

A Framework for Harnessing Public Wisdom to Ensure Food Safety

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Abstract—Food safety issues often draw public attention after the discovery of suspected or confirmed cases of food poisoning and contamination. Food safety incidents reveal voids in existing food safety practices established by food science, governmental policies, and business processes. The vulnerability in food supply chain may yield room for potential food terrorism. This paper presents a framework for harnessing public wisdom from mass media to improve and advance existing practices to better ensure our food safety. The framework incorporates the use of content and social network analyses to distill important issues into food safety knowledge.

Keywords—food safety; food terrorism; social networking websites; knowledge discovery; iterative framework

I. INTRODUCTION

The food safety incident of melamine-tainted milk in 2008 raised a tremendous public concern in global scale. The public has been voicing their concerns from different perspectives in various social networking platforms such as blogs and online forums. The captured public voices have the potential to turn into valuable sources for deriving better practices to ensure food safety, which is traditionally safeguarded by food safety practices from food science and technology, government policies and regulations, and supply chain management.

Food science has contributed in areas like defining the storage conditions in terms of time and temperature for pasteurized milk [11]. Governmental policies have been in place like imposing safety measures and standards on various food products including milk [14]. Traceability in supply chain management has been proven to be vital once more regarding the world-wide food recall process for food products having tainted milk as ingredient [12]. Given all the precaution in place to safeguard milk for consumption, the presence of melamine did slip through the food safety net. Besides, the incident exposed vulnerabilities in our food supply chain and food safety ensuring practices.

A common characteristic of current model of food safety practices is that only a relatively small group of experts in food science, policy making, and food industry takes up the entire responsibility to safeguard all food supply chains. The general public may play a new role in the social dimension to share the responsibility. A framework for harnessing public wisdom from social discussions concerning food safety incidents will be shown to provide a better model for food safety practices.

The vigorous discussions in social networking sites after the discovery of a food safety incident often have multiple perspectives about the weaknesses in the current safeguarding model. The unrestricted discussions also yield some new and even unexpected ideas that may offer remedies for the incident or solutions for other possible glitches. The public wisdom derived from these open discussions can be both beneficial and harmful to our society depending on how it is being used. If we do not harness them to strengthen our food safety practices, terrorists may make use of those new ideas to pose threats.

II. VULNERABILITIES IN FOOD SAFETY

Food industry players observe appropriate policies and regulations and employ efficient and cost-effective practices to produce, process, store, transport, and prepare food for general public to safely consume. However, the underlying activities for food safety practices are loosely coordinated. Some activities focus on using appropriate and economical packaging material to preserve food quality whereas some target on preventing foodborne diseases from food. In an experiment of investigating different containers for refrigerated mandarin juice, carton containers with an inner layer of aluminum foil demonstrated the ability to provide the juices with the best quality throughout their storage [1]. It is due to its ability to limit the rise in oxygen in the headspace of storage containers.

Preventing food contamination from pathogens is a primary and effective effort to avoid any foodborne disease outbreak [3]. An athermal process was investigated to reduce the growth of *Salmonella* spp. during storage of concentrated orange juice [20]. Such an athermal process is able to preserve the nutritional and sensory benefits from concentrated fruit juices. Another study showed that drying temperature was found to be a major factor influencing the heat resistance of *Salmonella* during drying of a model vegetable [4]. With drying temperature setting at 70°C, the majority of *Salmonella* cells were destroyed even before shrinkage of the leaves took place. Therefore, vegetable quality can be preserved.

According to the Centre for Food Safety in Hong Kong, the Centre issued 84 food alerts between 2006 and 2008 [2]. The incident of melamine in 2008 caused a global recall of milk products and other food products having tainted milk as ingredient [21]. The tainted milk led to the deaths of several babies and made some 300,000 ill. Although food terrorism was not the cause or the intention for the incident, the use of

melamine was profit-driven. Melamine can inexpensively provide extra nitrogen quantity, which is measured to indirectly examine the protein quantity. However, the deficiency in this control measure was not widely known before the melamine incident. Food safety incidents reveal the imperfection in the existing food safety practices. They expose the possibilities to contaminate food for the purpose of food terrorism, too.

A review of foodborne disease outbreaks from 1996 to 2006 in Hong Kong revealed that over 80% of total confirmed outbreaks were due to bacterial pathogens among all identified etiological agents [3]. The same review also depicted that inadequate cooking and contamination by raw food were the principal factors contributing to the outbreaks. The findings may derive better food safety promotion campaigns and prevention practices to reduce foodborne disease outbreaks.

In addition, rapid and accurate monitoring methods – destructive and non-destructive – are needed to ensure safer food. One of destructive methods is to develop a rapid and highly sensitive shell crush method for the recovery of microorganisms from post-processed shell eggs [7]. An electronic nose (e-nose) system is a non-destructive method to assess the various degrees of oyster quality by correlating sensory panel scores with e-nose data [5].

A low-cost ultra-high temperature milk treatment technique was investigated to bring a technically viable bottling option for small-size dairy processing plants to preserve the sensory stability of milk [13]. The milk quality can be ensured locally prior to the bottling process in dairy plants. The extra procedures and logistics to safely store in local plants and transport to bottling plants can be eliminated.

One of the characteristics of food products is short shelf-life. Handling a large volume and variety of foods, facing more and stricter traceability requirements, as well as monitoring the temperature in supply chains are the challenges in food supply chain management. Radio frequency identification (RFID) systems have demonstrated the ability to solve the problems associated with the logistics of short shelf-life grocery goods [6]. In addition, some traceability systems were developed to restore consumer confidence after major outbreaks of mad cow disease and Salmonella [8], [9], [18]. Furthermore, time-temperature indicators have been used to show remaining shelf-life of food products and frozen food being exposed to surrounding environments [15], [16].

III. PUBLIC WISDOM IN VIRTUAL COMMUNITY

Although there has no confirmed case of food terrorism, many food safety incidents have been vigorously discussed in both real and virtual communities. Fig. 1 shows the sequence of events happening before and after the discovery of a food safety incident. Prior to a particular incident, different food safety practices have been carried out to ensure food safety. Often times, a food safety incident triggers the public to voice their concerns in social networking platforms on the Web.

Social networking Websites have been open platforms for the general public to voice their thoughts and concerns whenever interesting social events like Olympics and World Cup Soccer happen [10]. Some events are unexpected or

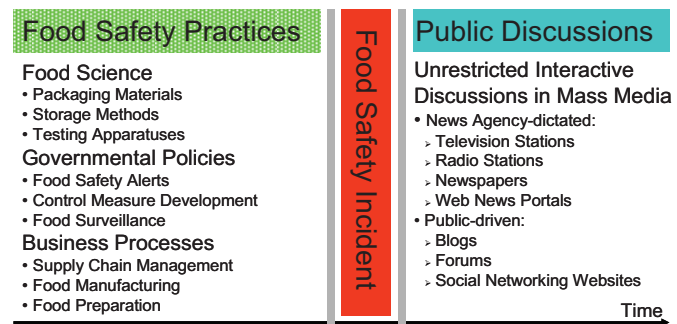


Figure 1. Sequence of food safety practices, incident, and public discussions

destructive incidents like terrorist attacks and food poisoning cases [22]. The anonymity characteristic of posting opinions also makes the public freely express their ideas any time, any place [17]. Furthermore, an individual may participate in more than a virtual community to exchange conversations. The end result is a rich record of voices for corresponding events.

Because of the diversity of the public, the content of discussions comes with multiple perspectives and rhetoric. The content may include some conspiracy theories, wild assumptions, misunderstandings, or misperceptions about an event or incident. These discussions form a rich information base for distilling new kinds of knowledge to look at particular events. Regarding food safety incidents, unexpected or under-mind weaknesses may be discovered from the collective public wisdom. Therefore, harnessing public driven wisdom from online communities is fruitful to ensure food safety.

IV. FRAMEWORK FOR HARNESSING PUBLIC WISDOM

In order to reduce vulnerabilities in our current model for food safety practices, an enhanced model is depicted in a framework for harnessing public wisdom for food safety in Fig. 2. The framework has two core components. The first one is to extract public wisdom from all Web discussions being generated after a food safety incident. The second one is to make use of the asynchronous public wisdom to reduce or even eliminate vulnerabilities discovered from the incident and to strengthen current practices. Overall, it is an iterative model, which iterates through each food safety incident. It is also important to incorporate all investigation findings to revise practices. In terms of the timing of information being available, public discussions are almost always available right after the discovery of an incident. It is simply a common phenomenon of how people use social networking sites to instantly express their opinions, comments, and thoughts about an interesting or disturbing event. Contrarily, findings from investigation will be available after a detailed and often lengthy analysis. Public discussions also include more topics in multiple perspectives and even some unexpected or surprising suggestions and ideas.

Ideally, if a proactive model could be created such that public opinions could be obtained prior to any incident, we would have had a very safe food supply chain. However, the public do not have the urge, incentive, or imagination to give opinions in advance of any incident. Thus, the framework offers a reactive model to immediately make use of public wisdom generated after an incident. That is, at worst, the good usage of this model starts to safeguard our food supply chains

while any possible bad usage of the same information is prepared to harm us. This framework offers an advantage in competing with possible food terrorists against time.

It is the fact that current food safety practices incorporate some sampling of public opinions through survey programs from health and food safety agencies. However, the coverage of such surveys may be limited to targeted findings and is only suitable for fine-tuning certain steps in practices. Contrarily, the public discussions are open-ended and unrestricted. All topics being discussed are driven by individuals.

Because of the huge volume of discussions cumulated after an incident, the framework is able to incorporate various analysis techniques to discover useful knowledge. Content analysis such as clustering algorithms, topic detection and tracking, and natural language processing will be used to summarize and prioritize topics being discussed. In addition, the relationships and roles of people participating in discussion will be analyzed by social network analysis [19]. Suitable summarization and visualization techniques can tie together the results from both content and social network analyses for further systematic examination of underlying discussions [22].

V. CONCLUSION

This paper introduces a framework for harnessing public wisdom to ensure safety in our food supply chains. This social dimension adds to the existing three dimensions from food science, governmental policies, and business practices to ensure food safety. However, the knowledge from social discussions can only be available after some unfortunate food safety incident. The framework incorporates the asynchronous public wisdom to iteratively strengthen food safety practices. The future work includes gathering discussions from social networking sites regarding food safety incidents, applying various content and social network analyses, and then testing the framework with the analyzed results.

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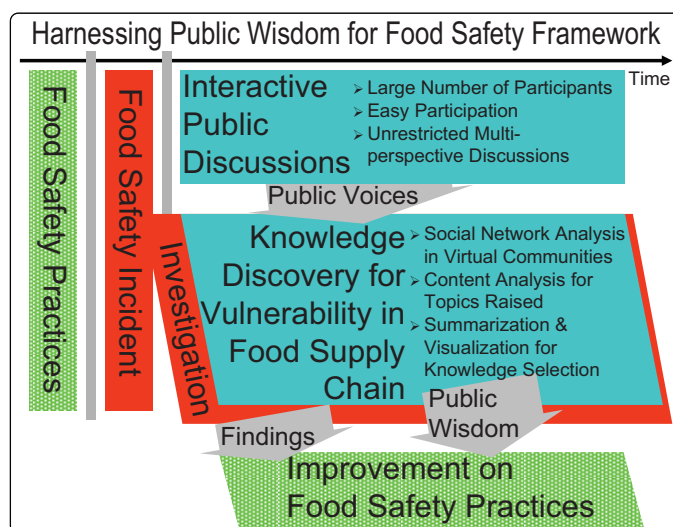


Figure 2. Framework for harnessing public wisdom to ensure food safety

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