A model to calculate the recall cost for any defective food product

Student

Yang Li
Reg. Number: 83030903515130

Msc Program

Management Economics and Consumer Studies
Major Thesis Business Economics
BEC-80433
33 ECTS

Supervisor

Dr. Ir. A.G.J. Annet Velthuis
Business Economics Group
Wageningen University

Acknowledgments

I would first of all like to thank my supervisor: Annet Velthuis, who gave me the opportunity of being part of this research. All her support and understanding have contributed with the accomplishment of this thesis.

Annet, thank you for your always present encouragement, for letting me be part of this study and for your patience.

I would like to thank Alfons Oude Lansink, because of his important help at the end of this research and all people who have given me important information and data to fulfill and improve the model.

I want to thank my boyfriend who support me and encourage me to move on all the time during this research. He even brought badminton sport to my life. Zhenwei Ye, he lets me know about nothing great was ever achieved without enthusiasm.

Table of contents

Acknowledgments iii

Table of contents v

Abstract ix

1 Introduction 11

1.1 Food recalls 11

1.2 Food recalls in the Netherlands 12

1.3 Food recall costs model 13

1.4 Objectives 14

1.5 Outline of the research 15

2 The process of a food recall 16

2.1 Initiate a recall 17

2.2 Stopping the production line(s) 17

2.3 Tracking and tracing 18

2.4 Destruction of products and ingredients 19

2.5 Refunding consumers 20

2.6 Applying corrective activity 20

2.7 Evaluation of the recall 20

2.8 New marketing activities 21

3 Model description 22

3.1 Questionnaire 22

3.2 Inputs 24

3.2.1 Specific inputs 24

3.2.2 General inputs 25

3.3 Calculation 28
3.3.1 Initiate a recall 29
3.3.2 Stopping the production line(s) 30
3.3.3 Tracking and tracing 31
3.3.4 Destruction of products and ingredients 32
3.3.5 Refunding consumers 33
3.3.6 Applying corrective activity 34
3.3.7 Evaluation of the recall 35
3.3.8 New marketing activities 35
4 Demonstration of the recall cost model for Dutch custard 37
4.1 Demonstration data 37
4.2 Sensitivity analysis 38
5 Results 39
5.1 Results for the eight activities of a Dutch custard recall 39
5.1.1 Results for initiation a recall 40
5.1.2 Results for stopping the production line(s) 41
5.1.3 Results for tracking and tracing 41
5.1.4 Results for destruction of products and ingredients 42
5.1.5 Results for refunding consumers 42
5.1.6 Results for applying corrective activity 43
5.1.7 Results for evaluation of the recall 43
5.1.8 Results for new marketing activities 44
5.2 Sensitivity analysis 45
6 Conclusions 46
7 Discussions 47

References 49

Appendices LIII

Appendix 1 LIII

Appendix 2 LIV

Appendix 3 LX

Abstract

In this paper, a model is developed to calculate the recall cost for a batch of defective food products produced and sold in the Netherlands. This model is created for the manager in a food business to gain insight into risk management.

This paper describes a recall process has eight activities. These activities are used when managers' respond to the situation of a recall. They include: initiate a recall, stopping the production line(s), tracking and tracing, destruction of products and ingredients, refunding consumers, applying corrective activity, evaluation of the recall, new marketing activities. After defining and structuring the cost items in these eight activities, a general approach was used for calculating the recall costs by using partial budgeting.

By simulating the recall process, scientists as well as decision makers in Dutch food business can obtain better insight into the various activities involved, can identify areas where more knowledge would have the greatest payoff, and can priorities in terms of economic result. Consequently, this model is useful to obtain information and knowledge about quantify the costs and benefits happened in a recall.

In this model, it uses the Dutch custard data to calculate the recall costs. The total net value is €72,582. This result concludes that the recall activity can get the 'Negative Effect' and even the recall is costly. That dues to several reasons, like some indirect costs are not included since it is very difficult to get the relevant data. In addition, some recall costs are got by assumptions so that they may deviate from the true value. However, the major function of this model is quantifying the real recall costs and benefits for the Dutch food business. The result is able to use by manager of a food business to gain insight into risk management and to prepare for future recall incidents.

1 Introduction

When defective food products reach the market, they may harm to the public health. If a product is of bad quality or unsafe for the consumption, it should be recalled by law. In the European Union, food processors are responsible for a recall. For the food processors, it would be good to know the possible recall costs they may face so that they could gain more information about the risk management. A recall can be very costly, since it actually involves a reversal of the distribution process, the goods moving from the consumer and retailer to the distributor or dealer and more sometimes back to the processor. It is, therefore, possible that some processors might hesitate or even try to avoid embarking on a product recall, especially if the products involved have been widely sold to consumers (OECD, 1981). Sometimes a recall is the most extreme action because the losses can be significant (Skees, Botts, &Zeuli, 2001). However, scientific information on these possible recall losses is scarce. For that reason, a food recall cost model is created.

1.1 Food recalls

Food business operators in the European Union must not bring food products to the market if it is unsafe (Article 14, European Council (EC 2002)). The product must be withdrawn from downstream businesses or recalled from the consumer if food is unsafe and/or unsuitable for consumption (Article 19, European Council (EC 2002)).

In the previous regulation, two types of actions are described: a withdrawal and a recall. A withdrawal is an action to remove the defective food products from the supply chain excluding the consumers' level. A recall is an action to remove products from the supply chain including the consumers' level. In this project, only a recall is considered. To initiate a food recall, the manufacturer or distributor should have an affirmatory reason to believe the food products may be unsafe and/or unsuitable. The food is unsafe when it is injurious to health or unfit for human consumption (Article 14, EC 2002). Analogously, when the quality of the food cannot fulfill consumers' reasonable expectation, it is defined as unsuitable food. In this project, the unsafe food and unsuitable food are all defined as defective food.

1.2 Food recalls in the Netherlands

In The Netherlands, there are three recalls known in the Dutch industries during the past years.

1. *September 20, 2002*. The cartons of semi-skimmed milk were removed from the shelves in two large supermarkets concerned. The reason for this recall was an exceeding high concentration of penicillin in the milk. Together with the removal of milk a press article was released. Within the article, it contained the information from the milk company that the semi-skimmed milk was not risky for human health. If the consumers with an allergic to penicillin, they could get problems concerning their skin. Moreover, the article described how consumers could identify the specific cartons of milk by mentioning the contents and date described. If the recalled milk cartons were bought, consumers can be informed to get a refund. The milk company itself noticed the contamination of the milk (Anonymous[a], 2004).

2. *December, 2002.* Twenty-two cartons of semi-skimmed milk were by accident filled with water and a small amount of hydrogen peroxide. The cartons of 0.5 liter were already sold in the supermarket and had reached consumers at home. After drinking the product, the consumer could taste sour and irritated the mouth although the products look similar to milk. In a media announcement, the milk company made apologies for the inconvenience and requested consumers who bought 0.5 liter cartons of milk in the last days to check production codes on the cartons. The specific cartons of milk were only spread in two provinces of The Netherlands. Consumers were also informed about refunding (Anonymous[b], 2004).

3. *2004.* Elevated levels of polychlorinated dibenzo-p-dioxins (PCDDs) were identified in milk samples obtained from two Dutch dairy farms in 2004 (Hoogenboom et al., 2009). The cause of these high dioxin levels was the use of contaminated potato peels as feed material. High levels of dioxins were found in kaolinic (marl) clay used for washing and sorting potatoes in the French fry production process and this was believed to be the main source of contamination (Hoogenboom et al., 2009; Kreft, 2006). Potato peels containing particles of clay (Kreft, 2006) were obtained from scrubbing processes carried out after sorting potatoes (Hoogenboom et al., 2009). Additionally, as potato peels were used as feed material not

only for dairy cows but also for pigs, dioxins were found in pig fat samples, but were not as high as in milk samples. Therefore, it was found that the pig fat samples with abnormal levels of dioxins and milk samples with elevated levels of dioxins. Several animal farms were temporally closed because of the use of contaminated feed (Kreft, 2006). The dioxin incident did not become a serious threat for human health. Only the stakeholders at different stages of the agri-food chain beard the financial consequences (Hoogenboom et al., 2009).

When the recall happened, the procedures of executing a recall are different. If the defective product has not reach the retailer a product can be recalled relatively easy. But if the defective products are already at the retailer and bought by consumers, recalling all products will be much more complicated.

In the Netherlands, there are two kinds of the procedures for recalling defective food which depends on the hazard defected. If the defective food is unsafe, the processor should inform the consumers and announce the situation on its own Web site. More important, the Food and Consumer Product Safety Authority (VWA) should be informed directly. Then the processor could start a recall immediately. Otherwise the Minister of Health, Welfare and Sport can compel the company to issue a public warning when the processor did not start recall properly. If the defective food is unsuitable, the processor also needs to notify the VWA and take measures after consultation with VWA. If the quality standards are not met, the processor could decide to start an internal recall or an external recall (Velthuis, A. G. J., et al., 2009)[a].

1.3 Food recall costs model

During a food recall, the recall costs will develop. It is very attractive to know the food recall costs. Because the managers will not choose to undertake a recall, if the costs outweigh the benefits in a recall (Skee, Botts, &Zeuli, 2001). Therefore, a recall cost model was built to calculate the possible recall costs. In general, the recall costs have direct costs and indirect costs. Direct costs include media announcements, transportation, warehousing costs, extra employee costs, extra cleaning costs, and destruction costs (Meuwissen et al., 2006).

Indirect costs of a recall, include reduction in sales and revenues, lower stock price, costs incurred for brand rehabilitation, and crisis response expenses (Salin et al., 2005). Due to the food recall, clients could cancel orders of the corresponding food products. In some cases, the recall could also affect other food products of the same brand. In case of a media announcement in which consumers are asked to return a specific product, it is not unusual that other products of the same brand are returned. For example, the consumers return cartons of skimmed milk in a recall that is restricted on semi-skimmed milk. To rehabilitate the brand and maintain the market share, different actions like advertising campaigns, special promotions and consumer education are needed. Moreover, crisis-response expenses like employ the external consultants to identify the product contamination and to solve recall problems are made. Although the indirect costs of a recall are hard to quantify (Kramer et al., 2005), the different categories of indirect recall-cost were addressed in the model.

In the Netherlands, the recall costs of two kinds of food products are calculated by using recall cost models. One is a Dutch custard recall, if a spoilage problem would be detected in one batch of custard. The recall costs over the supply chain were calculated by a partial budgeting model (Velthuis, A. G. J., et al., 2009)[a]. The other one is about the recall-cost of the drinking milk. A recall cost model was built to calculate the recall costs for a milk production processer (Velthuis, A. G. J., et al., 2009)[b]. The approach of recall-cost calculations is quite analogous in these two cases. Therefore, we believe that one common approach can be applied to recall costs calculation of all types of food products. This gave us the idea to develop a model that can calculate the recall costs for any defective food products produced and sold in the Netherlands.

1.4 Objectives

The objective of this research is to develop a model to calculate the recall costs for any defective food products produced and sold in the Netherlands. The model can be a tool to be used for the development of risk management strategies of the manager in a food business. At the same time it may also serves as a decision-making tool for food producers to make decisions on quality management and incident management of carrying out a recall event or not. Other more specific objectives are:

- To study recall-cost models in the literature to find a general approach for calculation of recall costs
- To define and structure the cost-items (positive and negative effects in the partial budgeting approach) of a product recall including direct and indirect recall costs.
- To build a model that calculates the net recall costs and to identify the most important inputs.
- To include the sensitivity analysis that indicates the most important input which affects the total recall costs.

1.5 Outline of the research

A detailed description of the eight activities of a food recall progress and an explanation of the core activities and the optional activities are discussed in chapter 2. The methodology used to carry out this study is depicted in chapter 3. In the same chapter, the calculation is deliberated the cost and benefits of a recall following the structure of eight activities of the recall progress. In chapter 4, a demonstration is performed which calculates the input data from a Dutch custard example. The results of total net value of each activity are depicted for the Dutch custard as well in chapter 5. The conclusions are delineated followed by the discussions in the last two chapters.

2 The process of a food recall

In different food industries, the activities of a food recall process can be different. For a general recall costs model, it finds a way include the general activities of any types of food recall. In this research, the recall costs calculation is based on the activities happened in the recall process, therefore it must set down the possible recalling activities. This model, only considers the generalized activities from different food industries. Eight generalized activities are included: initiate a recall, stopping the production line(s), tracking and tracing, destruction of products and ingredients, refunding consumers, applying corrective activity, evaluation of the recall, new marketing activities. Within these activities, initiate a recall, tracking and tracing and applying corrective activity are necessary for all food recall process and the other five activities are optional activities. In a food recall process, these eight activities should be executed as a sequence showed in Figure 1.

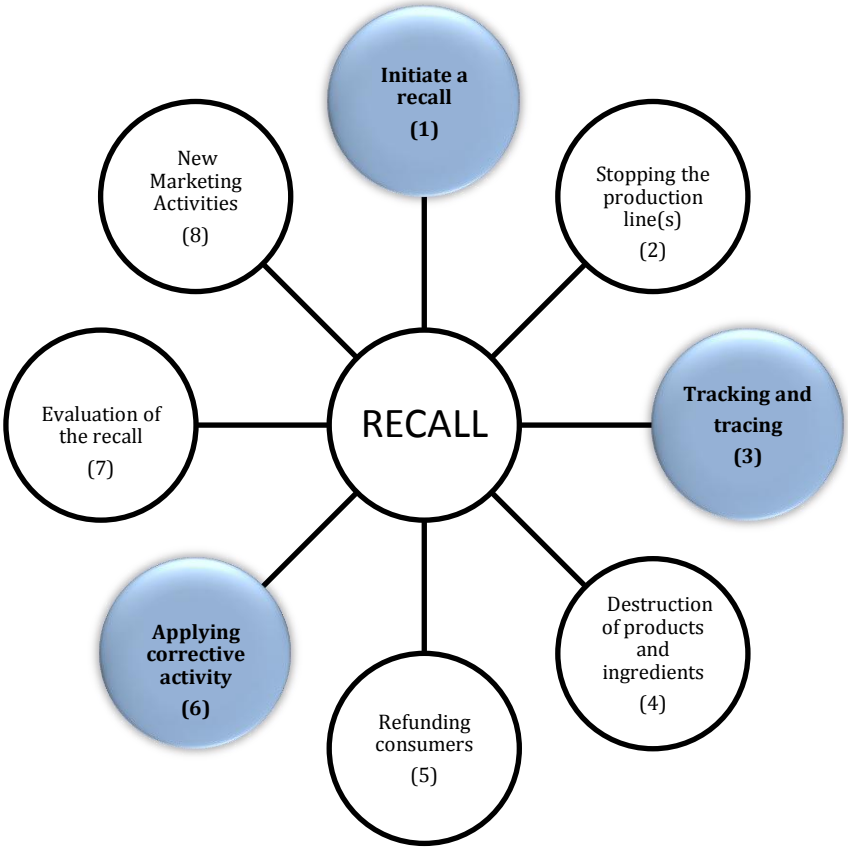

Figure 1. The eight activities of a recall. Dark circles are necessary activities, and white circles are optional activities.

2.1 Initiate a recall

A product recall can be initiated only when it was determined to pose a potentially substantial risk of injury to the public. The initiation of a recall which treated as the first action during the recall progress is commonly due to the discovery of product hazards (M. N. Kramer. et al., 2005). Normally the discovery consists of two parts; first, the hazard must be identified and isolated and, second, determination must be made by food processor as announcement for a recall (OECD, 1981).

There are different channels of discovering the product hazard. The product defect may be discovered by:

1) a retailer or a dealer. They will notify the processor;
2) the processor as a result of the investigation of consumer complaints or as a result of liability claim related;
3) a governmental organization, perhaps through its injury-data collection system;
4) local authorities who are responsible for the enforcement of product safety regulations;
5) importers, who may be required by law, to notify the regulatory agency of any hazardous defects they may detect in foreign products;
6) other sources, such as testing laboratories and insurance companies, which normally with notify the processor of the defective product;

The other part of initiate a recall activity is to announce the recall. The aim of recall announcement is to inform consumers and clients about the fact that products are recalled.

The recall announcement can be public by an advertisement in newspapers and/or an announcement on the website. If food products are defective, it is important to inform the consumers and clients in time. Information dissemination may take the forms as a press release, letter to the concerned parties, advertisements in the media, making public announcement and putting up leaflets and/or posters in stores.

2.2 Stopping the production line(s)

Stopping the production line(s) is carried out to prevent the contamination in further batches of food products. Stopping the production line(s) aims to remove the contaminated ingredients and contaminated products from the production line(s) and

in storage. Extra cleaning of the production line(s) is also included in this activity.

2.3 Tracking and tracing

The General Food Law (Regulation (EC) No 178/2002) requires that food and food ingredients are traceable (Meulen and Velde, 2008). Recitals 28 and 29 to the General Food Law read:

> '*Experience has shown that the functioning of the internal market in food or feed can be jeopardized where it is impossible to trace food and feed. It is therefore necessary to establish a comprehensive system of traceability within food and feed businesses so that targeted and accurate withdrawals can be undertaken or information given to consumers or control officials, thereby avoiding the potential for unnecessary wider disruption in the event of food safety problems'.*
>
> *'It is necessary to ensure that a food or feed business including an importer can identify at least the business from which the food, feed, animal or substance that may be incorporated into a food or feed has been supplied, to ensure that on investigation, traceability can be assured at all stages*'.

In the tracking and tracing activity, two main directions can be distinguished, respectively tracking and tracing. Tracking describes the ability to track food and food ingredients forward along the supply chain. It can be used to find and recall products determined to present a serious risk to consumer's health. Adverse, tracing describes the ability to trace food and food ingredients back along the supply chain. It is aimed at finding the history of a product, for example, to identify the source of contamination (Meuwissen et al., 2003).

Tracking as a decision to be taken, means a company is able to detect the exact locations where the defective products in which quantities are. Therefore, the company has to identify the production batches with specific codes or labels. In combination with a management program on the computer, the company must be able to track the defective products via the identification codes. The cause of the defective products has to be traced backwards in the supply chain.

In case of a defective product, tracing is necessary to be able to identify all the

suppliers who contributed in the production chain. The cause of the defective product can be investigated by checking the ingredients, packaging and processing methods. If the cause is known, other products can be investigated in which the specific ingredients are processed. A contamination in one part of the chain has an effect on all the following steps in the chain and finally for the consumer. Therefore, to investigate the source of a problem and eliminate the cause it is important that companies are able to track and trace their products efficiently and effectively (van Dorp, 2004).

The causes of defects are needed for constant tracking and tracing activity through the entire life cycle of a product. And all parties are required to come into contact with the subject product.

2.4 Destruction of products and ingredients

Destruction of the contaminated products and ingredients are done by outsourced destroying companies. This activity is executed when reusing of the contaminated products and ingredients may be too costly or impossible. Frequently, destruction must take place under properly controlled conditions for which the outsourced destroying company is responsible. Thus, the food processor needs to pay for the invoice from destroying the products and ingredients including the waste.

Another option is the reuse of the products and ingredients. Food re-using is a more complicated way of saying “food recycling” (M. Susan Brewer, 1992). For example, the milk for producing yogurt is not used, but it is still possible for coffee cream production under some kind of specific measures. Thus the processor can sell these contaminated milk ingredients to other business and get some amount of benefits from that.

Food re-using can have a number of environmental, social, and economic benefits, including (Unger and Wooten, 2006):

1) reducing pollution within a community;
2) generating needed compost for urban and rural agriculture production;
3) reducing trash collection and disposal fees for individuals and businesses;
4) ensuring that edible food is redistributed to those who require emergency food provision;

2.5 Refunding consumers

Refunding consumers is a compensation activity in which the processor will reimburse the consumers either the full amount of the original purchase price of the product, or even a higher price. In this recall-cost model, we suppose the compensation price is equal to the retail price. Then the proof of purchase by the user of the product is necessary and this may identified by the barcodes on the food products. After the consumers post the barcodes on the defective food products back to the company, they can get compensation of the products.

2.6 Applying corrective activity

Applying corrective activity includes the repairing, modification, adjustment, re-labeling of the products and production process. They are carried out due to the poor food quality, or safety reasons. For example, the applying corrective activity may include a change in the design of packaging material. If the first time of applying corrective activity is failed, a second corrective activity should be considered.

Possible applying corrective activity may also include changing the design of the production method and improving the instructions supplied with a product (e.g. adding additional information about the correct use of products). After carrying out the applying corrective activity, the products should reach an acceptable standard for resale. Products that have been rectified which need to be clearly marked and the documents accompanying them may need to be updated.

2.7 Evaluation of the recall

Evaluation of the recall is the firm's responsibility to determine whether its recall is progressing satisfactorily. The firm can conduct effectiveness checks as part of its recall process, but it is not necessary activity. Effectiveness checks assists on the verification of whether affected consignees have received notification about a recall and the recall have taken appropriate actions.

The evaluation of the recall includes whether the food processor has taken the

responsibilities efficiently, whether the recall process was in time, whether the extra workers for the consumer help-desk were working properly (such as call or visit some of customers at random). For example, after informing the consumers about the recall fact, some percentage of the total purchased consumers can be contacted. This percentage is used for giving feedback about the recall process's effectiveness check. If only 20 percentages of all consumers who had purchased these products got the information about the recall, other consumers did not get any information about this fact. Consequently the recalling company did not take responsibilities for adequate performance of recalling its products.

2.8 New marketing activities

Additional new marketing activities can be initiated after the recall. They are aimed to increase the sales and trust the recalled products, which may have a new look. These can be done by presenting the products at affordable prices and in accessible places and the customer has to be informed about them (Meulen and Velde, 2008). The new look is made recognizable with the help of trademarks, trade names, shapes, colors, packaging materials and by other measures. Their content, however, goes beyond these visible aspects and may include an entire image of quality, reliability, and style. All the information of new look can be advertised on the consumer magazines, the TV or radio programs, or other medias.

3 Model description

The recall-cost model is a deterministic model which built in Microsoft Excel 2010 (Microsoft Corp., Redmond, WA). Visual Basic Application language (VBA) is applied to improve the usability of the model. The model aims to quantify the direct costs and indirect costs of a recall activity. The model follows the eight activities of a food recall process (see chapter 2).

Totally, this recall-cost model consists of four worksheets: the questionnaire, the inputs, the calculations and the outputs (figure 2). The questionnaire worksheet is designed to acquire the data from the management professional in a specific food business. All data from the questionnaire is linked to the input sheet. The input sheet is one worksheet which divided into specific inputs and general inputs. Only specific inputs can acquired from the questionnaire. The general inputs are inflexible values and each one has its default value. Within the calculation sheet, all cost and benefit items are calculated for a recall incident. However, the results of the calculations are expressed in the output sheet which presented in the chapter 5.

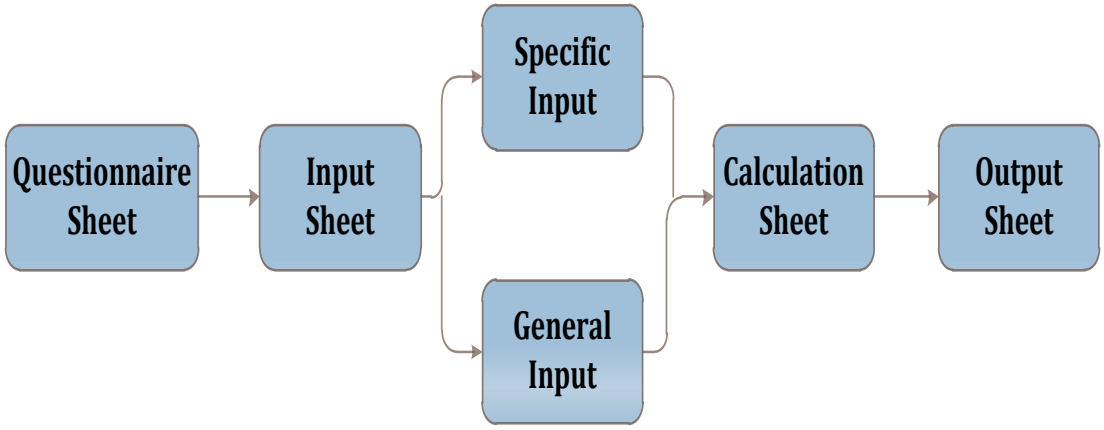

Figure 2. The worksheets of the recall-cost model.

3.1 Questionnaire

The questionnaire worksheet provides clear questions that guide the food business manager to give the right input for the model. It contains 49 open questions that follow the eight activities of a recall progress. If a food manger cannot answer a

question, he can indicate the reason for this in the "comment area" which is behind each question. The working flow of the questionnaire is presented in figure 3 and all details of the questionnaire are shown in appendix 2.

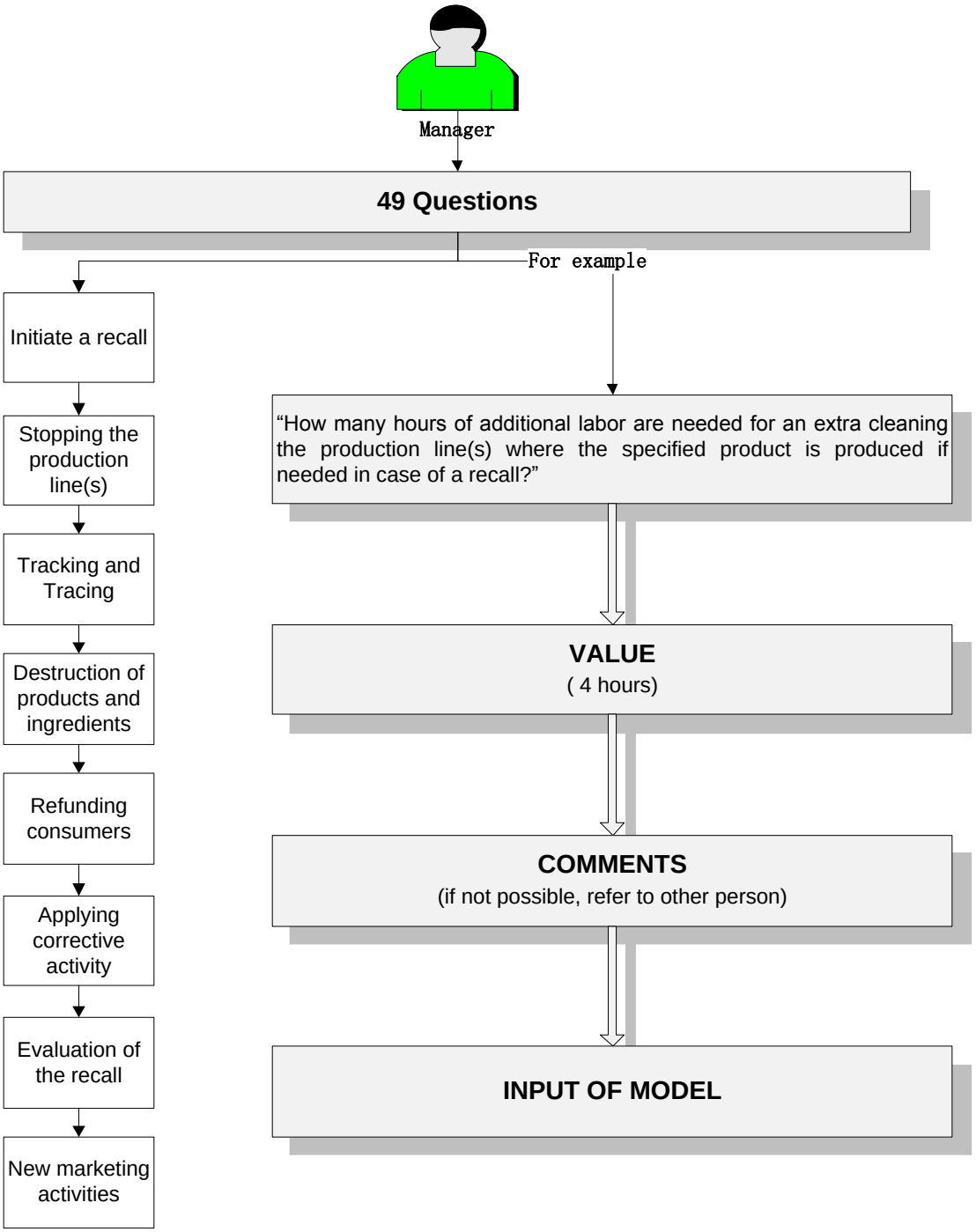

Figure 3. The workflow of questionnaire.

3.2 Inputs

In this model, the process of selecting the model inputs should be general for all types of food products and the number of inputs ought to be low. The inputs for the model are gathered from the manager, literature, internet, personal experience and help from the experts. Assumptions are also made based on experience and expectations of the researcher. The inputs are divided into specific inputs and general inputs.

3.2.1 Specific inputs

The specific inputs are designed to describe the set of variable parameters of all eight activities in the recall process. A parameter is specific when its value will vary with the product type. For example, the first specific input is "Additional labor needed for extra cleaning of production line(s) where the specified product is produced". Here the assumed value is 4 hours, but other production lines of this value might be different. Therefore, the specific inputs here have no values. Totally this model includes 49 specific inputs which are listed in table 1.

Table 1. The specific inputs designed for the recall cost model.

No	*Input name*	*Unit*
1	Additional labour needed for extra cleaning of production line(s) where the specified product is produced	hours
2	Cost of cleaning materials in total for all m2	€
3	Total amount of ingredients that are blocked in storage and might be contaminated	kg
4	Labour hours (on average) to sample and test the possible contaminated ingredients in storage	hours
5	Labour hours within your own company to prepare collection for the destruction of the contaminated ingredients	hours
6	% Positive ingredients of the total amount of blocked ingredients	%
7	Price of each re-used positive tested ingredient per kilogram (or per litre)	€/kg(liter)
8	Kilograms or Litres of each re-used positive tested ingredient which will sell to others for re-use	kg or liter
9	Hours of temporary workers stopped working at the production line(s) during the recall	hours
10	% Factory overhead in your annual revenue per year	%
11	Days are needed from the process of starting to stop the production line(s) to the process of finishing the new marketing activities	days
12	When the mangers will focus more on recall management in case of a recall. Hours (on average) are required about the manager spends on these tasks	hours
13	In general, # of cost of your company might receive an invoice from retailers as compensation for their losses	€
14	In case of a recall, extra staff is needed at the consumer care lines. # Hours are required.	hours
15	Labour hours in-company are needed to prepare collection of re-using the defective PRODUCTS in destroying process	hours
16	% of defective products that can be re-used by others	%

No	*Input name*	*Unit*
17	Price of re-used products per kilogram (or per batch) on market	€
18	Daily production volume of the specified food product	kg/yr.
19	Consumer price of the food product	€
20	# Revenue of the food product per kg or litre	€/kg or liter
21	Production line(s) in general is the specified food product produced in your company every year	lines
22	Cost of additional material in the re-used products per kilogram (or batch)	€
23	% Customers in general that will ask for a refund for the defective products	%
24	Customers can get compensation in cash for the bought defective product(s). # Price as re fund per product	€/person
25	Hours do the INTERNAL technical labours work on the corrective actions	hours
26	Hours do the EXTERNAL technical labours for designing & researching.	hours
27	Additional cost for the analyses EXCEPT the direct labour cost	€/kg or liter
28	Cost per sampled product for sampling the defective food products	€/sample
29	Samples would you (in general) take to test whether the corrective actions in the production process are sufficient	samples
30	If the first designing & researching is failed, number of labour hours (for RE-DESIGNING & RESEARCHING) is still required.	hours
31	Labour hours are required to do the corrective actions on the recall problems	hours
32	Cost per kg or litre for doing the corrective actions on the recall problems	€/kg or liter
33	Before the recalling, # of stock price of your company per share	€/share
34	Before the recalling, # of shares did your company have on market	shares
35	After the recalling, # of stock price of your company per share	€/share
36	After the recalling, # of shares does your company have on market	shares
37	% of sales reduced during the 1st and 2nd weeks after the start of the recall	%
38	% of sales reduced during the 3rd and 4th weeks after the start of the recall	%
39	% of sales reduced during the 5th and 6th weeks after the start of the recall	%
40	% of sales reduced during the 7th and 8th weeks after the start of the recall	%
41	What is the retail price of product per kg or litre?	€/kg or liter
42	Orders do you expect to be cancelled by your clients due to the recall	orders
43	Average value of each order of your products by clients	€/order
44	Hours for the labours will be spent on customers' feedback investigation of market research on the re-new products	hours
45	Hours for the labours will be spent on designing the new market research of re-new products	hours
46	Additional cost of new package material per kg or litre	€/kg or liter
47	If the product is re-new sometimes samples are sent out to be tasted by consumers. # Hours for the labours do you think they will work on it	hours
48	If the product is re-new sometimes samples are sent out to be tasted by consumers. # Samples do you expect you will send them out for free	products
49	Other additional costs could occurred during this recall	€

3.2.2 General inputs

A general input will not vary with the food product. All general inputs are listed in table 2. This model includes 23 general inputs.

Table 2. The general inputs used in the recall model.

No	*Input name*	*Unit*	**Unit**
1	Wages of labour per hour per person, at a lower level	20	€/hour
2	Destruction costs of low risk material	0.33	€/kg
3	Destruction costs of high risk material	0.99	€/kg
4	Wages of labour per hour per person, at a high level	30	€/hour
5	# Production months in one year	12	month/yr
6	# Production weeks in one year	52	week/yr
7	# Production days in one week	6	days/wk
8	Price of placing an advertisement in a national paper	6,000	€/paper
9	Price of placing an advertisement in a foreign paper	5,000	€/paper
10	Cost of post stamp to consumers who will send the barcode of product refunded	0.44	€/person
11	# Hours of internal text writer to write the press publication and other notices	4	hours
12	# Hours of external text writer to write the press publication and other notices	0	hours
13	# Advertisements in the national paper	2	paper
14	# Advertisements in the foreign paper	0	paper
15	# Hours needed for an internal audit	4	hours
16	# Hours needed for an external audit	4	hours
17	# Papers of placing advertisements on press notices for new advertisement activities (extra marketing)	2	paper
18	# Consumer magazines of placing advertisement for new advertisement activities (extra marketing)	0	pages
19	# Hours of extra accountants to do the recall account's check	20	hours
20	# Hours of text writer working on new advertisement activities (extra marketing)	4	hours
21	Cost of placing advertisement per minute on consumer TV and radio program for new advertisement activities (extra marketing)	200	€/minute
22	# Minutes of going to place advertisement on consumer TV and radio program for new advertisement activities	5	minute/time
23	# Times needed to place advertisement on consumer TV and radio program for new advertisement activities	10	€/minute

Within this model, the labor wages are treated as inflexible; the average wage of labor at a high level is 30 euro per hour, otherwise the average wages of labor without high level is 20 euro per hour in the Netherlands. Then the destroying cost with low risk is 0.33 euro per kilogram from destruction businesses and the destroying cost with high risk is 0.99 euro per kilogram. The destruction information is only valid in the Netherlands. About the production time, usually the industry or company produces in 12 months (52 weeks) of the whole year and also 6 working days per week. However, the production time is variable based on the different types of businesses. Afterwards, the internal auditing is a profession and activity involved in helping the company to achieve calculating the recall costs efficiently. They are also called internal auditors who employed by businesses to perform the internal auditing activity. On average their work on the recall account's check is 4 hours (Anonymous, 2005). For example,

the auditor conduct checks for calculating the costs and benefits happened during the recall. Sometimes the external auditors are also needed in helping internal auditor to achieve calculating the recall costs and they are employed by businesses to perform the external auditing activity.

3.3 Calculation

The recall costs are calculated based on the partial budgeting approach. Partial budgeting is a decision- making tool used to compare the costs and benefits. It only focuses on the changes in incomes and expenses that result from the process of implementing a recall within the farm business. Thus, this approach is based on the principle that a small change in the supply chain can eliminate or reduce some costs, eliminate or reduce some returns, cause additional costs to be incurred, and cause additional returns to be received. The net costs of the recall, is the net effect of the change (Dijkhuizen and Morris, 1997):

$$NC_r = AC_r + RR_r + RC_r + AR_r,$$

Where NCr is the net costs of the recall, ACr is the additional costs, RRr is the reduced returns, RCr is the reduced costs, and ARr is the additional returns. In the model, the additional costs and the reduced returns are both 'Negative Effects' and indicated as green color. The reduced costs and the additional returns are both 'Positive Effects' and indicated as pink color. Therefore NCr (the net costs of the recall) equals to the 'Positive Effects' plus 'Negative Effects' (Velthuis, A. G. J., et al., 2009)[b].

The calculation is executed following the eight activities of a recall process. For each activity is considered as the four sections: additional costs, reduced returns, reduced costs and additional returns. For example, in the table 3 the calculation of the recall costs for stopping the production line(s) is shown.

Table 3. Recall costs of stopping the production line(s) activity via Partial Budgeting (using fictive values).

Activity	**Section**	**Costs**
Stopping the production line(s)	Additional returns	€0
	Reduced costs	€-151,200
	Additional costs	€452
	Reduced returns	€0
Total value		**€-150,748**

In case of a recall 'additional returns' does not exist. Stopping the production line(s) will not lead to temporary workers, factory overhead and administrative overhead and therefore they will be saved and accounted for in the 'reduced costs'. Because the 'reduced costs' and the 'additional returns' are treated as the 'positive effect', so they are shown as the minus value in calculation. The 'reduced returns' is the cost that would have been paid for the removed product and in this activity it does not exist. The 'additional costs' are costs that are directly made as result of this activity occurred in a recall, for example additional labor costs for extra production line(s) cleaning. In the following paragraphs, the calculation of each activity will be explained in details.

3.3.1 Initiate a recall

During the initiation of a recall, the food hazard has to be identified and isolated. Secondly, the food processor has to decide whether to make an announcement for a recall (OECD, 1981). In this activity, only one sub-activity which called recall announcement is considered in the calculation.

Table 4. Cost items for the activity of initiating of a recall.

Sub-activities	**Cost items**	**Formulas**
Recall announcement	Text writer	Labor wage per hour * hours
	External text writer	Labor wage per hour * hours
	Placing advertisement on national papers	Cost of advertisement per national paper* papers
	Placing advertisement on foreign papers	Cost of advertisement per foreign paper* paper
	Publicized programs on TV and radio	Cost of advertisement per minute * minutes
Total value		*Sum up all items*

The costs of recall announcements are based on the criteria of the Dutch Food and Consumer Product Safety Authority. These include that the advertisements must be place in at least two national papers, an official press release should be sent out and an

announcement should be on the Web site of the producer. The cost of placing an advertisement in a national paper is 6,000 euro (Velthuis, A. G. J., et al., 2009) [a]. The cost of designing and advertising is the internal text writer working hours times the average wage per hour. In this paper, we suppose it is not necessary to ask for an external text writer. The cost of publishing a press release, including publication on the producer's Web site or the radio programs, is assumed to be 1,000 euro as well. Therefore, the placing the advertisements costs and publicized program costs for recall announcements are treated as fixed costs in the initiation of a recall activity.

3.3.2 Stopping the production line(s)

The production line(s) are stopped in case when a suspicious of contamination in a feed or food business with the aim of preventing the contamination in further stages of the chain. The sub-activities include additional production line(s) cleaning, handling possible contaminative ingredients in storage and cost control. The cost items for these sub-activities and related formulas are given below.

Table 5. Cost items for the activity of stopping the production line(s).

Sub-activities	**Cost items**	**Formulas**
Additional production line(s) cleaning	Additional labor	Labor wage per hour * hours
	Additional cleaning materials	The cost of cleaning materials in total
Handling possible contaminative ingredients in storage	Testing the possible contaminative ingredients still in storage	Labor wage per hour * hours
Cost control	Temporary workers	Labor wage per hour * hours
	Factory overhead	(% of factory overhead accounts in the yearly production revenue * production revenue of this year) / 360 days * days in recalling
	Administrative overhead	Labor wage per hour * hours
Total value		*Sum up all items*

The temporary workers are not workers who are employed in the food business, but only employed within a certain period of time. If the production is stopped, the food processor does not have to pay for their wages. On the contrary, the official workers are still paid for wages no matter stopping the production line(s) because they have contracts with the business. Therefore, the official workers are not considered as the reduced costs in a recall. The reduced costs of temporary workers can be calculated by average hours of working at the production line(s) multiplies by the wages of a labor per hour at a low level.

According to the factory overhead, it is generated as all manufacturing expenses except direct materials and direct labor in producing, for example, janitorial services. During the stop producing process in the recall, factory overhead costs are reduced. It can be calculated by the percentage of factory overhead accounts in the year production revenue multiplies by the production revenue of the whole year. That is the yearly factory overhead. If only the factory overhead which during the recalling process is reduced, we have to use the yearly factory overhead divide by 360 days of the whole year, then times the days of the whole recalling process (which is from starting the initiation of the recall till finish the new marketing activities).

3.3.3 Tracking and tracing

Tracking is used to track food and food ingredients forward along the supply chain and tracing describes the ability to trace food and food ingredients back along the supply chain (Meuwissen et al., 2003). Only labor costs are considered in this activity.

Table 6. Cost items for the activity of tracking and tracing.

Sub-activities	**Cost items**	**Formulas**
	Labor costs	Labor wage per hour * hours
Total value		*Sum up the item*

3.3.4 Destruction of products and ingredients

Destruction of the contaminated products and the contaminated ingredients are carried out by the outsourced destroying company which occurs when the contamination may be too costly or impossible to reuse. Destruction of contaminated ingredients is carried out by the incineration of low risk material and the incineration of high risk materials.

However, if the contamination still can be re-used, additional returns as positive effect can be occurred in a recall. The contaminated ingredients and products are used again for some other function, and the food processor can gain the returns. The cost items for sub-activities and related formulas are given as below.

Table 7. Cost items for the activity of destruction the products and ingredients.

Sub-activities	**Cost items**	**Formulas**
Dealing with the destruction costs	An invoice from destroying the food PRODUCTS	Low risk of destroying cost per kg *kgs High risk of destroying cost per kg *kgs
	An invoice from destroying the food INGREDIENTS	Low risk of destroying cost per kg *kgs High risk of destroying cost per kg *kgs
	Re-using the contaminated PRODUCTS	kgs * price/kg
	Re-using the contaminated INGREDIENTS	kgs * price/kg
	Influence of the unsold products	Retailer price of this product per kg or per liter * production volume during the recalling process
Total value		*Sum up all items*

In calculating the destruction in a recall, the invoice from the outsourced destruction center is depending on the different levels of risk of destroying cost and the kilograms of the production. The extra destroying cost of low level risk is 0.33 euro/kg, and the high level risk is 0.99 euro/kg which both are depending on the average destroying costs in the Netherlands (Velthuis, A. G. J., et al., 2009)[a]. In addition, we assumed that only 8% of all consumers (who purchased and consumed the defective products)

will send the barcodes back to the food processor when they were informed about the recall fact.

According to "influence of the unsold products", these products should be sold on market previously. However, due to the recall happened, the food processor is responsible to recall them. "Influence of the unsold products" is calculated by the retailer price of this product per kg or per liter multiplies the production volume should be produced during these recall days.

3.3.5 Refunding consumers

Refunding consumers activity is that the processor will reimburse the consumers the purchase price of the product, or even a higher price. Before getting the compensation, the proof of purchase by the consumer is necessary for example the barcode. The barcode should be sent together with additional personal information to the food company. In addition, refunding the retailers is also considered as the compensation in this activity. After initiating the recall, the retailers who sell the products to consumers are affected by decreasing the sales. Therefore, some compensation for the retailers is necessary. For example, the retailer needs to collect all the recalled products to other required places or the retailer needs to send additional labor to transport these products. All cost items for this sub-activity and related formulas are given below.

Table 8. Cost items for the activity of refunding consumers.

Sub-activities	**Cost items**	**Formulas**
Refund consumers	Cost of post stamps	Cost of post stamp * customers returned barcodes
	Labors service on consumer help-desk	Labor wage per hour * hours
Compensation for the retailers	Received an invoice as the compensation from a retailer	The value of one invoice per retailer*number of retailers
Total value		*Sum up all items*

The compensations of refunding the consumers is calculated by the number of consumers that will send the barcodes on the defective products back multiplied by the post stamp price which is 0.44 euro in the Netherlands. In addition, extra labor is needed at the consumer help desk to guide and assist consumers with the procedures

of refunding and to advice on possible health consequences of the recalled products. The invoice of compensating the retailers is assumed as fixed costs of 2,000 euro (Velthuis, A. G. J., et al., 2009)[a].

3.3.6 Applying corrective activity

Product applying corrective activity aims to solve the poor food quality, and/or safety of food defects and includes the repair, modification, adjustment or re-labeling. The sub-activities include designing and researching, extra testing, and repairing. For example, designing and researching include a change in the design of the packaging material. If the consumer does not like the color of the food product, extra testing is needed by the food processor to execute. The cost items for these sub-activities and related formulas are given in table 9.

Table 9. Cost items for the applying corrective activity related to a recall progress.

Sub-activities	**Cost items**	**Formulas**
Designing and researching	Technique labor	Labor wage per hour * hours
	External expert	Labor wage per hour * hours
	Analysis costs	
	Sending sample costs	
Extra testing	Technique labor	Labor wage per hour * hours
	External expert	Labor wage per hour * hours
	Analysis costs	
	Sending sample costs	
Repairing	Labor	Labor wage per hour * hours
	Material	
Total value		*Sum up all items*

3.3.7 Evaluation of the recall

Evaluation of the recall aims to check whether the food processor has taken the responsibilities, whether the recall process could be more efficient, whether the recall activities were timely, whether the consumer help-service functioned properly. Furthermore, the evaluation the recall includes an audit. The cost items for the sub-activities within the evaluation of the recall and related formulas are given in table 10.

Table 10. Cost items for the activity of evaluation the recall.

Sub-activities	**Cost items**	**Formulas**
Monitor	Labor to perform monitoring check	Labor wage per hour * hours
Audit	Labor to perform internal audit	Labor wage per hour * hours
	Labor to perform external audit (additional help)	Labor wage per hour * hours
Total value		*Sum up all items*

3.3.8 New marketing activities

New marketing activities aim to bring about a new look for the recalled products and to recover the sales of the food products. The new marketing activities include the calculation of market influence which has stock influence, sales influences, and decreased orders. In addition, new marketing activities also include new advertisements activities such as place advertisement on press notices, send samples as promotion etc. The cost items for these sub-activities and related formulas are given in table 11.

Table 11. Cost items for the new marketing activity.

Sub-activities	**Cost items**	**Formulas**
Market influence	Stock influence	Net value per share *shares
	Sales influence	% sales reduced* sales

	Decreased orders	price/order * # of decreased orders
New advertisement activities	Text writer	Labor wage per hour * hours
	Placing advertisement on press notices	Cost of advertisement per paper* papers
	Consumer magazines	Cost of advertisement per magazine* magazines
	Consumer TV and radio program	Cost of advertisement per minute * minutes
	Send samples as promotion	Labor wage per hour * hours + cost per product * products sent as promotion
	New packing	Labor wage per hour * hours + new material cost per product * products needed new packages
Liability items	Liability costs	Liability costs
Other additional costs	Other additional costs	Other additional costs
Total value		*Sum up all items*

Within the table according to the stock influence, it is the net value per share (the stock price after recalling minus the stock price before recalling) times amount of shares on market. The sale influence is treated as the percentage of sales reduced each two weeks after the start of a recall multiples the previous profit of every two weeks. In addition to the negative brand reputation after recalled, the orders of the products are decreased or cancelled from the relevant suppliers. In this model, we assume there are no liability costs the other additional costs.

4 Demonstration of the recall cost model for Dutch custard

To validate the recall cost model, a real food product, i.e. Dutch custard is used to test the performance of the model. The following two sub-sections depict the data of the Dutch custard recall case and the results of sensitivity analysis.

4.1 Demonstration data

The inputs for the recall of Dutch custard were found in the literature. The title of that article is "Recall costs balanced against spoilage control in Dutch custard" (Velthuis, A. G. J., et al., 2009)[b]. Not all inputs of this recall cost model were found in this paper. To accomplish all needed data, Annet Velthuis expert about the food safety and author of the Dutch custard paper gave additional inputs. Table 12 lists the input of Dutch custard.

Table 12: The specific inputs of the recall model for Dutch custard.

No	*Input name*	*Value*	*Unit*
1	Additional labour needed for extra cleaning of production line(s) where the specified product is produced	40	hours
2	Cost of cleaning materials in total for all m2	332	€
3	Total amount of ingredients that are blocked in storage and might be contaminated	17,000	kg
4	Labour hours (on average) to sample and test the possible contaminated ingredients in storage	2	hours
5	Labour hours within your own company to prepare collection for the destruction of the contaminated ingredients	8	hours
6	% Positive ingredients of the total amount of blocked ingredients	50%	%
7	Price of each re-used positive tested ingredients per kilogram (or per litre) which is going to sell to others	0.5	€/kg(liter)
8	Kilograms or Litres of each re-used positive tested ingredient which will sell to others for re-use	850	kg or liter
9	Hours of temporary workers stopped working at the production line(s)	0	hours
10	% Factory overhead in your annual revenue per year	5%	%
11	Days are needed from the process of starting to stop the production line(s) to the process of finishing the new marketing activities	24	days
12	If the manger will focus more on recall management in case of a recall, hours (on average) are required about the manager spends on them.	8	hours
13	In general, # of cost of your company might receive an invoice from retailers as compensation for their losses	2,000	€
14	In case of a recall, extra staff is needed at the consumer care lines. # of hours in total if required.	40	hours
15	Labour hours in-company are needed to prepare collection of re-using the defective PRODUCTS in destroying process	8	hours
16	% of defective products that can be re-used by others	95%	%
17	Price of re-used products per kilogram (or per batch) on market	0.5	€

No	Input name	Value	Unit
18	Daily production volume of the specified food product	50,000	kg/year
19	Cost price of the food product per kg or per litre	1.20	€
20	# Revenue of the food product per kg or litre	0.05	€/kg or liter
21	Production line(s) in general is the specified food product produced in your company every year	4	lines
22	Cost of additional material in the re-used products per kilogram (or batch)	0.46	€
23	% Customers in general that will ask for a refund for the defective products	8%	%
24	Postal stamps that are refunded for the letters which consumers sent back	4000	stamps
25	Hours do the INTERNAL technical labours work on the corrective actions	12	hours
26	Hours do the EXTERNAL technical labours for designing & researching.	0	hours
27	Additional cost for the analyses EXCEPT the direct labour cost	0.01	€/kg or liter
28	Cost per sampled product for sampling the defective food products	0.0125	€/sample
29	Samples would you (in general) take to test whether the corrective actions in the production process are sufficient	50	samples
30	If the first designing & researching is failed, number of labour hours (for RE-DESIGNING & RESEARCHING) is still required.	0	hours
31	Labour hours are required to do the corrective actions on the recall problems	12	hours
32	Cost per kg or litre for doing the corrective actions on the recall problems	0.01	€/kg or liter
33	Before the recalling, # of stock price of your company per share	0	€/share
34	Before the recalling, # of shares did your company have on market	0	shares
35	After the recalling, # of stock price of your company per share	0	€/share
36	After the recalling, # of shares does your company have on market	0	shares
37	% of sales reduced during the 1st and 2nd weeks after the start of the recall	5%	%
38	% of sales reduced during the 3rd and 4th weeks after the start of the recall	1%	%
39	% of sales reduced during the 5th and 6th weeks after the start of the recall	0	%
40	% of sales reduced during the 7th and 8th weeks after the start of the recall	0	%
41	What is the retail price of product per kg or litre?	1.25	€/kg or liter
42	Orders do you expect to be cancelled by your clients due to the recall	1	orders
43	Average value of each order of your products by clients	15,000	€/order
44	Hours for the labours will be spent on customers' feedback investigation of market research on the re-new products	28	hours
45	Hours for the labours will be spent on designing the new market research of re-new products	24	hours
46	Additional cost of new package material per kg or litre	0.01	€/kg or liter
47	If the product is re-new sometimes samples are sent out to be tasted by consumers. # Hours for the labours do you think they will work on it	28	hours
48	If the product is re-new sometimes samples are sent out to be tasted by consumers. # Samples do you expect you will send them out for free	15,000	products
49	Other additional costs could occurred during this recall	0	€

4.2 Sensitivity analysis

A sensitivity analysis is a tool to find the most significant inputs of a model on the output. The sensitivity analysis was performed where each input was changed 10% increase or decrease. This was done using by TopRank@ 5.0 which is from Palisade decision tool suite (Palisade- Corporation, 2011).

5 Results

The results of the recall costs of Dutch custard are presented in this chapter.

5.1 Results for the eight activities of a Dutch custard recall

To examine total positive effect and negative effect on this Dutch custard recall, the result of the total net value is €72,582 in the table 13. This is "Negative Effect" which showed as positive value. Consequently this "Negative Effect" means that it should be reduced returns and the additional costs on this recall.

Table 13. Total results for each activity and for a Dutch custard recall

Activities	**Results**
Initiation a recall	€13,120
Stopping the production line(s)	€902
Tracking and Tracing	€1,200
Destruction of products and ingredients	€12,247
Refunding consumers	€3,900
Applying corrective activity	€963
Evaluation the recall	€840
New advertisement activities	€39,410
Total value	**€72,582**

The most significant "Negative Effect" is shown in table 13 of destruction of products and ingredients in a recall of €72,582. Basically, "New marketing activities" can be the most significant negative effect which is €39,410. This is because market influence and sales influence are both costly. For example, the food processor has to place advertisements on press notices and some consumer magazines. These measures typically relate to advising customers to consume the products and proving reassurance that all necessary steps have been taken to ensure that the safe products launch in the market again.

In addition, "destruction of products and ingredients" is the secondly important consumed activity and the processor should be paid for other outsourced destructing company which is €12,247, therefore only "Negative Effect" might be got from destructed the contaminated ingredients and products.

The additional costs or reduced returns came from "Stopping production line(s)" is €902 which can be explained that the cost on temporary workers, factory overhead and administrative overhead. Another "Negative Effect" is from evaluation of the recall activity. For the manager in the company, may not put too much attention on these activities in case of a recall occurred.

The details of each activity in a Dutch custard recall are shown below.

5.1.1 Results for initiation a recall

According to the model calculation, the total value of initiation a recall activity is €13,120. The most significant cost item is placing an advertisement on national papers which has the result of €12,000. There are no costs of an external text writer and placing an advertisement on foreign papers, because a recall of Dutch custard there is no need to execute these activities.

Table 14. The results for the initiation of Dutch custard recall.

Sub-activities	**Cost items**	**Results**
Recall announcement	Text writer	€120
	External text writer	€0
	Placing advertisement on national papers	€12,000
	Placing advertisement on foreign papers	€0
	Publicized programs on TV and radio	€1,000
Total value		**€13,120**

5.1.2 Results for stopping the production line(s)

From the results in table 15, it can be seen that the administrative overhead is the most significant positive effect which has the value of €-240. The factory overhead only has the value of €-30.

Table 15. The results for stopping the production line(s) of Dutch custard recall.

Sub-activities	**Cost items**	**Results**
Additional production line(s) cleaning	Additional labor	€800
	Additional cleaning materials	€332
Handling possible contaminative ingredients in storage	Testing the possible contaminative ingredients still in storage	€40
Cost control	Temporary workers	€0
	Factory overhead	€-30
	Administrative overhead	€-240
Total value		**€902**

5.1.3 Results for tracking and tracing

From the results in table 16, it can be seen the total value in this tracking and tracing activity is €1,200.

Table 16. The results for tracking and tracing of Dutch custard recall.

Sub-activities	**Cost items**	**Results**
	Labor costs	€1,200
Total value		**€1,200**

5.1.4 Results for destruction of products and ingredients

The results in table 17 show that there are the positive effects of re-using the contaminated ingredients as €-8,075 and re-using the contaminated products as €-303.

Table 17. The results for destruction of products and ingredients of a Dutch custard recall.

Sub-activities	**Cost items**	**Results**
Dealing with the destruction costs	An invoice from destroying the food products	€4,950
	An invoice from destroying the food ingredients	€441
	Re-using the contaminated ingredients	€-8,075
	Re-using the contaminated products	€-303
	Influence of the unsold products	€15,234
Total value		**€12,247**

5.1.5 Results for refunding consumers

The results in table 18 show that the net cost of the refunding consumers' activity is €3,900. The most significant cost item is the invoice as the compensation from a retailer which is €2,000. On the contrary, the cost item of post stamps is only €540 even it can ignore in the recall process.

Table 18. The results for refunding consumers of Dutch custard recall.

Sub-activities	**Cost items**	**Results**
Refund consumers	Cost of post stamps	€540
	Labors service on consumer help-desk	€1,360
Compensation for the retailer	Received an invoice as the compensation from a retailer	€2,000
Total value		**€3,900**

5.1.6 Results for applying corrective activity

The results in table 19 show that the net cost of applying corrective activity is €963. The most significant cost items are the technique labor of extra testing which are €360 and the labor costs of repairing which is also €360. On the contrary, the external expert cost, the analysis cost, the sending sample cost, and the material costs are all not important cost items in this activity.

Table 19. The results for applying corrective activity of Dutch custard recall.

Sub-activities	**Cost items**	**Results**
Designing & Researching	Technique labor	€240
	External expert	€0
	Analysis costs	€1
	Sending sample costs	€0
Extra testing	Technique labor	€360
	External expert	€0
	Analysis costs	€0
	Sending sample costs	€1
Repairing	Labor	€360
	Material	€1
Total value		**€963**

5.1.7 Results for evaluation of the recall

The results in table 20 show that the net cost of evaluation the recall activity is €840. Although the cost items of the audit sub-activity and the monitor sub-activity are both about labor, the cost on the monitor is larger than on the audit.

Table 20. The results for the evaluation the recall of Dutch custard recall.

Sub-activities	Cost items	Results
Audit	Labor to perform internal audit	€120
	Labor to perform external audit (additional help)	€120
Monitor	Labor to perform monitoring check	€600
Total value		**€840**

5.1.8 Results for new marketing activities

The results in table 21 show that the most significant cost items are the decreased order which is €15,000 and placing advertisement on press notices which €12,000 is. On the contrary, the stock influence cost item, consumer magazines cost item, liability costs item, and the other additional costs item are all the least important in this activity.

Table 21. The results for the new marketing activity of a recall

Sub-activities	Cost items	Results
Market influence	Stock influence	€0
	Sales influence	€11,250
	Decreased orders	€15,000
New advertisement activities	Text writer	€120
	Placing advertisement on press notices	€12,000
	Consumer magazines	€0
	Consumer TV and radio program	€0
	Send samples as promotion	€560
	New packing	€480
Liability items	Liability costs	€0

Other additional costs	Other additional costs	€0
Total value		**€39,410**

5.2 Sensitivity analysis

In the results discussed in this chapter, it is only considered the nine inputs which affect in more than 1% the economical impact obtained by the model (see figure 4). All detailers of sensitivity analysis are showed in the Appendix 1. The percentage of re-used products is the most important input obtained in the sensitivity analysis. Its importance is based on the fact that an increase or reduction of 10% in each of mentioned inputs could increase or reduce between 13.02% the output of the total net costs obtained in the model. Consequently, it is identified that has significant risk by changing the value. In other words, it can be also understand as a cost driver in order to make a decision. If the food processor would like to save the costs on recalling, it is better to consider changing this input carefully.

At the same time, other inputs items of "The price of re-used ingredients" and "Total amount of ingredients" are not very important. When increasing the value of these inputs, it can be seen the result only has slight influences of 1.11% and 1.03% separately. That means that the changes of these items cannot affect the decision maker too much.

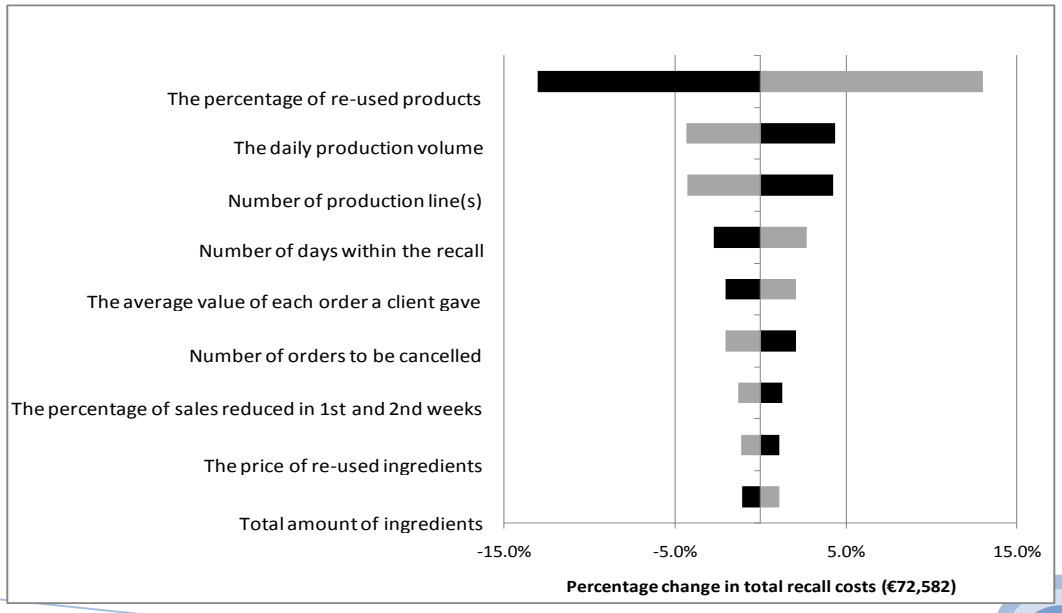

Figure 4. Sensitivity analysis of the inputs considering on the output variation.

6 Conclusions

As the results presented in this report, the total net value of this Dutch custard recall is €72,582, it strongly indicated that this recall activity can get "Negative Effect" as the recall is costly.

The results of the eight activities happened during the Dutch custard recall showed that 'new advertisement activities' has the greatest influence on the recall costs. It covers 54% of the total net value. The other two activities have the less great influences which are 'initiate a recall' activity and 'destruction of products and ingredients'. 'Initiate a recall' accounts for 18% and 'destruction of products and ingredients' accounts 17% respectively in the total net value. Theoretically, the conclusion can be the truth in a recall case. Normally, the costs for the destruction of products and ingredients would be the very significant as employing an outsourced company is essential to classify the contaminated ingredients and products and sequentially incinerate them.

In this study, a major contribution of this model is that the costs and benefits have been quantified for a real recall activity occurring in the Dutch food business, which uses the general recall activities in the Netherlands. For the calculations, the core activities are obligatory to be accomplished in a recall process, and the optional activities are selectable to execute. In this specific Dutch custard case, the recall costs for the core activities and the optional activities have been calculated. This recall-cost model is a general model for all types of food; therefore it is adjustable for the business to choose different activities when meeting the different requirements for recalls. This model would give food business managers an insight into risk management and facilitate to prepare for future recall incidents and improve incident management.

7 Discussions

In this report, the direct and indirect recall costs have been calculated. However, it is very difficult to measure the indirect costs due to the difficulties of to the practical quantification. For instance, the decreased orders from suppliers are measured as one of the indirect costs. However, these orders could have unknown effects and potential influences on this recall. During the two weeks of the recall process in this model, it has only one canceled order from suppliers. Since the decreased orders may be cancelled after the recall, they may be two months later then this model cannot calculate them as the recall-costs. In the reality, it is hard to get information exactly how many the orders can be cancelled during a recall.

Administrative overhead during this recall is another effect could be discussed in this model. On average each working day in a company, professionals or managers spend their major time on normal business tasks of performing administrative duties. When faced with a recall, the emergent situation, these professionals spend most time solely on recall matters and even additional working hours might be necessary. In the result, the cost of administrative overhead is €240. However, it is difficult to calculate the number of hours in general due to the high variability of working hours used for the different recall cases. More investigations are required for this point in order to obtain a more accurate calculation.

Tackling a recall event could significantly impact a company's entire staff - from regulatory departments, such as, producer, customer service, even sales and marketing to extra experts hired like external auditors. These employees involved in handling recall-related duties may not familiar with the required recall processes and the expertise are needed to handle the recall in an efficient and compliant manner. The result showed that both human and financial resources are exhausted and the recall is not properly managed in the most of cases. For instance, for the activity of tracking and tracing, €1,200 is used for the additional labor costs. However, it is not known that the number of labors involved in the tracking and tracing activity, as they may not have any experience or background to charge this activity successfully. Only limited concerns have been considered in this paper.

An additional factor introduced to this model would be the company type. In this model, some questions in the questionnaire are particularly about the market share information. These questions are designed for the big companies, which have even already met the recall problem. However, it is hard for a small scale business that has

never had the experience of recall fact to answer the questionnaire and quantify the recall costs. In fact, a small scale business can handle a recall by a manager personally in most of time. Consequently further studies are needed to design the questionnaire shortly for small business which used to have the recall cases.

References

Andrus. D., (2000). "*Product recall research*". Research commissioned by Consumer Affairs Directorate.

Anonymous[a], site Consumentenbond (Downloaded 26-07-2004), Available at: http://www.consumentenbond.nl/nieuws/terughaalacties/Archief.

Anonymous[b], site Consumentenbond (Downloaded 24-08-2004), Available at: http://www.agriholland.nl/nieuws/artikel/html?id=33458.

Anonymous, (2005). *"Milk withdrawn from the market"*. Ede post.

Cooter, R., Fulton. R., (2001). *"Food matters: Food safety research in The UK public sector, 1917-1990"*. Food Industry Journal, 4, 251-261.

Dorp, C. A. van, (2004). *"Reference-data modelling for tracking and tracing"*. Proefschrift Wageningen Universiteit.

European Council. (2002). Regulation (EC) No 178/2002 of the European Parliament and of the Council. In E. P. a. o. t. Council (Ed.), official Journal of the European Communities (Vol. 178, pp. 24). Brussels: Author.

Eneroth, A., A. Christiansson, J. Brendehaug, and G. Molin. (1998). *"Critical contamination sites in the production line of pasteurised milk, with reference to the psychrotrophic spoilage flora".* Int. Dairy J. 8(9):829-834.

Eneroth, A., S. Ahrne, and G. Molin. (2000). *"Contamination of milk with Gram-negative spoilage bacteria during filling of retail containers"*. International Journal of Food Microbiology 57(1-2):99-106.

European Commission, (2005). *"The Rapid Alert System for Food and Feed (RASFF). Annual Report 2005"*. (pp. 40). Brussels. http://ec.europa.eu/food/food/rapidalert/report2005_en.pdf.

G., Kreft, F., Van Leeuwen S.P.J., Waalwijk, C.,Hoogenboom, L.A.P., Marvin, H.J.P., eds. *"Proactive approaches to the identification of emerging risks in the food chain": Retrospectives*

case studies,Wageningen University and Research Centre (WUR), Report ASG06-I01112, pp. 9-21.

Hartford, (1997). *"Food processors product recall risk management"*. The Hartford Loss Control Department. The Hartford Financial Services Group, Inc., Hartford, CT. Available from http://www.thehartford.com/corporate/losscontrol/SBA/TIPS/855019/pdf#search=product%20recall%20risk%20management%20for%20processors.

Hoogenboom, L.A.P., Zeilmaker, M., Eijkeren, J. van, Kan, K., Mengelers, M., Luykx, D., Traag, W.A., (2009). *"Kaolinic clay derived PCDD/Fs in the feed chain from a sorting process for potatoes"*. Chemosphere.

Huck, J. R., M. Sonnen, and K. J. Boor., (2008). *"Tracking heat-resistant, cold-thriving fluid milk spoilage bacteria from farm to packaged product"*. J. DairySci. 91(3):1218-1228.

J. R. Skees, AletaBotts and Kimberly A. Zeuli, (2001). *"The potential for recall insurance to improve food safety"*. International food and agribusiness, management review 4 (2001) 99-111.

Knowles, T., Moody, R., McEachern, M. G., (2007). "*European food scares and their impact on EU food policy*". British Food Journal, 109, 43-67.

Lafferty, J., McCallum, A. & Pereira, F., (2001). *"Conditional Random Fields: Probabilistic Models for Segmenting and Labeling Sequence Data"*. Proceedings of the 18th International Conference on Machine Learning (ICML-2001), CA: Morgan Kaufmann, pp. 282-289.

Layden, W.,(1994). "*Food safety"*. Society, 31(4), 20-26.

Meuwissen, M. P. M., Velthuis, A. G. J., M., Hogeveen, H., Huirne, R.B.M., (2003). *"Traceability and certification in meat supply chains"*. Journal of Agribusiness (21):167-181.

Meuwissen, M. P. M. V. A., A.A.; Van Asseldonk, M.A.P.M.; Huirne, R.B.M., (2009). *"Eliciting processing industry damage from feed crises"*. British Food Journal In press.

Ministry for Health, Welfare and Sport- Food and Consumer Product Safety Authority (VWA), (2004). *"Product safety in Europe: a guide to corrective action including recalls"*. June 2004,

Official Journal of the European Commission Health and Consumer Protection Directorate General.

M. N. Kramer et al., (2005). "*The science of recalls"*. Meat Science 71 (2005) 158-163. Available online at www.sciencedirect.com.

Nayaga, R. M., Poghosyan, A. and Nichols, J. P., (2004). *"Will consumers accept irradiated food products?"* International Journal of Consumer Studies 28: 178-185.

Novoselova, T., Meuwissen, M. P. M., van der Lans, I. A. and Valeeva, N. I., (2002). *"Consumers' Perception on Milk Safety"*. Proceedings of the 13th International IFMA Congress of Farm Management, Arnhem, the Netherlands.

Organization for Economic Co-operation and Development (OECD), (1981). *"Recall procedures for unsafe products sold to the public"*. Committee on Consumer Policy. Published in Paris, 675/T.

Powers, David M. W., (2003). "*Recall and Precision versus the Bookmaker"*. Proceedings of the International Conference on Cognitive Science (ICSC-2003), Sydney Australia, 2003, pp. 529-534. Available online at
http://david.wardpowers.info/BM/index.htm

Powers, David M. W., (2007). Evaluation, Flinders InfoEng Tech Rept SIE07001. Available online at http://www.infoeng.flinders.edu.au/research/techreps/SIE07001.pdf

Serena Unger and Heather Wooten, (2006). *"A food system assessment for Oakland, CA: Toward a sustainable food plan"*. Oakland Mayor's office of sustainability, June 2006.

Skees, J. R., Botts, A., Zeuli, K.A., (2001). *"The potential for recall insurance to improve food safety"*. The international food and agribusiness management review 4(1):99.

The General Product Safety Regulations, 2005 (GPSR). RASFF database https://webgate.ec.europa.eu/rasffwindow/portal/index.cfm?event=searchResultList&StartRow=101

Van der Meulen B., and van der Velde M., (2008). *"European Food Law Handbook"*. Wageningen, The Netherlands: Wageningen Academic Pulishers, 2008 European Institute for Food Law series No.2.

Velthuis, A. G. J., M., M. P. M.; Huirne, R.B.M., (2009)[a]. *"Distribution of direct recall costs along the milk chain"*. Agribusiness: an International Journal 25(4):466-479.

Velthuis, A. G. J., M., W. R., K. Baritakis, M. Dang, and C. P. A. van., (2009)[b]. *"Recall Costs Balanced against Spoilage Control in Dutch Custard"*.

Vose, D. J. 2000. *"Risk analysis: a quantitative guide"*. 2 ed. John Wiley & Sons, Chichester, UK.

Appendices

Appendix 1

What-If Analysis Detail for Output Finally TOTAL / calculation

All Inputs Steps Ranked By Percentage Change

				Input Variation		Output Variation	
Rank	**Input Name**	**Cell**	**Step**	**Value**	**Change (%)**	**Value**	**Change (%)**
1	The percentage of re-used products	C66	5	1.045	10.00%	63130.89375	-13.02%
		C66	1	0.855	-10.00%	82033.51875	13.02%
2	The daily production volume	C30	5	55000	10.00%	75730.36438	4.34%
		C30	1	45000	-10.00%	69434.04813	-4.34%
3	Number of production line(s)	C27	5	4.4	10.00%	75676.28438	4.26%
		C27	1	3.6	-10.00%	69488.12813	-4.26%
4	Number of days within the recall	C28	1	21.6	-10.00%	70613.12813	-2.71%
		C28	5	26.4	10.00%	74551.28438	2.71%
5	The average value of each order a client gave	C95	1	13500	-10.00%	71082.20625	-2.07%
		C95	5	16500	10.00%	74082.20625	2.07%
6	Number of orders to be cancelled	C94	5	1.1	10.00%	74082.20625	2.07%
		C94	1	0.9	-10.00%	71082.20625	-2.07%
7	The percentage of sales reduced in 1st and 2nd weeks	C89	5	0.055	10.00%	73519.70625	1.29%
		C89	1	0.045	-10.00%	71644.70625	-1.29%
8	The price of re-used ingredients	C42	1	0.45	-10.00%	73389.70625	1.11%
		C42	5	0.55	10.00%	71774.70625	-1.11%
9	Total amount of ingredients	C37	5	18700	10.00%	71802.75625	-1.07%
		C37	1	15300	-10.00%	73361.65625	1.07%

Appendix 2

Food Recall Costs Questionnaire

From: Yang Li, MSc, Wageningen University

Supervisor: Dr. Ir. A.G.J. Annet Velthuis, Business Economics Group

Wageningen University

To: Food companies in the Netherlands

	Questions about the production site where the product is produced	Value	Unit
1	**For which food product do you want to calculate the recall costs?**		**text**
2	**On how many production line(s) in general is the specified food product produced in your company every year?**		
3	**How many days will it take from the process of starting to stop the productions line(s) to the process of finishing the new m arketing activities?**		**days**
4	**What is the average percentage of factory overhead in your annual revenue per year?** *(Factory overhead is defined as all manufacturing expenses except Direct Materials and Direct Labor, for example janitorial services)*		**%**
5	**What is the yearly production volume of the specified food product?**		**products**
6	**What is the consumer price the food product?**		**€**

	Questions about the specified products	Value	Unit
	A. STOP PRODUCTION LINE INFORMATION		
7	**How many hours of additional labor are needed for an extra cleaning the production line(s) where the specified product is produced if needed in case of a recall?**		**hours**
8	**What will be the cost of cleaning materials in total for all m2 during the extra cleaning?**		**€**
9	**What is the total amount of ingredients that are blocked in storage and might be contaminated?** *(Ingredient could be a component of a mixture or compound)*		**kg**
10	**How many labor hours (on average) will it take to sample and test the possible contaminated ingredients in storage?**		**hours**
11	**How many labor hours within your own company will it take to prepare collection for the destruction of the contaminated ingredients?**		**hours**
12	**What is your estimation of the percentage of positive ingredients of the total amount of blocked ingredients?** *(There are two ways to deal with the positive ingredients. One way you can destroy the positive ingredients directly, the other way you can re-use the positive ingredients to reduce the costs.)*		**%**
13	**What would be the price of each re-used positive tested ingredient per kilogram (or per liter) if you would sell it to others (for example a feed company)?**		
	*** Ingredient 1--- (** **)** *Please enter the name of this ingredient*		**€ / kg (or liter)**
	*** Ingredient 2--- (** **)** *Please enter the name of this ingredient*		**€ / kg (or liter)**
	*** Ingredient 3--- (** **)** *Please enter the name of this ingredient*		**€ / kg (or liter)**
	*** Ingredient 4--- (** **)** *Please enter the name of this ingredient*		**€ / kg (or liter)**

	*** Ingredient 5--- ( ) *Please enter the name of this ingredient***		**€ / kg (or liter)**
	*** Ingredient 6--- ( ) *Please enter the name of this ingredient***		**€ / kg (or liter)**
	*** Ingredient 7--- ( ) *Please enter the name of this ingredient***		**€ / kg (or liter)**
	** (If you have more types of ingredient, please only choose the top 7 types of ingredient)*		
14	**How many kilograms or liters of each re-used positive tested ingredient would you sell to others for re-use (for example a feed company)?**		
	*** Ingredient 1--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 2--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 3--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 4--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 5--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 6--- ( ) Please enter the name of this ingredient**		**kg or liter**
	*** Ingredient 7--- ( ) Please enter the name of this ingredient**		**kg or liter**
	** (If you have more types of ingredient, please only choose the top 7 types of ingredient)*		
15	**Generally, how many hours do temporary workers work at the production line(s) that are stopped due to the recall incident?** *(Due to the cost control induced by this recall, you do not need the temporary workers anymore, but to calculate the working hours is necessary.)*		**hours**
16	**The managers will focus more on recall management in case of a recall. How many hours (on average) will the manager(s) spend on these tasks?**		**hours**

17	**In case of a recall, your company might receive an invoice from retailers as compensation for their losses. In general, how much it is?**		**€**
18	**In case of a recall, extra staff is needed at the consumer care lines. Could you estimate how many extra hours in total are required for these tasks?**		**hours**
	B. RE-USING PRODUCTION INFORMATION		
19	**How many labor hours in-company are needed to prepare collection of re-using the defective PRODUCTS in destroying process?** *(Not defective ingredients as mentioned above, here the procedure is to re-use the defective products.)*		**hours**
20	**In general, what is the percentage of defective products that can be re-used by others (e.g. feed company)?**		**%**
21	**What is the price of re-used products per kilogram (or per batch) on market?**		**€**
22	**What is the cost of additional material added in the re-used products per kilogram (or per batch)?**		**€**
	C. REFUND CONSUMERS & CORRECTIVE ACTIONS INFORMATION		
23	**What is the percentage of customers in general that will ask for a refund for the defective products?**		**%**
24	**Customers can get compensation in cash for the bought defective product(s). Which price would they get refunded per product?**		**€**
25	**How many postal stamps that are refunded for the letters which consumers use to send the barcodes to your company?**		**people**
26	**How many hours are spent at the consumer help-desk on the recall problem?**		**hours**
27	**How many hours do the INTERNAL technical labors work on designing & researching, for the corrective actions?**		**hours**

28	How many hours do the EXTERNAL technical labors require to achieve this designing & researching, if the internal technique labors cannot do it?		hours
29	What is the additional cost per product used for the analyses EXCEPT the direct labor cost?		€
30	What is the cost per sampled product for sampling the defective food products?		€
31	How many samples would you (in general) take to test whether the corrective actions in the production process are sufficient?		samples
32	If the first designing & researching is failed, more activities (for RE-DESIGNING & RESEARCHING) are still required. How many labor hours are still needed?		hours
33	How many labor hours are required to do the corrective actions on the recall problems?		hours
34	What is the cost per product for doing the corrective actions on the recall problems?		€
	D. MARKETING INFORMATION		
35	**BEFORE the recalling, what was the stock price of your company per share?** *(If your company is not public company and does not have shares, please go to the question 41)*		€
36	BEFORE the recalling, how many shares did your company have on market?		shares
37	AFTER the recalling, what is the stock price of your company per share?		€
38	AFTER the recalling, how many shares does your company have on market?		shares
39	What do you expect to be the percentage of sales reduced during the 1st and 2nd weeks after the start of the recall?		%

40	**What do you expect to be the percentage of sales reduced during 3rd and 4th weeks after the start of the recall?**		%
41	**What do you expect to be the percentage of sales reduced during 5th and 6th weeks after the start of the recall?**		%
42	**What do you expect to be the percentage of sales reduced during 7th and 8th weeks after the start of the recall?**		%
43	**How many orders do you expect to be cancelled by your clients due to the recall?**		orders
44	**What is the average value of each order of your products by clients now?** *(The clients could be retailers as supermarkets, who purchases or hires something from someone else)*		€
45	**How many hours for the labors will be spent on customers' feedback investigation of market research on the re-new products?**		hours
46	**How many hours for the labors will be spent on designing the new market research of re-new products?**		hours
47	**What is the additional cost of new package material per product?**		€
48	**If the product is re-new sometimes samples are send out to be tasted by consumers. How many hours for the labors do you think they will work on it?**		hours
49	**If the product is re-new sometimes samples are send out to be tasted by consumers. How many samples do you expect you will send them out for free?**		
50	**During the whole recall process, if there are still other additional costs, how much of them?**		€

Appendix 3

A	B	C	D	E	F	G	H	I	J
MAJOR changes		**MINOR Activities**	**Economic Items**	**Input Name**	**Value**		**Unit**	**Calculation**	**Calculation Formula**
Stop production		***Steps for Producers***			***Input***	***calculation***			
4	**a**	**Production line cleaning**	**Additional labor**	wages of per labor per hour	**20**		€/hour	**800**	**=F4*F5**
5				# Hours of labor working	**400,000**		hours		
6			**Additional cleaning materials**	Cost of cleaning material per m^2	**0.00083**		€/m^2	**332**	**=F6*F7**
7				# m^2 needs to be cleaned	**100**		m^2		
8	**b**	**Handling contaminative ingredients in storage**	**Testing contaminative ingredients still in storage**	Total # contaminative ingredients in storage	**17000**		kg		
9				wages of per labor per hour		20	€/hour	**40**	**=G9*F10**
10				# Hours of labor working	**2**		hours		
11			**Destroying positive tested ingredients still in storage**	wages of per labor per hour		20	€/hour	**160**	**=G11*F12**
12				# Hours of labor working	**8**		hours		
13				Low risk of destroying cost per kg	**0.33**		€/kg	**281**	**=IF(E13="Low risk of destroying cost per kg",F13*G16,F14*G16)**
14					**0.99**		€/kg		
15				% positive ingredients in total contaminative ingredients	**5%**		kg		
16				# kgs of positive ingredients		850	kg		
17			**Re-using positive tested ingredients**	% Re-use rate in positive ingredient		95%	%	**-8,075**	**=-G17*F18**
18				Price of positive ingredients when you are going to sell them per kg	**0.5**		€/kg		
19				# kgs of positive ingredients can be re-used	**850**		kg		
20	**c**	**Cost control when stop production**	**Seasonal workers**	wages of per labor per hired hour		20	€/hour	**0**	**=-G20*F21**

21				# Hours of labor working	0		hours		
22			**Factory overhead**	Total # factory overhead in the whole year	5%	30.468	€/year	-30	=-G22*G24*F24
23				Production of this product every year		9,141	kg/yr		
24				# months will stay in recall progress	24	12,500	month		
25			**Administrative overhead**	wages of per labor per hour	30		€/hour	-240	=-F25*F26
26				# Hours of labor working	8		hours		
27		*Steps for Retailers*							
28	d	Compensation invoice from retailers	**Received a bill as the compensation from retailers**		2000		€	2000	=F28
TOTAL								-4,733	=SUM(J4:J28)
Track & Trace costs about the products that are probably contaminated									
31	e	Track and Trace	**Labor of information acquisition & analysis design**	wages of per labor per hour		30	€/hour	1200	=G31*F32
32				# Hours of labor working	40		hours		
TOTAL								1200	=SUM(J31:J32)
Destruction costs of secure destruction service about these waste and trash									
35	f	Dealing with the destruction costs	**A bill from destroying the product or semi- product including the waste**	Low risk of destroying cost per unit		0.33	€/kg	4,950	=IF(E35="Low risk of destroying cost per unit",G37*G38*G35,G37*G38*G36)
36						0.99	€/kg		
37				Production of this product every month		12,500	kg		
38				# months will stay in recall progress		24	Month	15,234	
39			**Re-using the products in destroying process**	wages of per labor per hour		20	€/hour	160	=G39*F40
40				# Hours of labor working	8		hours		
41				% Re-use rate in destroying of all products	95%	5789.062	%	-5,789	=-G41
42				Re-using price of products per kg	0.5	6093.75	€/kg		
43				Production of this product every year		182812.5	kg/yr		

44				# Working months of this production in one year	12		month/yr		
45				Production of this product every month		243750	kg/m		
46				# Working weeks of this production in one year	52		week/yr		
47				Production of this product every week		75000	kg/wk		
48				# working days of this production in one week	6		days/wk		
49				Production of this product every day		200000	kg/day		
50				# Prices of product per kg	1.25		€/kg		
51				Cost of re-using in production per kg	0.46	5325.93	€/kg	5,326	=G51
								19,881	=SUM(J35:J51)
		Refund consumers							
54	g	Recall communication							
55			Text writer	wages of per labor per hour		30	€/hour	120	=G55*F56
56				# Hours of labor working	4		hours		
57			External text writer	wages of per labor per hour		30	€/hour	0	=G57*F58
58				# Hours of labor working	0		hours		
59			Placing advertisement on national paper notices	Cost of placing advertisement per paper	6000		€/paper	12,000	=F59*F60
60				# papers do they have	2		paper		
61			Placing advertisement on foreign paper notices	Cost of placing advertisement per paper	5000		€/paper	0	=F61*F62
62				# papers do they have	0		paper		
63	h	Compensation to consumers	Cash	% consumers returning product	8%		%	400	
64				Cost of cash as compensation per customer	1.25		€/person		=F64*G65*F63
65		Steps for consumers		# customers do they bought your product		4000	persons		
66	i	Refund consumers	Post stamp	Cost of post stamp per customer	0.44		€/person	141	=F66*F67*F63
67				# customers do they bought your product	4000		persons		
68			Consumer help-desk working	wages of per labor they doing help-desk working per hour		20	€/hour	800	=G68*F69

69				# Hours of labor working	40		hours		
TOTAL								13,461	=SUM(J54:J69)
Corrective actions to solve recall problem									
72	j	Designing & Researching	Technique labor	wages of per labor per hour		20	€/hour	240	=G72*F73
73				# Hours of labor working	12		hours		
74			External expert	wages of per labor per hour		30	€/hour	0	=G74*F75
75				# Hours of labor working	0		hours		
76			Analysis costs	Cost of analyzing per product	0.01		€/product	1	=F76*G77
77				# products needed to be analysis		50	products		
78			Sending sample costs	Cost of sending sample per product	0.0125		€/product	1	=F78*F79
79				# products need to be sent as samples	50		products		
80	k	After-Design & Research service	Re-testing including get additional help	wages of per labor per hour		30	€/hour	0	=G80*F81
81				# Hours of labor working	0		hours		
82	l	Repairing	labor	wages of per labor per hour		30	€/hour	360	=G82*F83
83				# Hours of labor working	12		hours		
84			Material	Cost of repairing material per product	0.01		€/product	1	=F84*G85
85				# products needs to be putted on this material		50	products		
86	m	Extra testing	Labor	wages of per labor per hour		30	€/hour	360	=G86*F87
87				# Hours of labor working		12	hours		
88			Materials	Cost of doing extra testing per product		0.01	€/product	1	=F88*G89
89				# products needs to do the extra testing		50	products		
90			Analysis costs	Cost of analyzing per product		0.01	€/product	1	=G90*G91
91				# products of needs to be sent as samples		50	products		
TOTAL								963	=SUM(J72:J91)
Recall evaluation and additional order									
94	n	Auditor (Recall evaluation)	labor to perform internal audit	wages of per labor per hour		30	€/hour	120	=G94*F95
95				# Hours of labor working	4		hours		
96			labor to perform external audit	wages of per labor per hour		30	€/hour	120	=G96*F97

97				# Hours of labor working		4		hours		
98	o	Sub recall account's check								
99			Extra accountant	wages of per accountant per hour			30	€/hour	600	=G99*F100
100				# Hours working of accountant		20		hours		
TOTAL									840	=SUM(J94:J100)
Market withdrawal										
103	p	Stock influence	Before stock price per share	Before stock price per share	0			€/share	0	=G105-G108
105			number of stock in market	number of stock in market	0			shares		
106			After stock price per share	After stock price per share	0			€/share		
108			number of stock in the market	number of stock in market			0	shares		
109	q	Sales influence								
110			% less sales after 1-2 weeks recall	% of sales deducted by recall after 1-2 weeks	5%		150000	%	9,375	=G110*(1-F110)*F50
111				Sales of this product every week			75000	kg/m		
112			% less sales after 3-4 weeks recall	% of sales influenced by recall after 3-4 weeks	1%		150000	%	1,875	=G112*(1-F112)*F50
113							75000	kg/m		
114				% of sales influenced by recall after 5-6 weeks	0%		150000	%	0	=G114*(1-F114)*F50
115							75000	kg/m		
116				% of sales influenced by recall after 7-8 weeks	0%		150000	%	0	=G116*(1-F116)*F50
117							75000	kg/m		
118	r	Decreased orders	Decreased orders	# orders are cancelled because of this recall activity	1			orders	15,000	=F118*F119
119				Value of decreasing in product per order	15000			€/order		
TOTAL									26,250	=SUM(J103:J119)
Additional marketing activities										
122	s	Care ness your consumers	Send person to talk with your consumer	wages of per labor per hour			20	€/hour	560	=G122*F123

123				# Hours of labor working	28		hours		
124	t	New packing	labor	wages of per labor per hour		20	€/hour	480	=G124*F125
125				# Hours of labor working	24		hours		
126			Material	Cost of material which putting on new package per product	0.01		€/product	1	=F126*F127
127				# products needs to put on new packaging material	50		products		
128	u	New advertisement activities	Text writer	wages of per labor per hour		30	€/hour	120	=G128*F129
129				# Hours of labor working	4		hours		
130			Placing advertisement on press notices	Cost of placing advertisement per paper		6000	€/paper	12,000	=G130*F131
131				# papers do they have	2		paper		
132			Consumer magazines	Cost of placing advertisement per page		5000	€/page	0	=G132*F133
133				# pages do they needed	0		pages		
134			Consumer TV and radio program	Cost of placing advertisement per minute	200		€/minute	1,000	=F134*F135
135				# minutes do they have	5		minute		
136			Send samples to customers as promotion	wages of per labor per hour		20	€/hour		=G136*F137+F138*G139
137				# Hours of labor working	28		hours	560	
138				Cost of sending sample per product		0.0125	€/product		
139				# products they need to send as promotion		50	products		
140	v	Liability items			0				
142	w	Other additional costs					€	0	=F142
143									
TOTAL								14,721	=SUM(J122:J143)
Finally TOTAL NET VALUE								72,582	=SUM(J4:J28,J31:J32,J35:J51,J54:J69,J72:J91,J94:J100,J103:J119,J122:J143)