Journal of Information Systems Engineering and Management
2025, 10(46s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Strategic Insights into Foodborne Disease Prevention in Saudi Arabia: Public Awareness, Practices, and Policy Evaluation

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ARTICLE INFO

Received: 28 Dec 2024

Revised: 18 Feb 2025

Accepted: 26 Feb 2025

ABSTRACT

Introduction: Foodborne diseases stay a major public health concern in Saudi Arabia due to gaps in awareness, hygiene practices, and enforcement of safety regulations. Despite ongoing efforts, these challenges continue to impact food safety outcomes.

Objectives: The study aims to assess public knowledge, behavior, and perception of current food safety policies using a national survey.

Methods: A structured survey was conducted with 87 participants from various regions and professional backgrounds across the country. To support analysis and recommendations, strategic tools such as SWOT analysis, PESTLE, and the Balanced Scorecard (BSC) were applied to examine internal and external factors influencing food safety.

Results: Findings showed that 49.4% of participants lacked essential knowledge about foodborne diseases, while 52.9% were uncertain about the effectiveness of current food safety regulations. Around 93% of participants supported stricter penalties for violators while nearly 89% were in favor of using digital monitoring systems. About 67% also backed the idea of mandatory hygiene training for food workers which shows strong public support for improving food safety.

Conclusions: The results point to a clear need for focused public education efforts, better hygiene training for food workers and stronger enforcement of food safety regulations. These findings can support the development of more effective national strategies and help improve public health in Saudi Arabia.

Keywords: Food safety. Foodborne diseases. Public awareness. Hygiene practices. Policy perception. Digital monitoring. Public health. SWOT analysis. PESTLE analysis. Balanced Scorecard (BSC).

INTRODUCTION

Food safety is considered a major public health concern, especially in parts of the world where infrastructure is still developing and foodborne illnesses are common [1]. In Saudi Arabia, changes in how food is produced and distributed have made it important to adopt safety practices that work within the local context while also meeting international standards [2]. Although government programs are in place, challenges such as poor hygiene oversight, low public engagement, and uncoordinated regulations continue to slow progress [3]. To explore this issue, the study used a national survey to assess how people understand and practice food safety, as well as how they view the current regulations. The findings helped identify areas of weakness and risks that still need attention. To analyze the findings within a broader context, the study used strategic tools like SWOT, PESTLE, and BSC to understand how both internal and external elements influence food safety policies in Saudi Arabia [4][5]. This paper is structured as follows: Section 1 presents the introduction, including the research problem and objectives. Section 2 provides a

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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review of the relevant literature. Section 3 outlines the research methodology. Section 4 presents the results. Section 5 delivers the analysis and discussion. Finally, Section 6 offers the conclusion and recommendations.

a) Research problem

Despite ongoing government efforts to regulate food safety in Saudi Arabia, there remains a significant gap in public engagement and confidence. Many citizens are unaware of key foodborne disease risks, and a considerable percentage question the effectiveness of current regulatory mechanisms. These issues pose a risk to public health and underline the need for comprehensive and data-driven preventive strategies.

b) Objectives

The research has four main objectives:

1) To find out how much people in Saudi Arabia know about foodborne diseases and how they deal with hygiene in their daily lives.
2) To understand what the public thinks about the current food safety laws, and whether they believe these laws are really working or not.
3) To use tools like PESTLE and the Balanced Scorecard (BSC) to clearly understand what's working and what's not in food safety, and suggest realistic improvements based on the current situation.
4) To help design a digital system that monitors food safety in a way that fits with Saudi Arabia's society, politics, and economy.

LITERATURE REVIEW

1) Preventive Policies and Strategic Frameworks

The paper [1] outlines a comprehensive strategic plan to improve food safety, protect public health, and enhance operational efficiency, the plan is structured around three key goals, first is preventing foodborne illness and protecting public health, which includes efforts by ensuring compliance with food safety regulations, reducing pathogens, and enhancing consumer awareness, the second goal is transforming inspection strategies, policies, and scientific approaches, emphasizing the adoption of innovative technologies, data-driven decision-making, and enhanced laboratory capabilities, and the third goal which achieving operational excellence, focusing on workforce development, diversity, process efficiency, and technological advancements in service delivery, the plan is driven by core values of accountability, collaboration, empowerment, and solutions-oriented approaches, aligning with The Food Safety and Inspection Service (FSIS)'s mission to protect public health and ensure food safety.

Explored [2] the challenges and control measures of foodborne and waterborne diseases in India, and the public health burden posed by these diseases, especially in developing regions where infrastructure for disease surveillance is inadequate, this initiative is a part of a broader effort to support the "Global Strategy for Food Safety from 2022 to 2030", which examines the current situation of foodborne and waterborne diseases in India, highlighting the risk factors, control measures, and gaps in the public health system, utilizes a SWOT analysis to assess national initiatives and compares them with global programs, and findings indicate that despite various government initiatives like the Integrated Disease Surveillance Programme (IDSP) and Food Safety and Standards Authority of India (FSSAI), outbreaks of diseases like diarrhea continue due to the lack of a systematic national surveillance system, and improved surveillance and adherence to hygiene standards are critical for reducing foodborne illnesses.

Identified [6] food safety issues in§ Nepal, emphasizing common foodborne and waterborne diseases, regulatory frameworks, and existing challenges, highlights that foodborne illnesses, including cholera, typhoid, hepatitis, and infections from heavy metals and pesticides, remain a major public health concern, recognized key challenges such as inadequate regulatory frameworks, weak enforcement, limited surveillance, and poor infrastructure in rural areas, as well as informal food sectors and cross-border trade, complicate food safety enforcement, the authors advocate for a multisectoral One Health approach to improving food safety in Nepal by implementing food safety policies, strict monitoring and surveillance systems. The paper [7] discusses the importance of food safety which is important for ensuring that the food is safe and healthy it focus that unsafe food can lead to diseases and deaths most in developing countries like India where lack of knowledge and poor hygiene contribute to the problem the authors discuss that to

improve food safety a collaborative approach involving consumers health experts and policymakers is necessary to create effective strategies and policies.

The World Health Organization (WHO) has recently published a book that explains the global strategic goals for food safety from 2022 to 2030. This framework is built based on advice from scientific experts, Member States, and international partners that have been used to develop the recommendations contained in the book. Although no dataset appears in the document, global food safety strategies are also covered. The WHO developed a strategy that relies on five priority areas of action which are food control systems, responding to emerging risks, supporting scientific decision-making, enhancing stakeholder engagement, and improving food safety in trade. The strategy developed is holistic, focusing on many of the new challenges around food safety and novel technologies, and establishing a common collaboration effort is one of its essential elements. One of its core elements is international collaboration. However, it is difficult to implement the strategy, particularly in countries with limited capacities. In the book, the WHO offers a strategic plan based on the five critical priority areas identified above. In particular, the book advocates for an approach — a proactive and integrated one— that is innovative and makes better use of new technologies, as well as one that promotes international cooperation to address common challenges related to food safety [8].

The paper focused on the United States and Germany's foodborne disease policy. Although the research does not have any dataset, but it reviews political responses and measures taken in the US and Germany to manage foodborne disease outbreaks, such as the E.coli outbreak in the United States in 2006 and in Germany in 2011 in its methodology. As a strength of this paper, a comprehensive analysis of policy responses in two countries with well-documented outbreaks is defined . However, weaknesses stem from its focus on historical outbreaks without covering recent technological advancements in monitoring or detection. The value of public health responses to disease outbreaks is highlighted, and foodborne outbreaks are tackled through international cooperation between countries and quick response systems, mentioned in the paper as big need the paper brings attention to. In the end, three main areas for the strategic plan were identified in the paper : (improving food safety through better coordination of health policies, developing quick response mechanisms, and strengthening international collaboration during outbreaks) to ensure public health protection [9].

The study, published in 2024 in the Emilia-Romagna region of Northern Italy, aimed to manage and prevent foodborne diseases. The study examined outbreaks of foodborne diseases by using new practices established to counter them. The Whole Genome Sequencing (WGS) tool is an innovative technological tool that helps the region to control and prevent foodborne diseases. One health approach is a result of this method, and it effectively manages diseases. However, the study regards Emilia-Romagna only, and its results may not be easily transposable to regions with different healthcare systems. To ensure food security, many points were highlighted in the paper, including the importance of integrating public health services and information systems into food safety programs and adjusting public health response strategies. For allocating information on any material useful to the MTA group, a shared computerized folder and new management procedures are being implemented, available only to MTA (Malattie Trasmesse da Alimenti) members.

Information sharing at all stages of managing the infectious episode, integrating the three services through creating the MTA group, updated criteria for procedure activation, and a dedicated training program are the main advantages of the updated procedure. To conclude, timely investigation, control, and management of MTA outbreaks are primary for both economic and health reasons. The new features and procedures may allow for the rapid identification of the causes of a case or outbreak, and better counteract their spread implemented in this Italian community [10]. The paper was recently published in 2023 and aims to focus on new strategies for controlling foodborne diseases in the red meat industry from a global perspective. Reviewing foodborne disease outbreaks, analyzing existing control strategies, and proposing new methods to address challenges in the meat industry were the paper's objectives to provide global foodborne disease outbreaks in the meat industry. A total of 1,729 outbreaks were identified globally, leading to 41,438 illnesses, 10,691 hospitalizations, and 10,063 deaths.

Among the pathogens identified, Salmonella was responsible for 469 outbreaks, E. coli for 414, and Clostridium for 294; 62.35% of outbreaks were linked to beef, and 32.1% to pork. The importance and the need for strong food safety management interventions are highlighted in the study, such as improved monitoring systems, greater food safety

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e-ISSN: 2468-4376
https://www.jisem-journal.com/

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awareness and practices, and more regulatory action in the meat industry along with the comprehensive review of current strategies, global perspective, and proposed new control measures is a strength in the study. Regardless of the strengths, it does not implement or test the proposed strategies, limiting its practical application. In the end, the paper recommended a strategic plan to develop risk-based control strategies in the meat industry through two proposals: first, enhancing communication between stakeholders along the food supply chain; second, ultimately, better controlling risks posed by foodborne diseases [11].

2) Climate Change and Environmental Contamination

Reviewed [4] how climate change affects food safety by increasing the spread of food-borne pathogens and highlights potential mitigation strategies, and how rising temperatures, altered precipitation patterns, and extreme weather events contribute to the proliferation of food-borne diseases, pathogens thrive in warmer environments, increasing the risk of food contamination, the floods and droughts affect food production systems, further exacerbating the problem by contaminating water supplies and agricultural products, used comprehensive literature review that compiles findings from previous research on the correlation between climate change and food-borne pathogens and also proposes strategies to improve food safety regulations, implement climate-smart agricultural practices, enhance surveillance systems, and public health interventions.

Discussed [5] the role of anticipatory actions in mitigating the effects of climate-sensitive infectious diseases in Latin America and the Caribbean, highlights the impact of climate hazards such as extreme temperatures, floods, droughts, and storms on the spread of infectious diseases, how these environmental changes influence disease transmission pathways, including vector-borne diseases like malaria, dengue, and leishmaniasis, as well as waterborne diseases like cholera, identifies vulnerable populations, at-risk regions, and existing early warning systems (EWS) while proposing improvements to epidemic preparedness activities, recommends the report developing anticipatory action plans to prevent disease outbreaks.

Examined [12] the challenges posed by climate change on food safety explores policy-driven solutions to mitigate these risks, and highlighted the impacts of climate variability, including temperature fluctuations, extreme weather events, and altered precipitation patterns, on agricultural production and food safety, discussed how climate-induced changes increase the prevalence of foodborne pathogens which threatening food security and public health, to address these issues, the study advocates for a policy framework integrating climate-smart agricultural practices, improved food safety regulations, and robust surveillance mechanisms.

Emphasized [13] the importance of addressing contamination risks at the preharvest stage, as postharvest decontamination alone is insufficient to ensure food safety, identified that soil and irrigation water as major sources of contamination, highlighting pathogens such as Escherichia coli, Salmonella, and Listeria monocytogenes and also discusses the challenges posed by environmental factors, poor agricultural practices, and deficiencies in food safety regulations, proposed strategies include enhancing early detection of pathogens, implementing Good Agricultural Practices (GAP), and enforcing food safety measures such as HACCP and the Food Safety Modernization Act (FSMA).

The paper [14] discusses how climate change affect food safety and the environment it focus on the need for strategies that can reduce food safety risks the authors suggest using specific tools to assess and manage these risks like risk assessment RA for evaluating dangers from chemicals or microbes in food and life cycle assessment LCA looks at the overall impact of food systems. By integrating these tools, we can create safer and more friendly food systems that are sustainable for the planet. The paper [15] focuses on environmental microbiology, which studies tiny organisms that can cause diseases and affect public health. The writers discuss methods to reduce germs in water and air the strategies include using different water treatment technologies, like filtration to remove harmful microorganisms from water. This strategy aims to protect public health by ensuring access to safe drinking water and reducing the spread of diseases caused by dirty water. The goal is to prevent diseases caused by these pathogens, like cholera and COVID-19, by using new technologies and monitoring systems.

The paper [16] discusses the risks of foodborne diseases in drinks consumed in Nigeria from 2000 to 2020 the researchers reviewed many articles and found that drinks like sachet water and raw milk it contaminated with harmful bacteria that can cause disease this study focus to the important of understanding these risks to help to

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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improve public health and safety in Nigeria. Paper [17] discusses a study on bacterial contamination in water in Thailand, which is a main cause of health problems. The researchers found that environmental factors, such as the type of water and rainfall, affect the amount of bacteria in the water. They discovered that Chumphon province had higher contamination levels and that heavy rain made the water quality worse, leading to increased risks of waterborne diseases.

The paper was published in 2024 in Bangladesh; it discusses the microbial quality assessment of drinking water in restaurants located in Dumki and Patuakhali Sadar Upazilla, Patuakhali district, as well as unsanitary practices in restaurants. Twenty water samples from the chosen restaurants are considered the study dataset. The methodology followed involved collecting samples and analyzing them for microbial contamination as well and biochemical tests were also performed to identify the bacterial species in the samples. As a result, all collected samples were contaminated; with bacteria, with 26 bacterial species identified. The comprehensive review of microbial contamination in drinking water is the main strength of the study is that it provides. However, its weaknesses are the issues surrounding dirty restaurants that result in much contamination. Improving water quality management in restaurants through better sanitation practices and effective treatment methods are some of the study recommendations that may be considered in future applications [18].

3) Surveillance Systems and Early Detection Mechanisms

Aims [3] to analyze the implementation of early detection programs for non-communicable diseases at the elderly Posyandu (integrated health post) at the Beras Basah Health Center in Langkat District, North Sumatra, used a qualitative descriptive approach with data collection through observations, in-depth interviews, and documentation, used SWOT analysis framework to identify strengths, weaknesses, opportunities, and threats associated with the program, found that early detection efforts were inconsistent and faced multiple challenges, such as limited medical equipment, lack of participation from the local government, and inadequate awareness among families and the elderly as well as the knowledge of Posyandu cadres was insufficient, hindering the program's overall effectiveness, the researchers suggested advocacy efforts and training for cadres as potential strategies to enhance early detection activities and increased awareness among elderly individuals and their families.

This paper [19] discusses the problem of foodborne zoonoses which is diseases that spread from animals to humans through food. Through resilient surveillance and strategies to prevent harmful germs in food at all stages, from before harvesting (like using probiotics and vaccines) to after harvesting (like advanced food processing and cleaning). The authors suggest various strategies to quickly identify where contamination comes from and how infections spread including advanced food processing techniques like high-pressure processing and ultraviolet light treatment and careful monitoring at different stages of food production to reduce the risk of contamination and ensure food safety for everyone from farmers to consumers can help to ensure food safety.

The paper [20] discusses how emerging infectious diseases EIDs it become threat to global food security and public health. Foodborne diseases are dangerous microorganisms like bacteria and viruses that can contaminate food and cause disease in humans. An example is the SARS-CoV-2 virus, which is known to cause COVID-19 and can spread through food from infected animals to humans. The authors propose approach called the DAMA protocol which focuses on documenting, assessing, monitoring and act to predict and mitigate the impacts of these diseases before they spread. This paper [21] discusses about a study on food borne pathogens like Salmonella and E.coli that induce serious disease the paper discusses the challenges the pathogens effect to public health and the strategies needed to maintain food safety like implementing good farm practices, maintaining strict cleaning, using a good food handling techniques and training food industry workers by following these strategies food industry can reduce the risks associated with bad pathogens and ensure the safety of the food we eat it also focus on the importance of understanding how pathogens appear and need for improved methods to detect and control them in the food supply.

The paper was published in 2023 by Elsevier Ltd and aimed to design a risk-based monitoring plan for pathogens in food while focusing on designing and recommending a risk-based monitoring plan for detecting foodborne pathogens. The dataset utilized to develop risk-based monitoring plans includes historical data on foodborne pathogens. However, the methodology for designing a risk-based monitoring plan for pathogens in food consists of three key steps: 1- risk ranking, which includes the probability of contamination and the consequences to human

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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health; 2- selection of Food Business Operators (FBOs), which are selected based on historical contamination data and socio-economic factors; 3- sampling strategy which involves determining sample size, choosing appropriate sampling points and frequencies, and ensuring representation of sample components.

Moreover, the study is also comprehensive and includes three dimensions of risk-based monitoring of foodborne pathogens: (historical data, socio-economic factors, and sampling strategies). However, One main weakness is the dependence on the availability of data and resources, which makes it difficult to implement, especially in countries with limited resources. The study identified four key domains necessary for a risk-based monitoring approach to reach optimal contamination detection (risk-based monitoring, pathogen-product combinations, socioeconomic influences on FBOs, and sampling strategies). The paper identified three main areas for its strategic plan: (ranking pathogen product combinations by risk, choosing FBOs for inspection, and developing cost-effective sampling plans to identify pathogen presence). The 3 points answered the following questions: 1- what should be monitored, 2- who should be monitored, and 3- how should be monitored [22].

The study, published in 2023 in Guangzhou, China, aimed to compare the cost-effectiveness of risk-based detection strategies versus traditional culture-based methods for detecting Salmonella in raw aquatic products. This research dataset contains a total of 360 samples used in the study, which were collected from 2018 to 2020 by the Guangzhou Center for Disease Control and Prevention. Moreover, to simulate different scenarios based on the sampling inspection plan, a stochastic scenario tree model was used, and depending on the categorized risk levels of the products, various detection methods (culture or PCR) were applied. The comprehensive use of a scenario tree model for simulating different detection approaches and analyzing cost-effectiveness is the study's strength. Despite the strengths, the study suffers from its reliance on data collected from one city (Guangzhou), which may limit the application of the results to other regions with different healthcare systems. Additionally, the sensitivity and specificity of the methods were not always optimal across all samples.

The findings indicated that detecting Salmonella in aquatic products using a risk-based detection strategy using PCR was more effective compared to traditional culture-based methods. It was found that PCR detected more contamination, but this came at a higher cost as well as this method was also more efficient in terms of reducing testing personnel time. PCR-only detection showed better detection rates but higher operational costs than traditional culture methods. In the end, the authors agreed that enhancing cost-effectiveness, improving food safety, and reducing the economic burden of foodborne diseases can be done by implementing risk-based detection strategies. Improving monitoring systems, using more sensitive detection tools like PCR, and adjusting public health strategies for better food safety management were explained as a proposed strategic plan in the paper to be taken into account [23].

4) Public Health Burden and Zoonotic Diseases

Evaluated [24] existing strategies to mitigate food safety risks, which microbial, chemical, and physical contamination sources in animal-derived foods, highlight that foodborne illnesses result in substantial health and economic burdens, particularly in LMICs, where regulatory enforcement and food safety awareness are often inadequate the Nigeria, as Africa's most populous nation, records a high prevalence of foodborne illnesses, leading to over 200,000 deaths annually, which underscores the importance of adopting comprehensive food safety measures, including the implementation of Hazard Analysis and Critical Control Points (HACCP), improved regulatory enforcement, and enhanced public awareness campaigns. Investigated [25] modern detection methods and control strategies to mitigate foodborne bacteria contamination in fresh produce, highlights the increasing risk of contamination in raw and ready-to-eat fruits and vegetables due to improper handling, environmental exposure, and global trade expansion, and reviews control strategies, including cold plasma treatment, ultraviolet irradiation, and the application of edible coatings to reduce bacterial contamination and improve food safety, emphasize the need for integrating rapid detection techniques with preventative measures to ensure the microbiological safety of fresh produce.

Paper [26] discusses salmonella bacteria in food and in water and human samples to see how resistant bacteria antibiotics. the writers collected 501 samples and found that 7% contained Salmonella strains showed resistance to important antibiotics which could make it harder to treat infections in people like children and pregnant women also

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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paper find antibiotic resistant salmonella in food products like cattle meat and fast foods the study also confirm the need for more research to understand the genetic factors behind this antibiotic resistance.

The paper [27] discusses a decrease infections caused by germs that are commonly spread through food during the COVID-19 pandemic founded on data collected from 10 sites in the U.S between 2017 and 2020 this decrease in foodborne diseases is belief to the changes in people behavior during the pandemic like increased hand washing and fewer people dining out the paper also confirm the importance of ongoing monitoring and safe food handling practices to continue reducing these infections. The research was carried out in Jeddah, Saudi Arabia, in 2023, on fresh vegetable contamination with parasites. The data set was 250 samples collected from different markets in Jeddah from September 2020 to July 2021. The samples included a variety of leafy green vegetables (green onion, watercress, lettuce, parsley, leek, and coriander).

The study is cross-sectional, and the methodology followed was that samples were washed and examined under a microscope for parasitic contamination; Chromatographic immunoassay tests were also used for confirmation. The importance of good food sanitation practices was addressed in the study to reduce and minimize the risk of parasitic infections from leafy green vegetables. The paper also utilized a variety of leafy green vegetables in the study, along with many techniques used for parasite detection. Despite the importance of the study, some limitations were addressed, such as no samples collected in spring and the need for molecular parasite detection. The research found that 35.2% of vegetable samples were contaminated with parasites, and coriander was the most contaminated (64.2%), as Summer had the highest number of parasites among the year's seasons. Lastly, the study does not contain any strategic plan [28].

The research was conducted in Saudi Arabia in 2022, and it focuses on analyzing 11,148 confirmed cases of foodborne hepatitis A reported from 2005 to 2015 in Saudi Arabia. A cross-sectional methodology relied on retrospective chart reviews of these confirmed cases. Data specific to KSA, 2022 investigated 11,148 cases of foodborne hepatitis A continuing in Saudi Arabia between 2005 and 2015. This was a cross-sectional study using retrospective chart reviews of confirmed cases. The strength of the study is that it gathered information across eleven years. After collecting the data, careful study was also necessary to explore trends and analyze the regional distribution of the disease. However, there were some problems, like missing data, uneven age groups, and insufficient information about the types of bacteria, how long people were exposed, where the food and water came from, and how many people died. Children aged 5 to 14 years had the highest prevalence of hepatitis A in the Riyadh area, and the disease occurred most frequently in 2006. The incidence was also higher in males and Saudi nationals. In the end, there is no specific strategic plan in the study, but it is recommended to improve reporting systems and food safety education [29].

The paper was recently published in 2023 and aims to focus on new strategies for controlling foodborne diseases in the red meat industry from a global perspective. Reviewing foodborne disease outbreaks, analyzing existing control strategies, and proposing new methods to address challenges in the meat industry were the paper's objectives to provide global foodborne disease outbreaks in the meat industry. A total of 1,729 outbreaks were identified globally, leading to 41,438 illnesses, 10,691 hospitalizations, and 10,063 deaths. Among the pathogens identified, Salmonella was responsible for 469 outbreaks, E. coli for 414, and Clostridium for 294; 62.35% of outbreaks were linked to beef, and 32.1% to pork. The importance and the need for strong food safety management interventions are highlighted in the study, such as improved monitoring systems, greater food safety awareness and practices, and more regulatory action in the meat industry along with the comprehensive review of current strategies, global perspective, and proposed new control measures is a strength in the study. Regardless of the strengths, it does not implement or test the proposed strategies, limiting its practical application. In the end, the paper recommended a strategic plan to develop risk-based control strategies in the meat industry through two proposals: first, enhancing communication between stakeholders along the food supply chain; second, ultimately, better controlling risks posed by foodborne diseases [11].

The study was published in Denmark in 2024 and it is objective to estimate the national burden of foodborne diseases (FBD) caused by both pathogens and chemicals. The dataset used is national data for the reference year 2019 to evaluate the incidence, mortality, and severity of health outcomes related to FBD. Several data sources are used in the study methodology used, including national statistics, in order to estimate the burden of foodborne diseases from both microbiological and chemical hazards. The comprehensive national approach along with its valuable insights

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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into the impact of FBD are considered to be one of the study's strengths. However, the main limitation of the study is that the study results may not be generalizable to other countries with differing food safety systems or epidemiological profiles due to the study location being limited to Denmark. Additionally, another limitation of the study is that while the study suggests diversifying food safety strategies, it does not provide the road map for the application of these strategies. As a result of this paper, both microbiological pathogens and chemical hazards were significant contributors to foodborne diseases in Denmark. In terms of numbers, The results revealed that in 2019, there were 41,438 reported cases of foodborne diseases, 10,691 hospitalizations, and 10,063 deaths attributed to these diseases in Denmark. The proposed strategic plan in the paper considers a single area related to diversifying food safety strategies to tackle both types of risks [30].

TABLE I. SUMMARY LITERATURE REVIEW

Group	Paper	Finding
Agricultural Practices and Contamination	[19]	Foodborne zoonoses cause 60% of communicable diseases. Pre-harvest interventions such as probiotics, vaccines, and monitoring systems reduce transmission risk across the food chain.
Climate and Environmental Risk	[12], [14], [20], [4]	EIDs affecting crops, livestock, seafood, and supply chains are intensified by climate change. Climate-smart practices and surveillance are proposed as adaptation strategies.
General Strategies	[10], [13], [16], [18], [24], [26], [27], [28], [29], [30]	Studies emphasize early action plans, multisource data integration, and cross-national coordination to manage outbreaks. Some studies provide region-specific insights, including data on coliform prevalence.
Pathogen Monitoring and Trends	[11], [15], [17], [1]	Global data show 1,729 foodborne outbreaks, mainly linked to Salmonella and E. coli. Beef and pork are the leading sources. The literature calls for better inspection, regulation, and awareness to reduce risks.
Regulatory Strategies	[6]	Highlights the role of regulations, monitoring systems, and public education in reducing foodborne disease outbreaks.

METHODOLOGY

A. Research design and methodology

A mixed-methods approach was followed to identify strategic directions for the enhancement of foodborne disease prevention in the Kingdom of Saudi Arabia. The research methodology starts with exploring the literature to gain a conceptual foundation and inform the making of a structured survey. The survey was distributed among relevant stakeholders in public health, food inspection, and the social community connections. External and internal challenges facing food safety were identified using the data collected from the survey in conducting a PESTE and SWOT analysis. Further, BSC has been implemented in accordance with the official Ministry of Health Branches and Offices Operational Manual that describes the strategic objectives KPIs from four perspectives: Stakeholder, Internal Process, Organizational Capacity, and Financial. The complete methodological process is illustrated in Figure 1, which maps the step-by-step integration of qualitative and quantitative components.

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2025, 10(44s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

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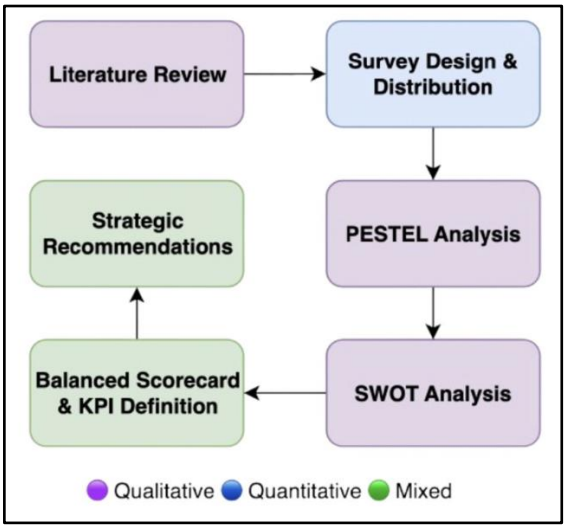
FIGURE 1: RESEARCH DESIGN AND METHODOLOGY



B. Data collection method (survey)

People from different backgrounds were asked to fill out a short online survey made with Google Forms, aiming to get a clearer picture of how people think about foodborne illnesses and their opinions regarding government policies related to the topic. It was completed by 87 participants. The questions were grouped into five clear sections: demographic information, personal and household practices related to food safety, knowledge and awareness of foodborne diseases, perceptions of government policies, and perceptions of institutional preparedness. Answering the survey was completely optional, and everyone's responses stayed anonymous to keep things private and make people feel safe sharing their thoughts.

RESULTS

A. Survey Results

1) Demographic Data

The Figure(2) demographic analysis reveals that the majority of participants (60.9%) were between the ages of 25 and 34, followed by those aged 18 to 24 (14.9%), and the age 35 to 44 (12.6%), indicating a higher level of engagement from young and middle-aged adults, and female respondents constituted a larger portion (60.9%) compared to males (39.1%), suggesting a greater interest in food safety among women, In terms of professional background, the majority of respondents (66.7%) were from the general public, while healthcare professionals made up (18.4%), the researcher academic has (4.6%), government official (5.7%), and food industry worker (4.6%), offering a balanced perspective between consumer insights and expert opinions, and geographically, the western region had the highest representation (78.2%), whereas participation from other regions was comparatively lower, highlighting the need for broader regional diversity in future research.

2) Awareness and Knowledge of Foodborne Diseases

The Figure(3) show that only 49.4% of participants have knowledge of foodborne diseases while 50.6% are unknown highlight the need for extensive awareness campaigns and when asked about diseases linked to contaminated food 87.4% identified food poisoning (Salmonella and E. coli) while 42.5% associated hepatitis A with contaminated food and only 23% mentioned cholera and typhoid fever 12.6% revealing gaps in knowledge Additionally only 33.3% of participants believe that current government regulations are highly effective while 13.8% think they need improvement reflecting a lack of confidence in enforcement measures.

3) Food Safety Behaviors and Practices

The Figure(4) shows that only 27.6% of participants always check food safety labels before purchasing while 43.7% check sometimes and 21.8% rarely so indicating a significant variation in consumer awareness regarding food

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e-ISSN: 2468-4376
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purchasing sources 85.1% rely on supermarkets 47.1% buy from local markets and 39.1% use online delivery services and 6.9% purchase from street vendors reflecting a preference for regulated retail channels but also a reliance on informal sources In terms of trust in restaurant hygiene standards 49.4% of participants expressed confidence while 42.5% were uncertain and 8% did not trust restaurants at all highlighting the need for greater transparency in food safety compliance.

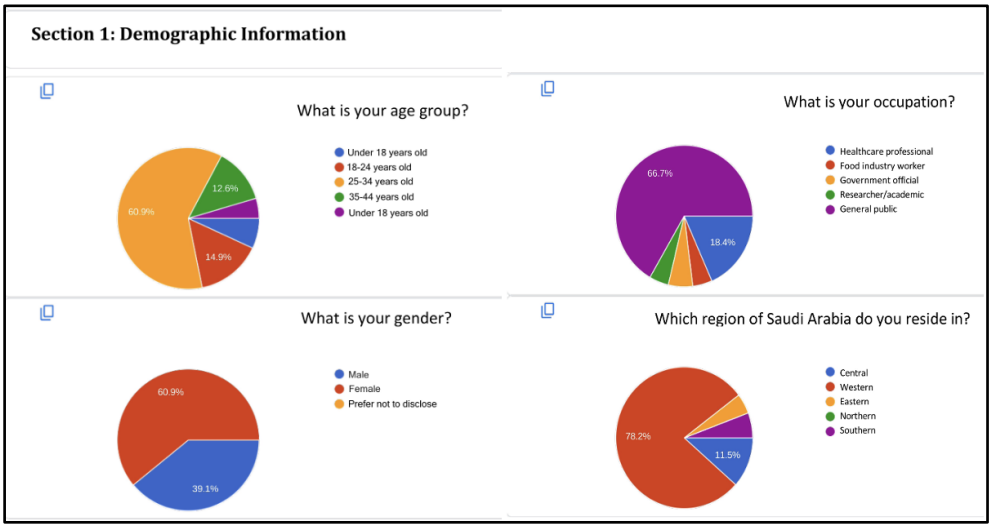
4) Government Strategies and Policy Effectiveness

Figure (5) focuses on government strategies and policy effectiveness, aiming to understand the potential gap between the implementation of food safety policies and the level of compliance with relevant measures, as well as exploring public and consumer acceptance of new standards. According to the survey results, 60.9% of respondents agreed that the government is effective in reducing foodborne diseases through its policies. Of these, 35.6% viewed the policies as very effective, while only 3.5% considered them ineffective. Additionally, 74.7% of participants believed that more frequent health inspections in restaurants and food facilities would be the most impactful initiative. Support was also expressed for mandatory hygiene training for restaurant workers (66.7%), stricter food safety regulations (63.2%), increased public awareness campaigns (59.8%), and the implementation of food tracking and traceability systems (57.5%). Notably, 88.5% favored implementing digital monitoring systems for inspections, while 11.5% were undecided and none opposed. These results highlight strong public support for technology-based solutions and stricter enforcement. Regarding punitive actions, 93.1% of respondents agreed that violators of food safety laws should face stricter penalties, whereas only 2.3% disagreed and 4.6% remained neutral.

5) Future Strategies and Public Perception

The Figure (6) discusses the public readiness to adopt healthy eating behavior and the most significant challenges in combating the foodborne epidemic in Saudi Arabia. Knowledge of these components will guide sound policies and planning to maintain public health and safety. Results show that 97.7% of subjects (a combination of 59.8% very willing and 37.9% somewhat willing) are ready to modify their eating habits at some level, while 2.3% are not willing, and this indicates a strong awareness of the connection between food selection and disease prevention. However, while change readiness did exist, there were still several challenges. The most significant issue is a lack of awareness about food safety practices, 75.9%, followed by poor food storage and transportation, 66.7%, and noncompliance with hygiene standards in restaurants and cafes, 57.5%. Furthermore, weak regulatory oversight was 51.7%, and environmental factors like high temperatures and humidity were 55.2%. Moreover, there are insufficient strict laws and penalties of 40.2%, and the presence of unregulated street vendors of 37.9%, pointing toward the need for better enforcement mechanisms and stricter health rules. An open-ended question was asked to participants regarding any suggestions to improve food safety policies in Saudi Arabia. We got 22 responses, and all answers were about strict supervision and intensified monitoring of food and drink providers.

FIGURE 2: DEMOGRAPHIC DATA



Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
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FIGURE 3: AWARENESS AND KNOWLEDGE OF FOODBORNE DISEASES

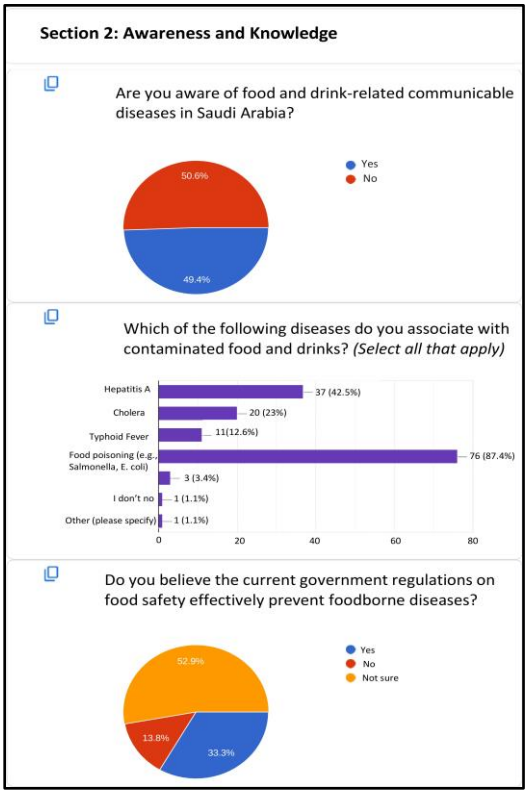
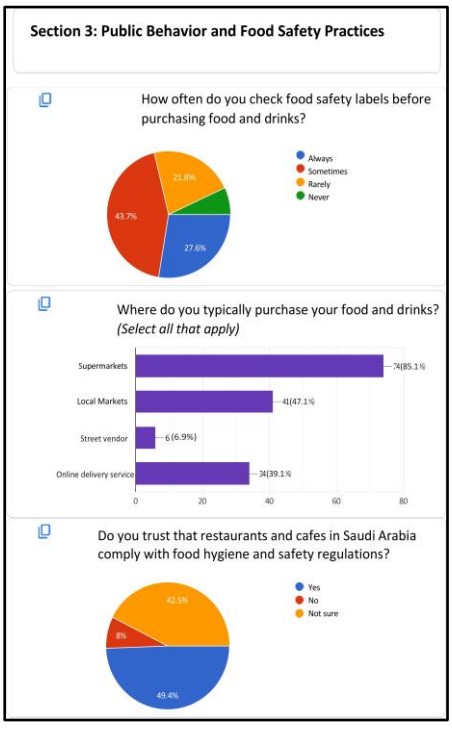


FIGURE 4: FOOD SAFETY BEHAVIORS AND PRACTICES



Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
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FIGURE 5: GOVERNMENT STRATEGIES AND POLICY EFFECTIVENESS

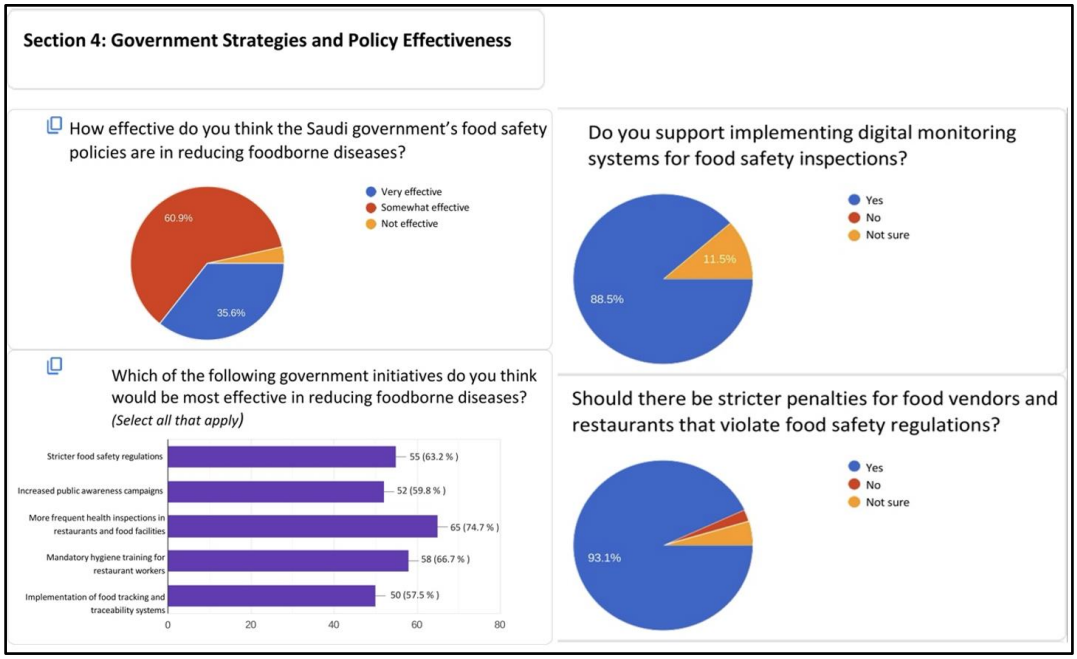
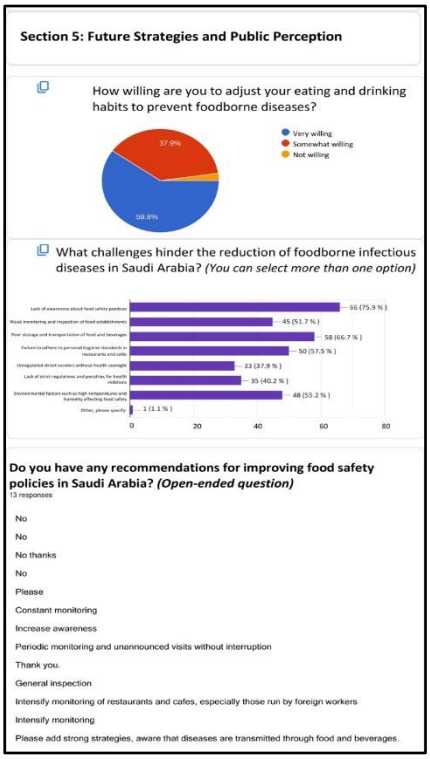


FIGURE 6: FUTURE STRATEGIES AND PUBLIC PERCEPTION



ANALYSIS AND DISCUSSION

1) SWOT Analysis

Table 2 presents a SWOT analysis based on the survey findings, highlighting public perspectives on foodborne disease prevention.

Journal of Information Systems Engineering and Management
2025, 10(44s)
e-ISSN: 2468-4376
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TABLE 2. SWOT ANALYSIS FOR FOOD SAFETY BASED ON PUBLIC AWARENESS SURVEY

Strengths	**Weaknesses**
▪ 59.8% of participants are very willing to adjust their eating habits to prevent foodborne diseases. ▪ 88.5% support implementing digital monitoring systems for food safety inspections. ▪ 93.1% agree there should be stricter punishments for violators of food safety regulations. ▪ High awareness of food poisoning as a common foodborne disease (87.4%). ▪ Most participants (85.1%) purchase food from supermarkets, which are easier to monitor and regulate.	▪ 50.6% of respondents are not aware of food and drink- related communicable diseases. ▪ 52.9% are not sure about whether they believe that the current food safety regulations are effective. ▪ 43.7% sometimes do not check food safety labels before purchasing. ▪ 42.5% not sure about trust in restaurants and cafes that comply with hygiene regulations.
Opportunities	**Threats**
▪ Increase public awareness campaigns as recommended by 59.8% of participants. ▪ Grow digital inspections and use technology to enhance transparency. ▪ Conduct more frequent and unannounced inspections to improve compliance. ▪ Target awareness efforts in regions or demographics with low knowledge. ▪ Encourage mandatory hygiene training for restaurant workers.	▪ Weak monitoring and inspection systems (51.7%) are a major barrier to disease control. ▪ Insufficient training of food workers (57.5%) reduces food safety compliance. ▪ 66.7% report poor storage and transportation of food and drinks. ▪ 40.2% highlight weakness of strict regulations and penalties for health violations.

2) PESTLE Analysis

Based on the survey findings regarding food and drink communicable disease prevention.

Political

- The existing government efforts to regulate food safety but 13.8% of participants believe current rules are not effective.
- Strong public support for strict laws and digital monitoring systems suggests political opportunity for improvement and policy increase.
- Weaknesses remain about the effectiveness of government food safety policies in reducing foodborne diseases (60.9%).

Economic

- Improving food safety via digital monitoring and staff training may require significant investment.
- Preventing foodborne diseases can reduce healthcare costs and economic losses linked to food-related outbreaks.
- Most consumers (85.1%) buy from supermarkets, showing potential for centralized regulation which is more cost-effective.

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e-ISSN: 2468-4376
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Social

- 50.6% are unaware of foodborne diseases, highlighting the need for public education campaigns.
- Public concern about hygiene in restaurants is significant, with only 49.4% trusting them.
- 59.8% support awareness programs, indicating readiness for behavior change.

Technological

- High support (88.5%) for using technology like digital checking systems shows public openness to tech-driven solutions.

Legal

- Current rules are sometimes seen as ineffective by more than half of the respondents.
- Strong demand for stricter punishments (63.2%) suggests need for legal reform and clear enforcement.
- Legal frameworks need updating to manage food risks and increase restaurant accountability.

Environmental

- Food handling and hygiene directly impact environmental health.
- Environmental factors like high temperature and humidity affect food safety and contribute to public health risks (55.2%).
- Encouraging eco-friendly practices in food production and handling may improve overall safety.

3) Balanced scorecard (BSC)

As part of evaluating the Ministry of Health's efforts in combating foodborne diseases and improving public health response, a Balanced Scorecard (BSC) was developed to align relevant performance indicators with the Ministry's strategic goals. The BSC is a strategic management tool that translates an organization's vision into measurable outcomes across four key perspectives: Stakeholder (Public/Beneficiaries), Internal Process, Organizational Capacity, and Financial [31]. In this study, and as shown in Table 3, all indicators were extracted from the official "2024 Ministry of Health Branches and Offices Operational Manual," which outlines operational responsibilities and performance monitoring related to food safety [32]. However, the manual does not explicitly include indicators that fall under the Financial or Organizational Capacity perspectives. Therefore, two supplementary indicators were proposed by the researcher to ensure a comprehensive and balanced representation of all four BSC perspectives in the context of food safety performance evaluation.

TABLE 3. BALANCED SCORECARD (BSC) INDICATORS

Perspective	Strategic Objectives	Indicator Name	Key Activities	Target	Page (Ref. [32])
Stakeholder (Public/Beneficiaries)	Improvement of Service Quality and Operational Efficiency Productivity and Efficiency	Health Awareness	• Measures the extent of the Health Cluster's commitment to public awareness through publishing and on theground engagement, with follow-up from the Ministry branch.	100%	P. 113

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		Percentage of compliance of each Health Cluster with the Ministry-defined Service Level Agreement (SLA) for handling complaints.	• Measures the compliance of Health Clusters with the 72-hour SLA for handling complaints submitted via 937, aiming to improve beneficiary satisfaction and ensure adherence to ticket closure quality standards.	100%	P. 140
		Beneficiary Satisfaction with Health Complaint Handling	• Measures beneficiary satisfaction with 937 complaints to improve service delivery outcomes.	100%	P. 138

TABLE 3 (CONTINUED): BALANCED SCORECARD (BSC) INDICATORS

Perspective	**Strategic Objectives**	**Indicator Name**	**Key Activities**	**Target**	**Page (Ref. [32])**
Internal Process	Enhancing the level of compliance with health standards Strengthening the preparedness of health regions to respond to health related emergencies and disasters	Percentage of Implementation of Awareness and Inspection Campaigns (8 campaigns)	• This indicator measures the completion rate of inspection awareness campaigns across all regions of the Kingdom.	≥ 50% from baseline	P. 133
		Readiness Indicator for Ministry of Health Branches	• This indicator targets health regions and provinces under the Ministry of Health. • It evaluates their readiness through 22 criteria that cover ministry branches, health clusters, and facilities. • Completion is tracked via emergency and disaster management centers. • The 2024 target is for each region to score 44 points by year-end.	100%	P. 117
		Coverage Rate of Health Institutions with SelfInspection and Routine Oversight Tasks	• This indicator measures the extent to which targeted health institutions are covered by self-inspection and routine monitoring activities.	≥ 50% from baseline	P. 131

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Organizational Capacity	Enhance the capabilities of healthcare staff in infection control	Percentage of Staff Trained in Infection Control Skills	• Monitor percentage of staff trained in infection control • Support capacity building within health institutions • Ensure compliance with infection prevention standards	≥ 90%	Not in [32] (proposed)
Financial	Align financial planning with actual execution in foodborne disease prevention	Budget Execution Rate for Food Safety Programs	• Compare actual expenditure with allocated budget Assess efficiency of financial utilization for food safety programs	≥ 90%	Not in [32] (proposed)
Note: Page numbers refer to the official "2024 Ministry of Health Branches and Offices Operational Manual" [32]. Indicators marked as Not in [32] were proposed by the researcher for BSC completeness.					

4) Discussion of strategic implementation

Indicators such as Health Awareness Campaign Completion Rate and Beneficiary Satisfaction with Complaints reflect priorities identified in the survey and supported by [8], who emphasized public education as a foundation for safety. People's trust and involvement can grow even more when there are clear ways for them to give feedback and see real action taken. This approach helps organizations take action more effectively and gain people's trust over time, as mentioned in [31]. [19] explained that raising awareness is one of the most important steps to stop diseases that spread from animals. [1] pointed out that having a direct and open line of communication between people and government agencies makes it easier to act quickly and keep everyone safe when health problems come up. Operational efficiency is supported through metrics like Inspection Campaign Coverage and Readiness Score of Health Regions. These KPIs reflect gaps identified in the field and by [14], who discussed the fragmented and reactive nature of many food safety responses. Within the BSC framework, these indicators help organizations stay on track, monitor compliance, and improve system readiness [31].

[18] mentioned that doing inspections regularly and planning them well, especially when supported by proper documentation and digital tools, can really help reduce health violations. [25] talked about the importance of having a clear and unified response system in healthcare settings because that helps contain outbreaks quickly before they get worse. Building a strong and capable team is essential in making all this work. Workforce development plays a big role because having well-trained staff is key to putting food safety measures into practice. The proposed KPI, Percentage of Staff Trained in Infection Control, aims for 90% coverage. This goal matches what came up in the survey, and [21] also explained that when staff don't get the right training, the chances of contamination go up. The BSC framework helps tie those everyday skills to the bigger strategy, making it easier to actually carry out plans and keep improving over time [31].

[25] pointed out that regular, role-based training is especially important for food handlers working in hospital settings, as it helps ensure that everyone follows proper procedures. [8] added that including food safety education as part of ongoing professional development helps build stronger and more reliable teams in the long run. The proposed KPI, Budget Execution Rate for Food Safety Programs, is set at 90% or higher. It helps make sure that planned resources are actually used to fund things like inspections, training, and smart systems. [22] and broader BSC literature confirms that tracking how budgets are spent is key to making sure food safety strategies are not just planned, but actually carried out effectively [31]. [18] pointed out that using smart tools like AI to detect pathogens

early can lead to strong and meaningful results. [25] suggested that budgets should be tailored to the level of risk, so areas facing bigger food safety challenges get the extra support and resources they need. Putting all of these performance indicators together under the BSC framework doesn't just help keep everything aligned with bigger institutional goals. It also reinforces responsibility and improves how resources are used [31], making the entire food safety system more stable and sustainable in the long term.

CONCLUSION AND RECOMMENDATION

The study highlights that many people in Saudi Arabia are willing to improve their eating habits and support food safety measures. There is still a significant lack of knowledge about foodborne diseases and doubts about the effectiveness of current government regulations. Many participants were unaware of food-related health risks and did not consistently follow safe food practices like checking labels. However, there is strong public support for stricter laws, digital monitoring, regular inspections, and mandatory hygiene training. To improve food safety, we recommend launching national awareness campaigns and increasing inspections in restaurants and markets, training food workers regularly, using innovative technologies for tracking and monitoring, enforcing more substantial penalties for violations, and incorporating food safety topics into school curricula. Additionally, utilize digital media platforms to reach broader audiences. These steps will help build public trust, reduce foodborne illnesses, and create a safer food environment across the Kingdom. Although the sample size represents a limitation, the findings nonetheless provide meaningful guidance for future development. Future works may share the form with more individuals, and focus on other Saudi Ministries regarding foodborne Disease Prevention, such as the Saudi Food & Drug Authority.

Acknowledgment
The authors would like to thank all individuals who participated in the survey for their time and valuable input. Their responses were essential to the success of this research.

Conflict of Interest
The authors declare no conflict of interest.

Ethical Approval Statement
This study does not include any animal or human subjects requiring ethical approval.

REFRENCES

[1] "Strategic Planning — Food Safety and Inspection Service," Usda.gov, 2023. https://www.fsis.usda.gov/about-fsis/strategic-planning.
[2] V. Albert et al., "Comprehending the Risk of Foodborne and Waterborne Disease Outbreaks: Current Situation and Control Measures with Special Reference to the Indian Scenario," Heliyon, vol. 10, no. 16, pp. e36344 e36344, Aug. 2024.
[3] U. F. Dalimunthe, S. Susilawati, and N. Susanti, "Analysis of Early Detection Implementation in Communicable Disease Program at Elderly Posyandu in Wet Rice, Langkat Regency," Journal La Medi healtico, vol. 5, no. 3, pp. 524–532, Jun. 2024.
[4] D. A. Awad, H. A. Masoud, and A. Hamad, "Climate changes and food-borne pathogens: the impact on human health and mitigation strategy," Climatic Change, vol. 177, no. 6, Jun. 2024.
[5] "Anticipatory action for climate-sensitive infectious diseases: Latin America regional assessment - Red Cross Red Crescent Climate Centre," Climatecentre.org, 2024.
[6] Deepak Subedi, Madhav Paudel, Sandesh Poudel, and Niranjan Koirala, "Food Safety in Developing Countries: Common Foodborne and Waterborne Illnesses, Regulations, Organizational Structure, and Challenges of Food Safety in the Context of Nepal," Food Frontiers, Nov. 2024.
[7] G. Basak, B. Sharma, S. Parul, U. Jain, R. P. Mishra, and M. K. Srivastava, "Strategies for food safety: A contemporary approach".
[8] World Health Organization, "WHO global strategy for food safety 2022–2030: towards stronger food safety systems and global cooperation," Executive summary, Geneva, Switzerland, 2022.

[9] K. D. Meagher, ”Policy responses to foodborne disease outbreaks in the United States and Germany,” Policy responses to foodborne disease outbreaks in the United States and Germany , 2021.
[10] T. Filippini, ”Foodborne disease outbreaks,” Acta Biomedica, vol. 95, no. 1, e2024022, 2024.
[11] D. Warmate and B. A. Onarinde, ”Food safety incidents in the red meat industry: A review of foodborne disease outbreaks linked to the consumption of red meat and its products, 1991 to 2021,” Int. J. Food Microbiol., vol. 398, art. no. 1102403, 2023.
[12] M. Alurame, “Policy strategies for managing food safety risks associated with climate change and agri- culture,” International journal of scholarly research and reviews, vol. 4, no. 1, pp. 021–032, Mar.2024.
[13] Ukti Bimal Sheth et al., “From Soil to Salad: Strategies for Reducing Foodborne Illness Outbreaks,” Food Science & Nutrition, Dec. 2024.
[14] R. J. Feliciano, P. Guzma´n-Luna, G. Boue´, M. Mauricio-Iglesias, A. Hospido, and J.-M. Membre´, “Strategies to mitigate food safety risk while minimizing environmental impacts in the era of climate change,” Trends Food Sci. Technol., vol. 126, pp. 180–191, Aug. 2022, doi: 10.1016/j.tifs.2022.02.027.
[15] A. O. Olatunji, J. Olaboye, C. Maha, T. Kolawole, and S. Abdul, “Environmental microbiology and public health: Advanced strategies for mitigating waterborne and airborne pathogens to prevent disease,” Int. Med. Sci. Res. J., vol. 4, Jul. 2024, doi:10.51594/imsrj.v4i7.1355.
[16] D. O. Oduori, E. Kwoba, L. Thomas, D. Grace, and F. Mutua, “Assessment of Foodborne Disease Hazards in Beverages Consumed in Nigeria: A Systematic Literature Review,” Foodborne Pathog. Dis., vol. 19, no. 1, pp. 1–18, Jan. 2022, doi: 10.1089/fpd.2021.0043.
[17] K. Ruangsombat, A. Lim, S. Pradit, V. Cholumpai, and P. Noppradit, “Risk Factors Affecting the Bacterial Contamination in Water of Thailand’s Upper South 2020 - 2022,” Trends Sci., vol. 21, no. 1, Art. no. 1, 2024, doi: 10.48048/tis.2024.7158.
[18] M. Abu Tareq, P. Mondol, Md. S. Islam, Md. T. Rifat, S. S. Das, and Md. S. I. Khan, ”Ensuring safe drinking water: microbial evaluation of restaurants in Patuakhali district, Bangladesh,” Asian Australas. J. Food Saf. Secur., vol. 8, no. 1, pp. 1-8, 2024.
[19] M. Sahoo, C. Panigrahi, and P. Aradwad, “Management strategies emphasizing advanced food processing approaches to mitigate food borne zoonotic pathogens in food system,” Food Front., vol. 3, no. 4, pp. 641–665, 2022, doi: 10.1002/fft2.153.
[20] “Emerging infectious disease: An underappreciated area of strategic concern for food security – Brooks - 2022 - Transboundary and Emerging Diseases - Wiley Online Library.” Accessed: Jan. 31, 2025. [Online]. Available: https://onlinelibrary.wiley.com/doi/full/10.1111/tbed.14009.
[21] “Emerging Foodborne Pathogens: Challenges and Strategies for Ensuring Food Safety.” Accessed: Jan. 31, 2025. [Online]. Available: https://www.mdpi.com/2673-9976/31/1/32.
[22] M. Focker, J. M. Ruzante, V. J. Davidson, A. Fazil, J. A. L. Cranfield, S. J. Henson, et al., ”Designing a risk-based monitoring plan for pathogens in food: A review,” Food Control, vol. 143, 2023.
[23] Y. Huo, H. Li, J. Wang, B. Gu, L. Zhou, G. Liu, X. Zhang, and J. Tian, “Risk-based detection as a cost- effective strategy to reduce foodborne illness due to salmonella,” Heliyon, vol. 9, no. e223925, 2023.
[24] Adediran, O. A., Alimba, C. G., and Adediran, O. H., “The burden of food contamination and foodborne illnesses in Low and Middle income countries and strategies for reduction: Nigeria as a case study”, Nig. J. Anim. Sci. Technol, vol. 7, no. 3, pp. 52 - 62, Dec. 2024.
[25] A. M. Abdelshafy et al., “Recent Advances in Detection and Control Strategies for Foodborne Bacteria in Raw and Ready-to-Eat Fruits and Vegetables,” Food Frontiers, Jan. 2025.
[26] I. Sabeq et al., “Prevalence and molecular characterization of foodborne and human-derived Salmonella strains for resistance to critically important antibiotics,” Transbound. Emerg. Dis., vol. 69, no. 5, pp. e2153–e2163, 2022, doi: 10.1111/tbed.14553.
[27] L. C. Ray, “Decreased Incidence of Infections Caused by Pathogens Transmitted Commonly Through Food During the COVID-19 Pandemic — Foodborne Diseases Active Surveillance Network, 10 U.S. Sites, 2017–2020,” MMWR Morb. Mortal. Wkly. Rep., vol. 70, 2021, doi: 10.15585/mmwr.mm7038a4.
[28] S. A. Altwaim, K. O. Duedu, E. A. Yarnie, P. B. Tetteh-Quarcoo, S. K. Attah, E. S. Donkor, P. F. Ayeh-Kumi, A. Alharbi, I. Alsaady, M. Alghanmi, A. El Bakri, N. M. Hussein, Z. A. Ibrahim, H. Hasan, R. AbuOdeh, M. M. Saied,

Research Article

K. S. Ghenghesh, ”Prevalence of intestinal parasites in leafy green vegetables consumed by inhabitants of Jeddah city, Saudi Arabia,” Emir. J. Food Agric., vol. 35, no. 12, pp. 1-7, 2023.

[29] J. Sharaheeli and B. Alibrahim, ”Confirmed Foodborne Hepatitis A in Saudi Arabia, 2005-2015,” Cureus, vol. 14, no. 1, e20878, Jan. 2022.

[30] S. M. Pires, L. S. Jakobsen, J. Pessoa, and E. Ethelberg, “Burden of disease estimates of seven pathogens commonly transmitted through foods in Denmark,” Foodborne Pathogens and Disease, vol.17, no. 1, pp. 81-88, 2020.

[31] M. K. Hassan and S. Alshahrani, “Digital transformation and organizational performance: The role of strategic alignment and IT capabilities,” *Business Horizons*, vol. 65, no. 5, pp. 553–565, doi: 10.1016/j.bushor.2022.01.002. 2022.

[32] Ministry of Health, 2024 MOH Branches and Offices Operational Manual, Riyadh, Saudi Arabia: Ministry of Health, 2024.