41.900.000
Others	Another cost from external communication	1.500.000
$Pr_{retailer}$	Substitution cost from Retailer	10.000
$Q_{retailer}$	Totally product recall from retailer	

III. METHODOLOGY

A. Selected Attribute

All determining cost in Table II then analyzed with relief to select the influenced/important attribute cost in dynamic recall cost which can control to get minimize cost. The result of the cost attribute selection with relief method is shown at average value weighted. The will be chosen by the highest average weighted. From result of relief analysis the cost attribute that most influence recall cost is transportation cost, with the average weighted value 0,441. The cost has to select from others attribute calculated as follow [5]:

$$w_i = w_i + |x^i - NM^i(x)| - |x^i - NH^i(x)| \quad (5)$$

The weighted average value for every attribute cost is showed in Table II.

TABLE II: RESULT OF SELECTED ATTRIBUTE WITH RELIEF METHOD

Cost Attribute	Average Weighted	Rank
Transportation cost and warehouse Cost	0,441	1
Reuse cost for Feed's Fish (Rp/Kg)	0,383	2
Extra cost of the employer (Rp/hour)	0,378	3

The value of cost is calculated based on the information that given by every stakeholder in traceability system. Based on analyzed of the process business that as an example at BPMN 2.0, there are five stakeholders that have important part in traceability system. The recall process just follow by two stakeholder, there are cold storage unit (the part of fish production) and stakeholder end user (restaurant or retailer) at external company. In consumer goods industry brands may not only be owned solely by factory [1]. Thus both of them, will make the cost documentation in traceability system, then give the data to their company for make the calculation of recall cost. Transportation cost and Throwing Fish Packaging cost was got from cold storage unit, while the substitution cost from retailer will be calculated by retailer.

B. Minimum Cost Determination

Clustering. Based on cost attribute result, so the recall cost analyze just at transportation calculation range from distribution process at retailer and finishing time of recall project. For make the minimum cost at transportation process, therefore spanning tree of minimum analyze is needed. The purpose is to know the minimum distance for all retailer access because transportation cost is influenced by the distance. For the example of the spanning tree was doing at retailer in Jakarta with total retailer is 50 retailer. Based on the coordinate data, every retailer was analyzed by clustering analysis for mapping the recall area, using *K*-Means Clustering [6]. Clustering result is shown at Fig. 2.

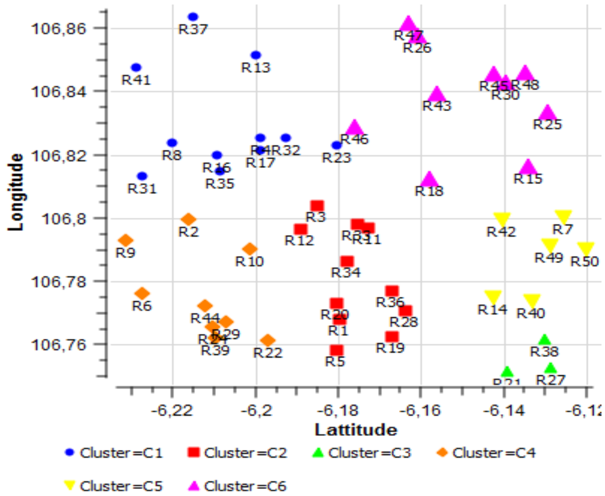


Fig. 2. Retailer clustering.

We assume that a recall will be performed if two or more samples are tested positive in the end-product on each retailer or if the true level of contamination is 5% on each cluster. Thus, recall cost will be estimated using several method, such as minimum spanning tree, service handling time and critical path method.

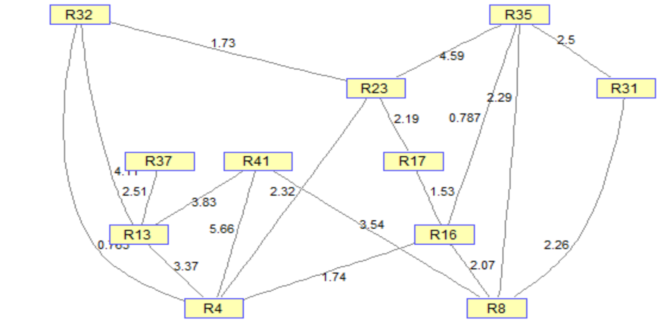
Minimum Spanning Tree. For example at first cluster, there were 11 retailer or restaurant, and then distance measurement was doing as the input of minimum spanning tree analysis. We measure the distance each retailer based on longitude and latitude data, and real possibility street on Jakarta City as show on Table III. The latititude and longitude value given a set of point terminals which connect by a network of direct terminal-to-terminal links with the smallest total length [7]. The data then was mannered use Matlab 7.10.0. For the result is vertex graphic and edge as show on

Fig. 3(a), and then the result of minimum spanning tree is shown at Fig. 3(b). This result of minimum spanning tree analysis from each cluster, we could determine for trip route to retailer for recall process, which can minimize the transportation cost.

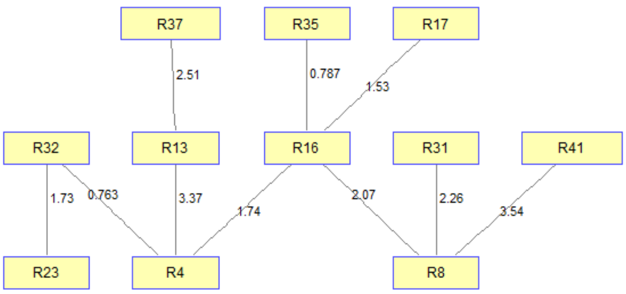
TABLE III: DISTANCE ON EACH RETAILER

From	To	Distance (Km)	From	To	Distance (Km)
R23	R32	1,73	R31	R35	2,5
R23	R4	2,32	R8	R35	2,29
R23	R17	2,19	R4	R16	1,74
R23	R35	4,59	R4	R13	3,37
R13	R32	4,11	R4	R41	5,66
R4	R32	0,763	R13	R37	2,51
R16	R17	1,53	R13	R41	3,83
R8	R16	2,07	R8	R41	3,54
R16	R35	0,787	R8	R31	2,26

Note: This data follow the normal distribution random hypothetical.



(a)



(b)

Fig. 3. (a) Graph Vertex and egde for every retailer at first cluster; (b) The result of minimum spanning tree.

Service Handling Time. Each retailer can save cold frozen milkfish product with total range 15-25 boxes with the weight of each box is 40 kg. We try to determine the service handling time, to carry out all of frozen milkfish product at retailer back to the factory using truck with refrigerator, and the capacity is 2 tons per unit. Each boxes are moved to the truck using a pallet, this step takes a few minute. We assumed that for prepared one full pallet (10 boxes) we need 15 minute to load the box on the truck and 10 minutes for unloading on factory. Thus we could calculate, total time needed to handle each cluster until all product transport to the factory [1]. In addition, travelling time also added for calculate the service handling time which depending on total distance of recall route and the traffic. For instance, total product which have to recall on cluster 1 is 8520 kg, the distance on recall route is 23,3 km, and the average on speed drive is 40 Km/h. the total service handling time for cluster 1 is show on Table IV.

Total service handling time for cluster 1, is 456,45 minutes, equals with 7,6 hour. Therefore, we can conclude that for one cluster the recall process almost equivalent to 8 hours of work per day, as mention on government regulations. Thus, we only handle one cluster in one day.

TABLE IV: CALCULATION OF HANDLING SERVICE TIME

Attribute	Total	Conversion Factor	Time (minute)
Box (unit)	8520 kg devided 40 kg/boxes = 213	20 minute/10 boxes	426,00
Distance (km)	20,3	1/40 km/h	30,45
Total handling Time			456,45

Critical Path Method. For scheduling all the recall process, we proposed CPM for this purpose. The best-known technique to support project scheduling is the Critical Path Method (CPM) [8]. The first step in a CPM network is to divide the entire project into significant activities in accordance with the work breakdown structure [8]. We use activity on node (AON) approach to draw the network on recall project. Based on total handling service time, we could determine the total time on each cluster, which represent as one node and as one activity. For handling the recall project we assumed this project used two unit truck for handling. Thus, each cluster could be immediate predecessor for other cluster. We begin to draw the starting activity which takes up zero time and resource. Start activity is an immediate predecessor for the next recall activity on two clusters. Before an activity can start, all the intermediate predecessors must be finished. The complete AON project network, for recall project is shown in Fig. 4.

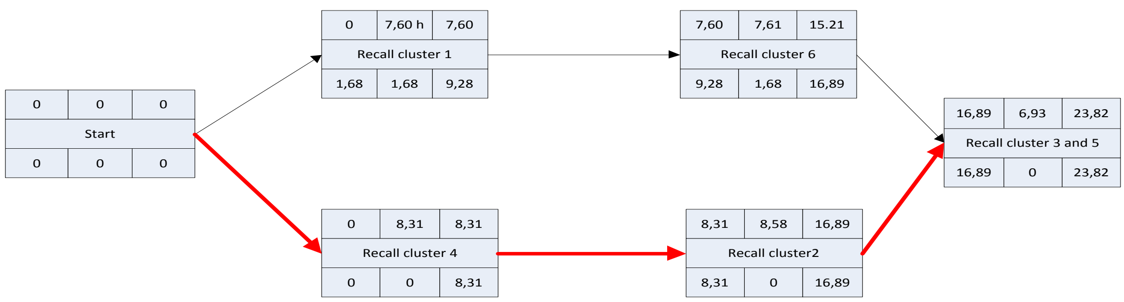


Fig. 4. Critical path method analysis.

Since recall cluster 3 and 5 is assumed as the last activity in recall project, this also implies that the earliest time in which the entire recall project can be complete is 24 hour, which equals with two days working time.

IV. Conclusion

Based on the analysis using that we proposed, the results of critical attribute determination by using relief method determined that transportation cost became critical attribute that influenced recall cost calculation. The results of minimum spanning tree model could guideline the factory to find the shortest route that influence transportation cost. After calculate the handling service time the rule of critical path method could show the critical project that have to finish. Thus from this proposed method we could predict the total cost for recall project. From this proposed method we could estimate the amount of recall cost by using total distance on transportation stages and total handling time for determine over time cost of labour. The other cost assumed as constant and unaffected by the dynamic variable such as distance and time.

Acknowledgment

The authors would like to thank PT Nusa Ayu Karamba for the participants to this work.

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