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A Review on Various Food Hazard Finding Techniques to Ensure the Public Food Safety

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Abstract: An increasing popularity of different food items leads to higher food consumption which is made of different food plants. However, some of ingredients present in the food might lead to various food hazards which needs to be find and defined well to avoid the causes to the human beings. Thus finding food hazard becomes most concerned and required research issue to prevent the tremendous causes which might occur. There are various researches has been conducted previously to detect the different kind of food hazards. Those research works illustrates the methods and techniques that can be used to find the food hazard patterns present in the food sources. Some of the research work illustrates the different kinds of hazards that might present in the food sources would lead to tremendous changes in the human health perspectives. This analysis work focus on discussing various research methods that focus on finding the food hazard event patterns, thus the prevention from food hazards can be attained fast. The existing research methodologies are discussed with their merits and demerits, so that the further research works can be concentrated more. The experimental tests conducted were on all the research works in matlab simulation environment and it is compared against each other to find the better approach under various performance measures.
Keywords: Food Hazard, Event pattern, Causes and prevention, Hazard parameters

I. INTRODUCTION

Food is any substance [1] consumed to provide nutritional support for the body. It is usually of plant or animal origin, and contains essential nutrients, such as fats, proteins, vitamins, or minerals. The substance is ingested by an organism and assimilated by the organism's cells to provide energy, maintain life, or stimulate growth. Historically, people secured food through two methods: hunting and gathering and agriculture. Today, the majority of the food energy required by the ever increasing population of the world is supplied by the food industry. Food safety and food security are monitored by agencies like the International Association for Food Protection, World Resources Institute, World Food Programme, Food and Agriculture Organization, and International Food Information Council. They address issues such as sustainability, biological diversity, climate change, nutritional economics, population growth, water supply, and access to food. The right to food is a human right derived from the International Covenant on Economic, Social and Cultural Rights (ICESCR), recognizing the "right to an adequate standard of living, including adequate food", as well as the "fundamental right to be free from hunger".

Foodborne illness, commonly called "food poisoning", is caused by bacteria, toxins, viruses, parasites, and prions. Roughly 7 million people die of food poisoning each year, with about 10 times as many suffering from a non-fatal version. The two most common factors leading to cases of bacterial foodborne illness are cross-contamination of ready-to-eat food from other uncooked foods and improper temperature control. Less commonly, acute adverse reactions can also occur if chemical contamination of food occurs, for example from improper storage, or use of non-food grade soaps and disinfectants. Food can also be adulterated by a very wide range of articles (known as "foreign bodies") during farming, manufacture, cooking, packaging, distribution, or sale. These foreign bodies can include pests or their droppings, hairs, cigarette butts, wood chips, and all manner of other contaminants. It is possible for certain types of food to become contaminated if stored or presented in an unsafe container, such as a ceramic pot with lead-based glaze [2].

Food poisoning has been recognized as a disease since as early as Hippocrates [3]. The sale of rancid, contaminated, or adulterated food was commonplace until the introduction of hygiene, refrigeration, and vermin controls in the 19th century. Discovery of techniques for killing bacteria using heat, and other microbiological studies by scientists such as Louis Pasteur, contributed to the modern sanitation standards that are ubiquitous in developed nations today. This was further underpinned by the work of Justus von Liebig, which led to the development of modern food storage and food preservation methods [4]. In more recent years, a greater understanding of the causes of food-borne illnesses has led to the development of more systematic approaches such as the Hazard Analysis and Critical Control Points (HACCP), which can identify and eliminate many risks [5].

Recommended measures for ensuring food safety include maintaining a clean preparation area with foods of different types kept separate, ensuring an adequate cooking temperature, and refrigerating foods promptly after cooking [6]. Foods that spoil easily, such as meats, dairy, and seafood, must be prepared a certain way to avoid contaminating the people for whom they are prepared. As such, the rule of thumb is that cold foods (such as dairy products) should be kept cold and hot foods (such as soup) should be kept hot until storage. Cold meats, such as chicken, that are to be cooked should not be placed at room temperature for thawing, at the risk of dangerous bacterial growth, such as Salmonella or E. coli [7].

Some people have allergies or sensitivities to foods which are not problematic to most people. This occurs when a person's immune system mistakes a certain food protein for a harmful foreign agent and attacks it. About 2% of adults and 8% of children have a food allergy. The amount of the food substance required to provoke a reaction in a particularly susceptible individual can be quite small. In some instances, traces of food in the air, too minute to be perceived through smell, have been known to provoke lethal reactions in extremely sensitive individuals. Common food allergens are gluten, corn, shellfish (mollusks), peanuts, and soy. Allergens frequently produce symptoms such as diarrhea, rashes, bloating, vomiting, and regurgitation. The digestive complaints usually develop within half an hour of ingesting the allergen [8]. Rarely, food allergies can lead to a medical emergency, such as anaphylactic shock, hypotension (low blood pressure), and loss of consciousness. An allergen associated with this type of reaction is peanut, although latex products can induce similar reactions. Initial treatment is with epinephrine (adrenaline), often carried by known patients in the form of an Epi-pen or Twinject [9] [10].

Human diet was estimated to cause perhaps around 35% of cancers in a human epidemiological analysis by Richard Doll and Richard Peto in 1981 [11]. This cancer may be caused by carcinogens that are present in food naturally or as contaminants. Food contaminated with fungal growth may contain mycotoxins such as aflatoxins which may be found in contaminated corn and peanuts. Other carcinogens identified in food include heterocyclic amines generated in meat when cooked at high temperature, polyaromatic hydrocarbons in charred meat and smoked fish, and nitrosamines generated from nitrites used as food preservatives in cured meat such as bacon. Anticarcinogens that may help prevent cancer can also be found in many food especially fruits and vegetable. Antioxidants are important groups of compounds that may help remove potentially harmful chemicals. It is however often difficult to identify the specific components in diet that serve to increase or decrease cancer risk since many food, such as beef steak and broccoli, contain low concentrations of both carcinogens and Anticarcinogens [12].

Thus food hazard event detection becomes a most prominent role in the food safety environment. The detection of food hazard is a most complex issue which is analyzed and evaluated by the various researchers using different methodologies. In this research work, those research methodologies are discussed in terms of their working procedure and their functionalities along with various performance measures. The benefits and drawbacks that arise in those methodologies also discussed in the detailed manner.

II. EXISTING RESEARCH METHODOLOGIES

Letia Ioan Alfred et al [13] proposes an agent-based solution to support small and medium companies willing to implement a Hazard Analysis Critical Control Point system in food supply chains. This approach generates two ontologies to differentiate the hazard effects. Hazards are defined as biological, chemical, or physical agents that are likely to cause illnesses or injuries to the consumer. In this approach, the customers are empowered with the capability to choose the exact product instance which best fits them from an existing set of items. Hence, they are offered a greater level of protection against hazards.

Ming Yi [14] performed an analysis of the various food safety strengthening requirement that might cause the food hazards in case of violation of parameter values. HACCP, namely, "Hazard Analysis Critical Control Point" is widely used in the developed countries in Europe and the United States to analyze, assess and control the significant food safety issues to minimize the food safety hazards to be in line with the food safety standards system, which is third-party certification system mainly used in food safety. When HACCP is introduced to strengthen food safety, principles below must be followed: hazard analysis, identify critical control points of a program, set critical limits, establish monitoring requirements, take corrective action, review whether the system is operating correctly, keep record. The implementation of HACCP principles can more effectively strengthen the food circulation safety and resolve many food safety issues arising in China's food circulation field, including: secondary contamination of food circulation, "three- no products" in the rural market, food safety issues in the circulation field caused by uncritical check on production process.

Hu Boran [15] attempted to ensure the food safety by detecting the food hazard related parameters by integrating the Petrinet with the HACCP. This is analyzed and evaluated in the strawberry production process. This analysis work builds the prevention and control measures which is collected from the strawberry food products. Petri nets are directed bipartite graphs, which includes transition, place, and arc. Transition and place are two kinds of nodes, and arc is the connecting of the nodes, which indicates the

number of tokens (Dynamic elements of a Petri net) that can be consumed from an input place by a connected transition. In order to gain the cause of hazard according to HACCP correctly, HACCP and Petri net are combined and applied to study the food safety and look for the cause of the food hazard, among which HACCP is a technology of food safety management, including the identification, evaluation and control of hazards in a particular food operation, and Petri net can offer the complementary framework to analyze the dynamical properties of concurrent systems from either a qualitative or a quantitative point of view.

Zhou Qiang et al [16] analyze the reason that led to the malfunction and inefficient status of food safety crisis management of China. It mainly focusing on problems of overlapping functions; overstaffing; stagnant information changing; inadequate legal protection; poor quality officers; obstructions of restriction in trade association; lacking of food security and social responsibility conscious; low participation of public and media between different departments. Under the background of advocating people-oriented and harmonious society in our country, the urgency and importance to establish and improve the food security crisis management mechanism is self-evident.

Hu Weizhong & Jin Han [17] explores factors influencing the efficacy of risk communication of food safety. The study shows consumer's risk perception of food safety changes rapidly according to the content of information. It seems that consumer's risk perception of food safety is unstable in that risk perception can be easily reversed by information opposite to consumer's previous attitude. Consumer's knowledge of genetic engineering neither has relation to the level of risk perception of food safety nor has influence on the efficacy of risk communication. This study has implications for food safety propaganda aiming at reassuring consumer's confidence on food safety.

Liang Meiyu et al [18] introduced the novel method that focus on detecting the semantic topic models from the food hazard events to improve the food safety system. It applies the CHCLDA method to establish the model for the news topics and reports, so as to realize the topic modeling in the semantic feature space. It can resolve the problems of high dimension and sparseness in the feature space and semantic relevance, and improve the time efficiency for LDA method to realize the semantic mapping of the feature space. It improves the traditional Single-pass incremental clustering algorithm by optimizing the updating strategy of the topic model. Meanwhile it establishes the topic detector combined with the news topic timing characteristics, and realizes the self-adaptive learning of the topic model so as to track the dynamic changes in topic.

Law Whisker TY et al [19] introduce an Advanced Rapid Alert System (ARAS) to effectively deliver food safety alerts in a timely manner with structured information to identify affected trades related to problematic food lots and prevent them from selling as soon as possible. The ARAS requires information integration from various government departments and public services through Web services and Service Oriented Architecture (SOA), such as maintaining the databases of food lot, laboratory test results, and food trades' information. The ARAS also interacts with the call center through alert mechanisms to integrate incident reporting processes.

Han Pengcheng et al [20] designed and implemented a cross-media information retrieval system based on the area of food safety emergencies. The system collects Internet information using topic crawler, establishes data index on cross-media information and makes fast retrieval by sort labeling. The system supports image semantic retrieval and expansion retrieval based on Ontology. The cross-media retrieval provides a new technology for the research of emergencies field, and meets unique retrieval needs by the largest extend.

Li Hui et al [21] constructed the system of total merit index of food safety warning and the technique of quantitatively calculating different levels is given. Consequently, it contributes to scientific grounds for an objective, comprehensive and deep analysis in online information of food safety sector. This work analyzes the real-time and transmissible characteristics of online information, based on the fast acquisition, content analysis, information tracing, model building and judgment of public sentiment of online information, establishing a food safety warning system upon Internet public opinion monitoring and tracing. Firstly, by building the core framework of the food safety sector, concepts in ontology are clarified in their literal relationships and logics. Secondly, by designing a self-adjusting technique for discriminating and collecting online popular discussion in food safety area, with the classification of information documentation vectors and realization of clustering algorithm, the monitoring and tracing of public opinions in known and underlying stages are effectively discovered. Lastly, total merit index system of food safety warning is built to provide scientific grounds to more objectively, totally and thoroughly analyze online public opinions in food safety sector.

Jihong Zhang [22] proposed a framework of food safety alert system and also put forward a new model for food safety management in China based on statistical analysis of food quality information on the Internet. Food safety involves a variety of processes, including food production, processing, storage and consumption, etc. And food safety faces biological, chemical and physical risks in each of these processes. There are two main factors affecting the effectiveness of the alert system. One factor is classification of food safety information and risk assessment, and the other is the consumer.

Li Fang et al [23] analyze event detection in the perspective of multiple data sources, combining news reports and micro blogs. Detect events from news, combining micro blogs to do event monitoring and early warning. Also improve feature selection methods for multiple data sources event detection. Finally, the methods are applied to the detection of food safety events and the results of the research show that event detection with multiple data sources is meaningful and valuable.

Jang Kyoungrok et al [24] introduce the preliminary work to build such system. The final system aims to detect and extract food hazard event from the live data shared on the Web. It defined information template for food hazard event. Then it used the template to extract informative keywords from the website of Ministry of Food and Drug Safety, the governmental organization responsible for ensuring food safety in Korea.

III. COMPARISON ANALYSIS

S. No	Reference	Method	Merits	Demerits	Results
1	Letia Ioan Alfred et al [13], 2010	Agent-based solution	Consumers can select the product on their own with the help of information about the hazards of existing products. Greater prevention from food hazards by representing and defining product description semantically	Construction of two ontologies in terms of company reviews and the HACCP system would be most complex process	Temperature of food products affects the quality cost model
2	Ming Yi [14], 2010	Analysis of food safety strengthening	HACCP principles can more effectively strengthen the food circulation safety. Food safety measures are handled well	HACCP cannot control all activities of food safety requirements analysis which should be separated each other. Hazards are not focused particularly	guarantees the food fresh and safe in every procedure through their own smooth logistics system and tons of cold storage, while also ensuring the safety of food in the circulation field
3	Hu Boran [15], 2010	Combined framework of HACCP and Petrinet	Petri net can offer the complementary framework to analyze the dynamical properties of concurrent systems from either a qualitative or a quantitative point of view. The experimental results show that the method is effective application in food safety analysis	It can analyze only the food hazard measures. Varying relationship present among the different food hazards cannot be focused separately. Food safety warning is not focused	In different critical points, it shows the better performance result
4	Zhou Qiang et al [16], 2011	Pre-warning system construction	Pre-warning system helps to warn the peoples priorly so that food hazard	It doesn't focus on how to enhance the status and	A good atmosphere of attaching importance to food

			problems can be avoided considerably	function of the crisis pre-warning system in food security crisis management system	safety has been gradually formed across the country and has yielded good results
5	Hu Weizhong & Jin Han [17] , 2011	Analysis of factors affecting safety communication	Enhanced warning system by preventing the causes made by different safety parameters Guaranteed food safety measures	Different interaction relation present between various food hazards is not focused particularly Semantic meaning of food hazards would cause the food safety system	Food safety propaganda aiming at reassuring consumer's confidence on food safety
6	Liang Meiyu et al [18], 2011	CHCLDA method	Effectively explores the semantic model of the varying food hazard topics Detection of food hazards parameters that are closely related to the concepts would be made easier	More varying dynamic changes cannot be predicted accurately	Experimental results indicate that this method of topic detection has a better performance; it can further improve the effect of topic detection
7	Law Whisker TY et al [19], 2012	Advanced Rapid Alert System	It will give warning to the people on time Prevention is achieved effectively by blocking selling of food products with hazards before selling Make ease of warning system by integrating with the smart phone technology	It requires lots of information to process and find the food hazard causes	ARAS shall deliver timely alerts, the reliability of the system is highly concerned
8	Han Pengcheng et al [20], 2012	Cross-media information retrieval system	It is used to predict the places which requires emergency treatments in terms of food safety The food safety emergency places are found by analyzing the data's that are gathered from the multiple social media	Irrelevant information present in the data gathered from the online system would lead to system failure Degradation in performance of the food safety requirement analysis	proposed algorithm can better make use of correlation between multimedia data
9	Li Hui et al [21], 2013	System of total merit index of	Efficient tracking system in terms of finding food hazard information	Internet public opinions would consists of more	Food safety warning system is preliminary

		food safety warning	effectively Accurate finding of food hazard information	noises which might leads to performance degradation	validated to be logical and feasible
10	Jihong Zhang [22], 2014	Framework of food safety alert system	Effectively address food safety issues in China, given the rapid development of the Internet and diverse, complex and dynamic features of enterprises, consumers' own supervision capability shall be brought into full play in food safety management	food safety alert system based on the feedback of consumers shall be established to effectively avoid the outbreak of wide-range food safety incidents, and thus reduce the food safety risks in China	Chinese consumers' knowledge about food quality can be greatly improved through education and training
11	Li Fang et al [23], 2015	Research of Food Safety Event Detection	Improved feature selection on different food resources about food hazard detection	Future food hazards events cannot be predicted efficiently	Results of the research show that event detection with multiple data sources is meaningful and valuable
12	Jang Kyoungrok et al [24], 2016	Food Hazard Event Extraction Model	Accurate detection of food hazard events in terms of using different classification approaches Analysis on live data would lead to system failure	More relative documents with relative words cannot given with more priority	Extracting food hazard event information in structured, computer-processable format will greatly reduce the efforts required for monitoring food hazard issues, and enable the public to be well informed of the issues

IV. CONCLUSION

Food safety is a scientific discipline describing handling, preparation, and storage of food in ways that prevent food borne illness. This includes a number of routines that should be followed to avoid potentially severe health hazards. This research work analyses the various food hazard events prediction and risk factor analysis methodologies by different authors has been discussed. Those research methodologies are discussed along with their benefits and drawbacks in the detailed manner to find the effectiveness of every algorithm. The research works has been compared with each other based on their resultant metrics to find the better approach to precede the further research scenario in future.

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