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FOOD SAFETY ECONOMICS – THE INFLUENCE OF THE LACK OF FOOD SAFETY

Abstract: Food safety economics (FSE) highlights wide range of costs of the lack of food safety. These are not only the costs associated with the food product, its recall, fines imposed by food regulatory institutions, but the catalog of costs and impacts is much broader. It includes loss of image, trust, costs of medical care, created doubts about the safety of food on the market, which also affects the quality of life and condition of the individual consumer as well as the whole country. Therefore, it is important to prevent the occurrence of a food hazard by, implementing at least mandatory quality assurance systems, traceability, and in the event of a food safety incident, responding as quickly as possible. The approach to FSE was characterized and its costs on the example of the food companies were shown, both the preventive costs and possible costs to take place if food hazard appears.

Keywords: food safety economics, food safety, traceability HACCP, costs

1. Introduction

Food safety is not just a case of food or the food industry but it refers to a wider approach – the society, the government, the trade and the quality of life as well. Food available to consumer has to be safe. Safe food is free from the food hazards. Regulation 178/2002 defines food safety requirement: “*food shall not be placed on the market if it is unsafe. Food shall be deemed to be unsafe if it is considered to be: (a) injurious to health; (b) unfit for human consumption*”. World Health Organization (WHO) focuses on the food safety by implementing various initiatives. According the the information published on the 4th of October 2024 an estimated 600 million – almost 1 in 10 people in the world – fall ill after eating contaminated food and 420 000 die every year; US\$ 110 billion is lost each year in productivity and medical expenses resulting from unsafe food in low-

and middle-income countries, and food safety is a shared responsibility among different national authorities and requires a multisectoral, one health approach. These three key facts show the complexity of the food safety as well as the consequences of the lack of food safety.

The costs of ensuring food safety can be divided into two categories: the cost of prevention, so of ensuring that food is safe and the cost of reaction when food hazard appears. As it usually happens the cost of ensuring the food safety are much lower that the costs of reaction toward food safety incidents. Delivering safe food is a process from the producers, through transport to sale. The last step in this process is consumer and his food safety behaviour. This process in not easy or costless. As Monteiro et al. (2018) say *the challenge is to deliver an “acceptable” level of food safety at the least possible cost.*

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Food safety is *what economists call a “credence” attribute, defined as one that cannot be verified before purchase or immediately after consumption*. Consumers are increasingly aware of the health, social and environmental consequences of their food choices and demand high quality food with integrity, safety guarantees and transparency (Aung & Chang, 2014; Myae & Goddard, 2012; Niewczas-Dobrowolska et al., 2024; Tang et al., 2015; Riccioli et al., 2020).

The aim of this paper is to characterize the food safety economics and identify the main costs.

2. Food safety economics

Food safety economics (FSE) is not very widely describe in the scientific literature. Food safety economics is an interdisciplinary field that integrates economics and food safety sciences. Its primary focus is on the allocation of scarce resources and the decision-making processes of economic actors within the food supply chain, specifically in the context of food safety management. This field examines, in particular: the economic consequences of microbiological, chemical, and physical hazards in food, the cost-effectiveness of control measures and monitoring systems, the incentives for producers and consumers to implement preventive and corrective actions. FSE also provides valuable insights into: the socio-economic costs associated with food safety incidents, consumer willingness to pay for higher levels of food safety, the impact of food safety risks on the agro-food sector and societal welfare. Furthermore, this discipline plays a crucial role in shaping public policy by offering tools for assessing the economic feasibility of prevention, control, and monitoring strategies, while taking into account the preferences and attitudes of key stakeholders (Focker & van der Fels-Klerx, 2020).

The economic impact of food safety outbreaks on food businesses encompasses both direct and indirect costs, including product recalls, litigation expenses, loss of market access, and damage to brand reputation. In the U.S. alone, these costs are estimated to amount to billions of dollars annually. The estimated cost of food safety incidents for the economy of the United States is around \$7 billion per year which comes from notifying consumers, removing food from shelves, and paying damages as a result of lawsuits (Hussain & Dawson, 2013). The core elements of food safety economics is presented in Table 1.

Table 1. Food safety economics – main elements

Element	Main aim
Economic Impact	It identifies the costs of foodborne illness, product recalls and lost productivity
Cost-Effectiveness	Assesses the effectiveness of preventive, control and monitoring measures
Stakeholder Analysis	Research into the incentives and behavior of industry, consumers, and government
Market Failures	Deals with the nature of the public good, externalities and information asymmetry
Policy Evaluation	Uses economic tools to guide regulation and public investment in food safety
Global Trade and Development	Linking food safety with market access, economic growth and sustainable development

Source: Adinolfi et al. (2016), WHO (2024), Ruzante et al. (2024)

2.1. Food safety costs

The economic costs of food safety can be broadly categorized into several key areas. Each area reflects the direct and indirect financial impacts associated with ensuring the safety of the food supply chain. Understanding these costs is essential for grasping the broader economic implications of food safety policies and practices. The main costs are shown in Figure 1.

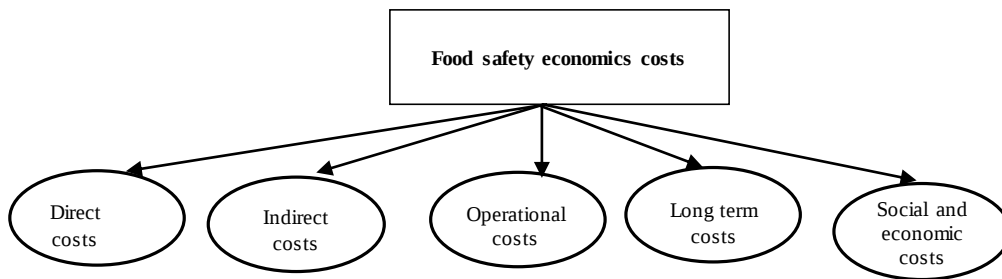


Figure 1. Main groups of food safety costs

The direct costs of food safety from the perspective of the food safety economics can be built of:

- prevention – for example the implementation of HACCP system, monitoring of food safety, employee training,
- product recall - unsafe product has to be removed from the market; costs of transport, disposal, money compensation to consumers and retailers,
- legal fees – money tha the producer has to pay for introduction the unsafe food to the market (it depends on the size of the company, the amount of production).

The indirect costs can be the following:

- image/reputation damage – food safety incident has a consequence of the lost of consumers trust, decrease the producer evaluation by consumers, lower sales. It is a long term cost, it is very hard to come back the reality before the lack of food safety, it involves much money and time,
- number of markets decrease – when the food safety incident happens, it results in the decrease of export, retailers. Money has to be spent for recover from this situation, so to come back to markets and retailers a company used to cooperate with,
- decrease of consumer demand – when the food incident appears or even when the information about the lack

of food safety is released, it results in the decrease of sale as consumers decide not to buy this product. Companies have to spend money and plan a campaign for trust recovery, what is costly and may lasts very long.

The operational costs may include:

- corrective actions taken in food safety systems, internal and external audits, recertification, trainings, implementation of changes in the food safety assurance processes, testing food products, finding the source of the problem. Sometimes it involves changes in the food safety culture, internal procedures. The time needed for the implementation of these actions depends on the maturity of the food safety culture in an organization.

Long-term costs (economic impact):

- food safety incident destroys the food chains, food supply and logistics, results in delays or lack of products. Also may results in losing cooperations in food chains. Rebuilding this collaboration as well as trust along the food chain may last long and involves funds. Moreover, the increase of the insurance usually take place because the analysis of risks changes due to the food safety incidents.

Social costs:

- hospitalization and medical care costs – food safety hazards, for

example microbiological, often result in the need for hospitalization. If the number of infections is big, it results in problem with the efficiency of the medical care,

- job absence – problem to production, services caused the the absence of the employees,
- perception of the lower quality of life, losing feeling of being safety. Food safety incidents often show the weak point of the medical services, inspections, food safety authorities or traceability system.

Beyond from this above division of costs, the food safety costs can be divided into two main categories: costs of the standard food safety situation, so the cost of prevention and food safety standards and systems, and the cost of reaction towards the lack of food safety (food safety incidents).

3. Food safety standards and systems – prevention costs

There are many food safety standards both obligatory and nonobligatory. In this paper the obligatory systems are being characterized as all of the participants of the food chain have to implement these systems: HACCP (Hazard Analysis and Critical Control Point), GHP (Good Hygienic Practice) and GMP (Good Manufacturing Practice). It can be assumed that the better implemented and developed food safety systems, the lower the possibility of the food safety incidents. The implementation of these systems involves costs – costs of elaboration of documentation, cost of trainings, cost of system review etc. These costs can be included in the prevention costs, which are significantly lower than the response costs, so cost of the food safety incidents. Roberts (2018) shows that the costs of HACCP helps to reduce risk of the food incident and ensure food safety. As a part of the procedures of HACCP the procedure of the withdrawal/recall of products from the

market is elaborated, as well as the traceability procedure (we talk about product withdrawal when action is taken to remove food from the supply chain before it has reached consumers, food recall happens when unsafe food is removed from the supply chain when the product is already available to consumers). HACCP helps to ensure food safety by preventive approach of identifying, evaluating, and controlling hazards throughout the food production process. HACCP has a preventive character and deals with three main food hazards: physical, chemical, and biological, rather than reacting to problems after they occur. The key characteristics of HACCP in aspect of food assurance are:

- hazard analysis conducting in the complex way for all main hazards, along each process in a food chain,
- Critical Control Point (CCP) – CCP is a point, step, or procedure in a food production or handling process at which a control can be applied to prevent, eliminate, or reduce a food safety hazard. Identification of the CCPs and monitoring them help to prevent the occurrence of food hazards,
- CCP monitoring and establishing critical limits – each CCP need to be monitored and critical limits of parameters have to be established. If a CCP is out of these limits the actions need to be taken immediately to prevent food hazards,
- HACCP system needs to be improved by regular reviews (Niewczas-Dobrowolska, 2020).

Another system solution/procedure to assure food safety as well as to enable fast product withdrawal/recall is traceability. In the Regulation 178/2002 traceability is defined as *“the ability to trace and follow a food, feed, food-producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production, processing and distribution”*. Bosona and Gebresenbet (2013) made a review of the

definitions of food traceability and pointed out that tracking and tracing are the key terms in definitions. The definition in the Regulation 178/2002 uses the word “trace”. Other definitions of food traceability from the perspective of tracing are shown in Table 2. Product recalls can lead to loss of consumer confidence (Kumar & Budin, 2006) and increase of logistical costs of products associated with a contaminated batch of products or materials need to be destroyed. Therefore, the rapid and unambiguous identification of associated products is critical to the management of product recalls (Fritz & Schiefer, 2009; Ringsberg, 2014). The role of traceability in a food emergency is critical to ensure consumer safety and effective crisis management. Traceability makes it possible to trace the origin of raw materials and products at all stages of the supply chain - from production to processing to distribution. This makes it possible to quickly and accurately locate the source of hazard and to recall defective batches of products. Specifically, traceability works in two directions: “backward” tracing identifies the cause and source of the hazard, such as the

manufacturer, raw material supplier, lot numbers and delivery dates. “Forward” tracing makes it possible to identify where unsafe batches have gone, allowing them to be quickly recalled and reducing further risk to consumers. With this system, the health and economic impact of food incidents can be minimized, and consumer confidence in the supply chain can be maintained. Traceability is also a legal requirement in the European Union (Regulation 178/2002), which underscores its fundamental importance in food safety systems. Traceability is an essential tool to: rapid detection and isolation of the source of the hazard, effective recall of unsafe products from the market, preventing the spread of hazards, protect public health and maintain food quality. Food traceability has a high potential for consumer protection by targeting recalls, eliminating unsaleable food and promoting the investigation of the causes of food safety problems; all by being an integral part of food safety, food quality, food defence and an essential requirement of the food supply chain (Badia-Melis et al., 2015).

Table 2. Definitions of food traceability using the word “trace

Definition	Source
Capacity to trace goods along the distribution chain on a batch number or series number basis	Tamayo et al. (2009)
The ability to trace food products up and down the production chain through all stages of production	Schwägele (2005)
The probability of finding the source of a problem	Resende-Filho and Hurley (2012)
The ability to trace the history of product through the supply chain to or from the place and time of production, including the identification of the inputs used and production operations undertaken	Manos and Manikas (2010)
The ability to trace the history, application or location of an entity by means of recorded identifications	Bertolini et al. (2006), Olsen and Aschan (2010); Karlson et al. (2013); Kelepouris et al. (2007)

Source: Bosona and Gebresenbet (2013)

While the implementation of traceability systems is partly aimed at restoring consumer confidence in food safety, there is limited understanding of consumer perceptions and beliefs related to food traceability (Aung & Chang 2014; Kim & Woo 2016; Van Rijswijk

& Frewer 2012; Matzembacher et al., 2018). Rapid technological advances, combined with consumer demand and government regulations, will make food traceability from 'farm to fork' a reality, driving new levels of supply chain visibility (Jouanjean, 2019). For

traceability systems to achieve their intended goal, it is imperative that consumers have confidence in such systems and are willing to bear the costs associated with a more transparent food system (Zhang et al., 2020).

4. Lack of food safety - response to this situation

As Mohapatra and Patbandha (2022) point out increased food safety regulations and consumer awareness have led to an increase in food recalls around the world. A food recall is an unavoidable situation when a hazard has entered the food chain and has the potential to cause adverse health effects to consumers. Many companies have faced bankruptcy as a result of a recall and the costs associated with it. It is therefore in the best interests of manufacturers to implement modern food safety systems, which can be costly, rather than face the threat of a food recall crisis. Recall requires advance preparation, arrangements and plans (Hu et al., 2017). A strong and robust traceability system will simplify the logistical complications of a recall event. Food recall procedures include several key steps to remove unsafe products quickly and effectively and protect consumers:

- identifying the problematic product and identifying batches or units of product that may pose a risk – basic information on the food products are then needed, for example the batch number or the best before date. It helps to identify the products that are unsafe, instead of all of the product produced in a company,
- determining the source of the problem and the extent of product distribution,
- preparation of a list of customers distributors that received the product to inform them of the recall, data collected in traceability procedure can be then used,

- informing authorities and stakeholders with the needed information as: name of the product, photos, batch number, best before date, all of these information is gathered in traceability procedure. In case of serious risks, notification to the RASFF (Rapid Alert System for Food and Feed) in the EU,
- informing the media – it is important to properly elaborate the communication, to focus on the facts. The company shouldn't get defensive or apportion blame, and continually emphasise the commitment to food safety. The company should be transparent. When it comes to recalls, honesty is the best policy. A poorly handled recall can damage an organisation's reputation, so it's important to control the narrative,
- removing unsafe food from stores and distribution,

It is also important to collect information and lessons learned from that situation to be better prepared for future actions. It is worth noting that consumers' reaction to recall strategies can differ from one country to another (Kher et al., 2013).

5. Food safety economics on the example of the selected companies

Three SME's companies operating in the food industry in Southern Poland are being taken into account. They all have a hand-made production and their market reach is regional. The author of this paper was involved in the process of implementation of food standards and their continuous development. Company No. 1: the main area of production concerns handmade cakes and cookies. It produces about 30 various types of cakes and cookies. They are made from raw materials or semi-finished products sourced mainly from local suppliers, secondarily from more distant

suppliers. Some of the products require storage in refrigerator (for example cakes), other not. The organizational structure is not extensive. The main responsibilities for running the business and ensuring the quality and safety of the products rest with the owner. The company was established in 1987. The company has obligatory food safety basic standards GHP, GMP and HACCP and traceability. The decision to implement these systems was dictated by the decision of the Food Safety Authority. Implementation of HACCP, GHP, GMP began in 2014, and took about 8 months. At the beginning, one could see reluctance and resistance on the part of the owner and employees to meet the new requirements. Implementation of HACCP, GHP, GMP was treated as another unnecessary duty. According to the steps of HACCP the products were described by the list of ingredients, storage conditions, allergens, hazard risk, then the CCPs were identified and system of monitoring the CCPs. No IT solutions were implemented, all stages based on paper or electronic documents. Quite a big challenge was the implementation of the traceability system due to the lack of IT support. Forms have been prepared for entering data related to traceability both backwards and forwards. As apart of the obligatory documentation the procedure of the product withdrawal/recall was elaborated. Then the owner and the employees were trained. Company No. 2: the main area of production concerns meat and meat products. It produces about 50 various types of meat and meat products. They are as a raw food (meat) or processed meat (for example ham) with the use of other ingredients and food additives. The raw food is sourced mainly from local suppliers, secondarily from more distant suppliers. All of the products require storage in refrigerator. The organizational structure is not extensive. The main responsibilities for running the business and ensuring the quality and safety of the products rest with the owner. The company was established in 1998. The company has obligatory food safety basic

standards GHP, GMP and HACCP and traceability. The decision to implement these systems was dictated by the decision of the Food Safety Authority. Implementation of HACCP/GHP, GMP began also in 2014, and took about 10 months. At the beginning, one could see reluctance and resistance on the part of the owner and employees to meet the new requirements. Implementation of HACCP, GHP, GMP was treated as another unnecessary duty. According to the steps of HACCP the product were described by the list of ingredients, storage conditions, allergens, hazard risk, then the CCPs were identified and system of monitoring the CCPs. No IT solutions were implemented, all stages based on paper or electronic documents that was also the challenge. Dedicated forms have been prepared for entering data related to traceability both backwards and forwards. As apart of the obligatory documentation the procedure of the product withdrawal/recall was elaborated. Then the owner and the employees were trained. From the perspective of the likelihood of danger, this company was of high risk because of the largely non-heat-treated products consumed. Company No. 3: the main area of production concerns frozen meals. It produces about 45 various types of frozen meals. These products are processed and have between 4 to 9 ingredients each. The raw food or semi-processed ingredients are sourced mainly from local suppliers, secondarily from more distant suppliers. All of the products require storage under frozen conditions and cannot be consumed after thawing. The organizational structure is of the owner and groups of employees responsible for ingredients preparation, food processing and products labelling. The main responsibilities for running the business and ensuring the quality and safety of the products rest with the owner. The company was established in 1989. The company has obligatory food safety basic standards GHP, GMP and HACCP and traceability. The decision to implement these systems was also dictated by the decision of the Food Safety

Authority. Implementation of HACCP/GHP, GMP began also in 2014, and took about 7 months. According to the steps of HACCP the product were described by the list of ingredients, storage conditions, allergens, hazard risk, then the CCPs were identified and system of monitoring the CCPs. No IT solutions were implemented, all stages based on paper or electronic documents. Also a big challenge was the implementation of the traceability system due to the lack of IT support. Forms have been prepared for entering data related to traceability both backwards and forwards. As apart of the obligatory documentation the procedure of the product withdrawal/recall was elaborated. Then the owner and the employees were trained.

Standards implementation assessment: looking from the perspective of the operation of the standards for 10 years, it can be said that they are properly maintained. Employees are trained twice a year and the review of the standard is being made one a year. The preventive costs of FSE are shown in Table 3. There have not been any large scale food recall/withdrawal for 10 years, however some situation of the lack of food safety took place, such as: wrong food labelling – no information about the food allergens or wrong best before date, lack of the full list of ingredients. Products were withdrawn mainly at the stage of distribution. Then the most useful solution was the traceability forms that made it possible to identify suppliers and detailers. The situations of the lack of potential food safety in these companies are shown in Table 4.

Table 3. Preventive costs of food safety in selected companies being revised

Cost	Description	Company 1	Company 2	Company 3
Implementation of GHP, GMP, HACCP	Elaboration of documentation, validating the documentation, employees training	50	55	50
Standards development, filling of records	Review of the standards (one a year)	10x10	10x10	10x10
	Employees training (twice a year)= 2 x number of employees x training rate. Over a period of 10 years: Review of the standards: 10 x rate of standard review, Training: 10 x 2 x number of employees x training rate per person	10x2x6x2	10x2x12x2	10x2x10x1,8
	Costs of delegating employee(s) to filling the record/forms: % of delegating x number of employees x average salary	0,3x1x60	0,5x1x65	0,5x1x65
	Materials: paper, food testing, equipment: computer, termometers, external laboratory costs average costs through 10 years	140	220	200
Total		548	887,50	742,50

*costs are calculated in units, 1 unit=100 PLN

Source: own elaboration on the basis of the collaboration with these companies

Table 4. Food safety incidents in revised companies

Company	Incidents description	Main costs
Company No. 1	Wrong information on the food label about the storage condition. The product should be stored in the refrigerator but was stored in 21°C. Product contained eggs, so there was a risk of potential Salmonella contamination. The product had to be withdrawn from the market, utilized. Some consumers had already bought this product, so shops had to be informed.	– elaboration of a new food label (external service cost), printing – food packages – cost of withdrawal (transport, labour costs) – utilization costs – cost of production (ingredients, energy, labour costs) – lost of cooperation – lost of trust and image – decrease in sales
	Internal error in food processing. The stage of eggs irradiation was omitted by an employee so there was a risk of Salmonella contamination as there was no heat process in the next stages. Product was utilized. The process had to start from the beginning.	– utilization costs – cost of production (ingredients, energy, labour costs)
	Lack of semi-product supervision, lack of information about food allergen – nuts. The product had to be withdrawn from the market, the food label had to be changed. Product had to be repacked.	– elaboration of a new food label (external service cost), printing – food packaging (cost of food packages and labour) – cost of withdrawal (transport, labour costs) – lost of trust and image – decrease in sales
Company No. 2	Wrong food labels information – lack of information about food allergens as a result of the food authority inspection	– elaboration of a new food labels (external service cost), printing – preparation for the next inspection (implementation of requirements) – large scale product withdrawal (transport, labour costs) – food repackaging or utilization – fine issued by the food authority – decrease in sales
Company No. 3	Wrong best before date. Due to an error by an employee responsible for packaging the products, the wrong best before date was stamped on the packaging, according to which the product was past its best-before date. The distributor returned the products to the manufacturer and demanded a refund. He did not reorder the products. After this incident the double check of product was implemented before sending them to distributors or detalists.	– repackaging the products – employee involved, costs of labour – food packages – lost of cooperation – lost of trust and image – decrease in sales
	Wrong ingredient lists on the food labels. Lack of information about containing the cottage cheese which is the source of the food allergen.	– repackaging the products – employee involved, costs of labour – food packages – lost of cooperation – lost of trust and image – decrease in sales

Source: own elaboration

It is very complicated to assess the costs of food recall or withdrawal. Usually companies do not present such data, so only estimated costs can be discussed. As Ackerley et al. (2025) mentioned the range of costs varies widely by type and size of business, with manufacturers incurring median costs per recall ranging from \$3.0 million to \$72.7 million per company, shippers/distributors from \$0.1 million to \$2.3 million per company, restaurants from \$0.04 million to \$1.1 million per company, and non-restaurant retailers from \$0.1 million to \$3.1 million per company. Overly broad recall is also a problem when a hazardous food product cannot be accurately identified. Certainly, most of the costs is borne by the manufacturer. The sooner the product is withdrawn from the market, the lower the costs are. The costs are also lower if the product is withdrawn from distribution before reaching the consumers. Here researchers estimate the costs that can be somehow calculated but there are still costs like lost of trust, image that are difficult to be estimated directly. They can for example be calculated by their negative results, as the decrease of sales or number of clients. Consumer trust is very important in any market but it is particularly essential in the food market as food directly influence our health. Food scandals results in lost of trust and the decrease of sales (Benson et al., 2020). Time and money is needed to recover from this situation. Edelman Trust Barometer Global Report 2024 shows the level of trust of various sectors. According to this report food and beverages sector is fourth most trusted industry (after technology, education, healthcare). So trust is important in food industry and companies should care about

quick trust recovery after the food scandal.

6. Conclusion

Food recalls are important because they protect consumers from potentially harmful products. Food recalls play a crucial role in the food safety system by enabling the rapid identification and removal of contaminated or unsafe food from the market. Companies operating in the food market should pay attention to the food recall procedures and check these procedures work in practice. A good recall procedure helps to reduce the health risks, costs as well as helps to communicate in a proper way. As it was shown in this paper food recalls generate many costs for the company, some of them can be calculated, some of them are hardly to be assessed, but still very essential, as: lost of trust, image. The appearance of a food hazard has a wide impact, not only related to the product itself, but to the image of the manufacturer, food control institutions, the feeling of consumers in terms of safety, the capacity of medical care in the short term, if it were needed, the possibility of cooperation. So it is not just the domain of the food industry but also the whole country and the government. Food safety standards and procedures of product recalls play an important role of ordering activities of food recall. The responsibility and engagement of all food chain actors involved in the food recall is undeniable. Another important aspect is the traceability which help to identify the source of the hazard. Traceability also prevent overly broad product recall because enables to accurately identify the unsafe product that reduce costs.

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