Harper Adams University

# A mixed-methods approach to analyse foodborne disease outbreaks in the hospitality sector: informing effective governance for the Dominican Republic.

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Thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

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## Declaration

I declare that this thesis has been written and composed by the author and all the work that has been reported is original. Any work reported in this thesis has never been submitted previously to attain an academic qualification. It contains work that has been published by the author in peer-reviewed journals.

## Peer-reviewed publications

Díaz de Oleo, D., McIntyre, L., Randall, N., Nayak, R., and Manning, L. (2022). Systematic mapping of food safety outbreaks in the hospitality sector in the Dominican Republic. *British Food Journal*, 1–22. https://doi.org/10.1108/BFJ-10-2021-1146

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## Dedication

I dedicated this thesis to my mother Ceverina De Oleo I am eternally indebted to you. Acknowledgement would not suffice to thank you for your love, encouragement and for always been there. You were the reason I never stepped back during the difficult times.

To my father Manuel, and siblings: Angelo, Lizza, and Sterling. Also, to my family members for their encouragement during the entire journal, even when it meant years of separation, your support strengthened me.
Think a little longer… Chunguita!

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## Abstract

The tourism and the hospitality sector is a key socio-economic driver of economic development. In the Dominican Republic, the increase in tourism and hospitality has led to economic growth with a significant contribution to the gross domestic product and job opportunities for the country. Hospitality settings are frequently associated with health-related crises that negatively impact public health and the tourism industry. However, the available information regarding foodborne disease outbreaks in the Dominican Republic is limited. In order to gain a greater understanding of the common attribution of contributing causes of foodborne diseases and the flaws in contemporary food safety practices and systems, this study examined foodborne disease outbreaks as a whole, considering the preconditions that might have contributed to or influenced their occurrence. To achieve its objectives, this study mainly adopted an exploratory sequential mixed-methods approach by adopting a systematic mapping review, a systemic accident analysis approach (AcciMap), and a stakeholders' investigation to evaluate from a wider, holistic perspective foodborne disease outbreaks and practices in hospitality premises to then inform policy development. The findings provide deeper understanding of factors associated these foodborne disease outbreaks. For instance, foodborne disease outbreaks are complex and result from both anticipated and unanticipated aspects within a chain of events. Therefore, the main recommendation to prevent and manage the occurrence of foodborne disease outbreaks specially in the hospitality sector is to establish a foodborne disease control plan that effectively designs and implements the guidelines for more efficient risk monitoring and mitigation. In such a control plan, water and wastewater management controls are a critical aspect of foodborne disease management to prevent similar incidents in the future by taking the appropriate precautionary measures.

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## List of Abbreviations

| | |
|---|---|
| AcciMap | Accident Map model |
| AGE | Acute Gastroenteritis |
| BSE | Bovine Spongiform Encephalopathy |
| CAC | Codex Alimentarius Commission |
| CARICOM-RD | Dominican Republic and the Caribbean Community |
| CAST | Causal Analysis is based on Stamp |
| CEE | Collaboration for Environmental Evidence |
| CFP | Ciguatera Fish Poisoning |
| CREAM | Cognitive Reliability and Error Analysis Method |
| DR | Dominican Republic |
| DR-CAFTA | Dominican Republic, Central America and the United States Free Trade Agreement |
| DREAM | Driver Reliability and Error Analysis Method |
| EHOs | Environmental Health Officers |
| EPA | Economic Partnership Agreement between the European Union and the CARIFORUM nations |
| ESR | Environmental Science and Research |
| EU | European Union |
| FBD | Foodborne Diseases |
| FBDO | Foodborne Diseases Outbreaks |
| FDA | Administration of Food and Drugs of the United States |
| FDI | Foreign Direct Investment |
| FMEA | Failure Mode and Effect Analysis |
| FRAM | Functional Resonance Accident Model |
| FS-culture | Food Safety Culture |
| FSMS | Food safety management system |
| FSSC 22000 | Food Safety System Certification 22000 |
| GAP | Good Agricultural Practices |
| GDP | Gross Domestic Product |
| GHP | Good Hygienic Practices |
| GMP | Good Manufacturing Practices |
| HACCP | Hazard Analysis Critical Control Point |
| HFACS | Human Factors Analysis and Classification System |
| IFS | Food International Featured Standards Foods |

| | |
|---|---|
| ISO | International Organization for Standardization |
| MERS | Middle East Respiratory Syndrome |
| NoV | Norovirus |
| OIE | World Organisation for Animal Health |
| POP | Gregorio Luperón International Airport |
| PPE | Personal Protection Equipment |
| PRISMA | Preferred Reporting Item for Systematic Reviews and Meta-Analyses |
| PRP | Pre-Requisite Programmes |
| PUJ | Punta Cana International Airport |
| RCA | Root Cause Analysis |
| SARS | Severe acute respiratory syndrome |
| SCM | Swiss Cheese Model |
| SDGs | Sustainable Development Goals |
| SDQ | Las Americas Airport |
| SMEs | Small and medium sized enterprises |
| SPS | Phytosanitary Standards |
| SQF | Safe Quality Food |
| STAMP | Systems-Theoretic Accident Model and Processes |
| STI | Cibao International Airport |
| STPA | Systems Theoretic Process Analysis |
| TD | Travellers' diarrhoea |
| U.K. | United Kingdom |
| US | United States |
| WTTC | World Travel and Tourism Council |

# CHAPTER ONE:

# 1. Introduction

This chapter sets the scene for the current research in the hospitality sector of the Dominican Republic (DR). It explores the importance of the tourism and hospitality sector as a tourist-dependent country in various contexts, such as Gross Domestic Product (GDP), international revenues, foreign investment, and the job employment opportunities within this sector. The problem statement section describes food safety issues affecting international travellers and specific foodborne disease outbreaks in the country of interest. Moreover, there is limited research in the hospitality sector from a holistic perspective considering multiple actors and the role they play in terms of the food safety performance in all-inclusive premises. The overarching aim and objectives are also stated, and the intention to evaluate and explore the evidence of foodborne disease outbreaks affecting travellers using a broader analytical perspective through a mixed-methods research approach. The study's significance for the DR government, private sectors, hotels and practitioners is also summarised. The final section in this chapter describes the thesis structure, graphically presenting the research steps and briefly describing the content of the following thesis chapters.

## 1.1. Study Background

The geographical setting of this study is in the DR, a Caribbean Island surrounded by the Atlantic Ocean in the north and the Caribbean Sea to the south. It is the second largest country in the Caribbean after Cuba and is located on the eastern part of the island “Hispaniola” bordering with the Republic of Haiti on the west. The DR is a tropical island boasting 1,668 kms of coastline with a unique and majestic biodiversity and beautiful contrasts of colour and heights in its landscapes. As a tourist destination it is dotted with fine white sandy beaches, luxury hotels and wide variety of entertainments and recreation. Its coastal and marine environments to appeal to travellers with its enormous leisure potential being easily accessible through its seven international airports and ports in the main tourist region (Figure 1.1). The DR, among others Caribbean countries, is a leading tourist destination attracting millions of visitors per year from all over the world and statistics shows it as a location of increasing popularity (León *et al.*, 2021).


Adapted from: (Del Rosario *et al.*, 2019).

*Figure 1.1 The main points of tourism interest in the Dominican Republic (tourist regions, cities, international airports and ports).*

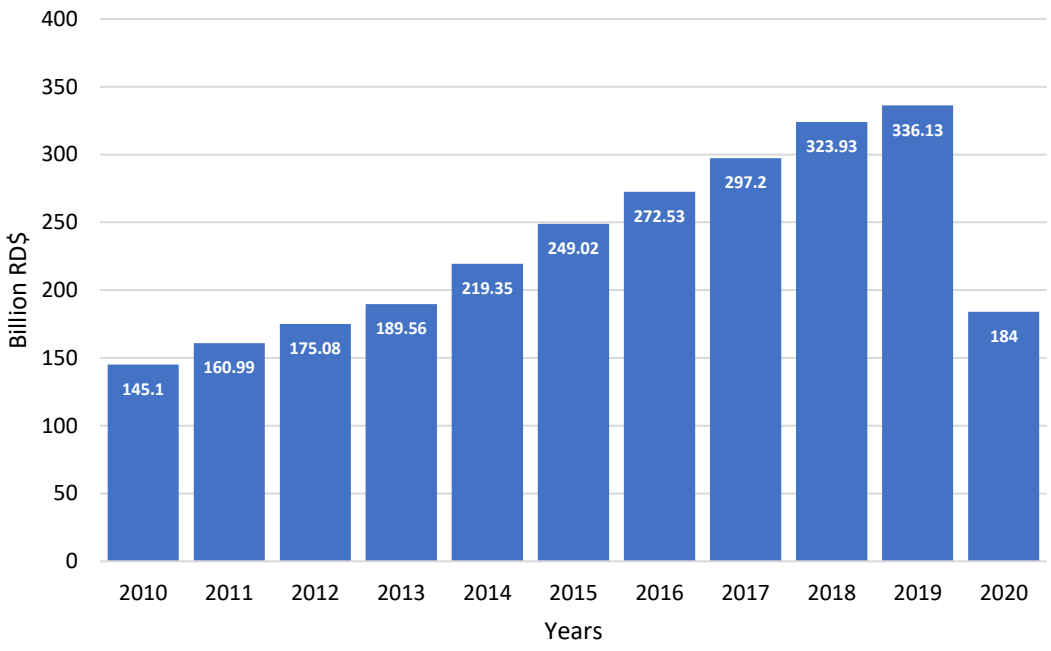
Tourists travel mostly to the Eastern Region of the DR because it is more popular, well-advertised and has recognised worldwide destinations such as Punta Cana-Bávaro, La Romana and Bayahíbe. In fact, 65% of the country's international tourists arrive through the Punta Cana International Airport (PUJ) which is surrounded by all-inclusive holiday hotels in the same region (Alvarado *et al.*, 2017). The next most used airports are Santo Domingo's Las Americas Airport (SDQ), Santiago's Cibao International Airport (STI) and Puerto Plata's Gregorio Luperón International Airport (POP). In this area, tourists can choose between 'sun and beach' and sports tourism (e.g., surfing and windsurfing), ecotourism, rural tourism and adventure tourism. However, business travellers prefer the hotels in the city of Santo Domingo.

The tourism industry in the country has exploded from the North to East Coast, flourishing in the country's most active tourist destinations and the metropolitan areas of Santo Domingo (ADG, 2019). As the leader in the Insular Caribbean region, tourism's relevance is determined through a series of socio-economic indicators not only GDP but also foreign direct investment (FDI), tourist expenditure, jobs creation and tourist hotel occupancy rates. Comparing tourism with other economic activities in the country, tourism alone is the largest recipient of FDI in the country (United Nations, 2015). FDI in tourism in the DR from 2016 to 2019 attracted

approximately $USD 10 million corresponding to 1.8% of total inflow investment in Latin America and the Caribbean (OECD/UNCTAD/ECLAC, 2020).

### 1.1.1. Importance of Tourism in the Dominican Republic (DR)

Tourism and travel's contribution to national GDP in 2019 were DOP$ 821.6 BN (US$ 14,390.5 MN), 17.2% of the total DR economy (WTTC, 2021). Tourism and travel's contribution to GDP in 2019 corresponded to 15.9 % of the total DR economy. The hospitality industry alone contributes 7.4% of the country's GDP (WTTC, 2021) with an average of 530,000 people visiting the country each month, with a direct contribution to the local economy of USD 630 million per annum. However, in the DR the average spending by tourists is USD 1160 which is not the highest expenditure rate per tourist in the region or in other Latin American countries (OECD/UNCTAD/ECLAC, 2020). Pre the COVID-19 pandemic, the contribution of tourism activities to national GDP grew steadily (Figure 1.2). However, the growth and revenue from international travellers were negatively impacted in 2020 triggered by the COVID-19 pandemic. The weak growth and declining share in global tourism make it difficult to determine the recovery time for the tourism sector in the DR, which in turn makes it more important to understand the drivers of, and risks to, tourism.

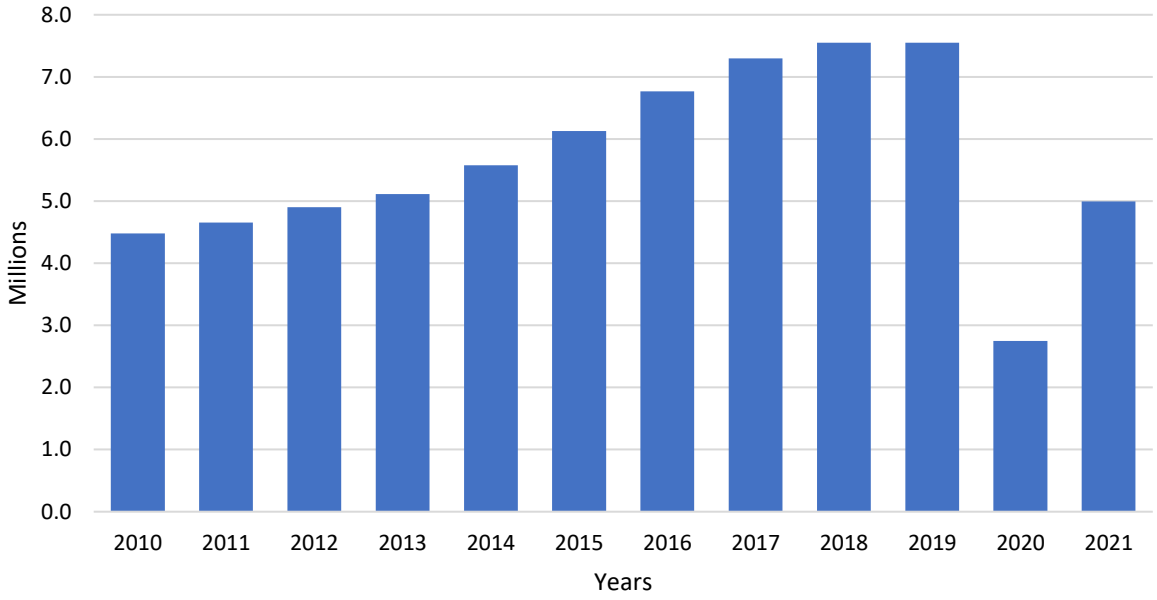



Adapted from: (Statista, 2020)

*Figure 1.2 The estimation of tourism's contribution to the DR' s economy from 2010-2020.*

Regarding the number of inbound tourists to the Caribbean, the DR recorded the highest number of international visitors and received 26% of all tourists visits in the region

(OECD/UNCTAD/ECLAC, 2020). As well, the DR has been characterised as one of the most tourist-dependent countries in the Caribbean region (Sinclair-Maragh and Gursoy, 2015; Thomas, 2015; Wong and Alfred, 2015). International visitors reached 6.7 million per year in 2016, revealing that the country remains one of the most attractive vacation destinations in the entire Caribbean region (Central America Data, 2019) (Figure 1.3) shows that international visitors increased by almost 1 million in 2018 and 2019 (UNWTO, 2022).

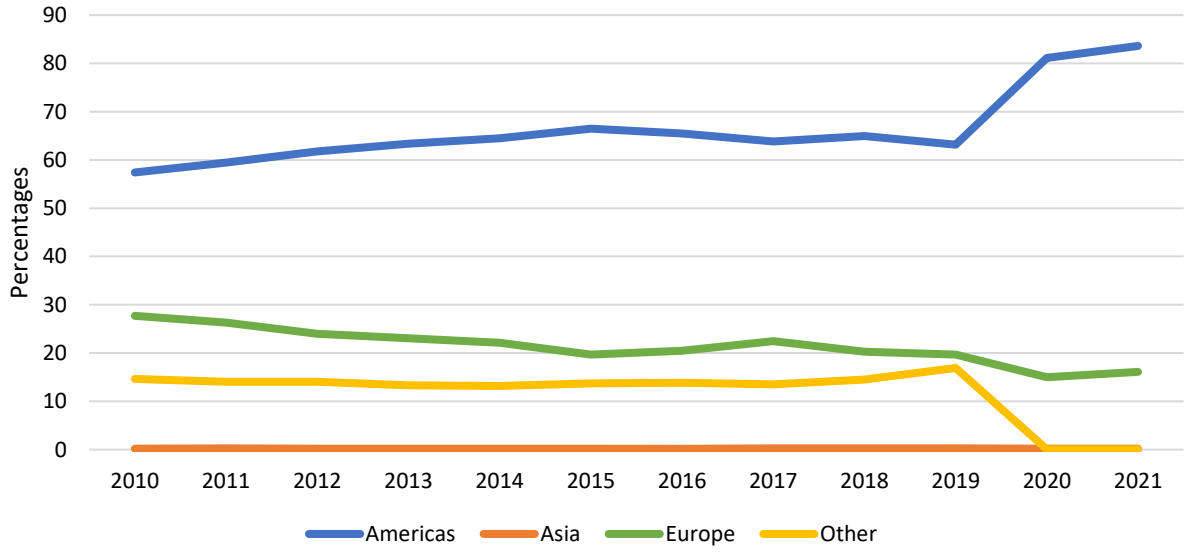



Adapted from: (UNWTO, 2022)

*Figure 1.3 The dynamic trend of the number of tourism visitors in the Dominican Republic between the years 2010-2021.*

Based on the country's growing tourism trend, high performance in terms of international tourist arrivals and the revenue received from tourism-related activities led the government in 2012 to set the ambitious goal of reaching 10 million tourists annually by 2020 (Hyland, 2020). A total of 907,545 visitors, both passengers and crew, arrived in the Dominican's ports from January to July in 2019 (Byers, 2019) which has increased numbers and oriented business to achieve the set goal. However, this trend changed in January 2021. Foreign visitors' arrivals were 130,093, which when compared to 474,152 arrivals in the same month of 2020, shows a decrease of 72.56% due to the effects of the COVID-19 pandemic that began in March 2020. This is an example of the challenges the country faces with regard to a shock to their tourism industry, notably perceived here using tourist arrivals. In this particular case, a health crisis has led to a sharp reduction of travellers impacting the DR economy, but this outcome could also happen as a result of from a variety of other external factors.

Research on economics and tourism underlines that tourist has a significant impact on economic growth in countries which depend on tourism income, including the DR (Cannonier and Burke, 2018; Khan *et al.*, 2020; Wu and Wu, 2016). Tourists from North America (especially the United States) constitute the market with the highest visitors traveling to the DR. As shown in Figure 1.4, the Americas encompasses visitors from North America 63.1%, South America with 13.6%, Central America and the Caribbean with 4.0%, followed by Europe with 23.7% and Asia and the rest of the world with joint participation of 0.3% (Lorenzo, 2017; MITUR, 2019). When international travel was reopened in 2021, a total of 45.5% of the visitors received came from the US travelled to the DR, followed by the French with 7.4% of visitors Ukraine with 6.1%, Colombia with 4.5%, Argentina 3.1%, Puerto Rico 3.0%, and Spain 2.9%. Other nationalities represented 9.9% of visitors (López Alberto *et al.*, 2021). This shows the dependence of the DR tourism sector on North America and especially the US.




Adapted from: (UNWTO, 2022)

*Figure 1.4 The origin of visitors who travelled to the DR between 2010-2021 as a proportion of the total.*

The higher rate of tourist arrivals to the DR, over the last decade especially, has been connected to several factors. Firstly, private investment and FDI in the infrastructure within the DR through the development of highways, ports, and airports. This has contributed to the accessibility of the main tourism destinations and created a tourism network between the most popular tourism locations in the country (Barrera *et al.*, 2007). The investment in infrastructure has become a logistic advantage over tourist destinations in other parts of the Caribbean region (Barrero *et al.*, 2015; Padilla *et al.*, 2018). Tourism and hospitality development in the DR have been a priority over the last 30 years. So what policy initiatives have driven this growth in tourism in the DR?

a. **Legal frameworks.** Tourism activities in the country embraced the legal framework composed by specific laws issued in the late ’60s (Guzman Ariza Attorneys, 2020). The proactive efforts to promote tourism by the government included the provision of incentives for new development such as the “Tourism Incentive Law 153-71” issued in 1971, which offers tax exemptions and other benefits for foreign and national investment enterprises (Jorge, 1997; Reisinger and Crotts, 2009; Seraphin, 2011). Investment in the country’s tourist destinations has been focused on both luxury hotels and high-end residential projects. This was expected to increase the average spending per tourist. Hotel room capacity has also grown alongside the renovation of luxurious and diverse accommodation options (Duffy *et al.*, 2015).

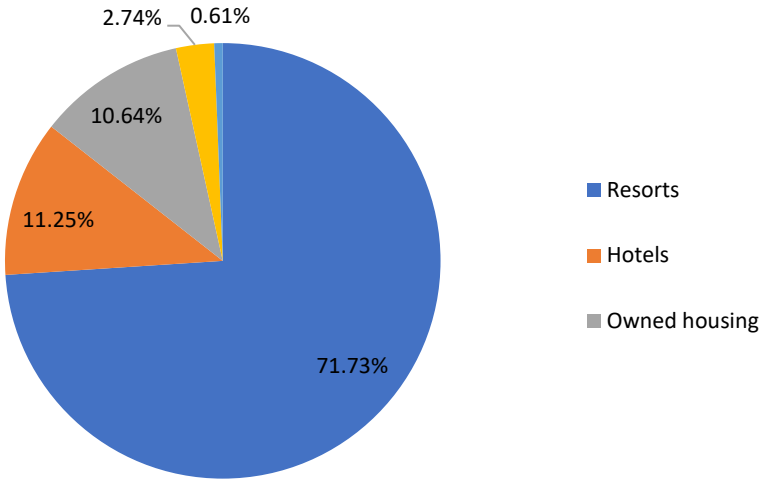
b. **Government and private initiatives, marketing strategies and their efforts in the allocation of land and resources management.** In addition, the Ministry of Tourism was promoting destination marketing strategies especially reinforcement of the promotion of a more diverse tourism offers (e.g., cultural, ecological, sport, health and adventure tourism). The Ministry of Tourism has signed numerous agreements for the promotion of tourism in international markets of interest to support growth in the number of visitors, as defined in the Presidential Goals (MITUR, 2022). The country as a tourist destination was advertised overseas for its spectacular sandy beaches and tropical weather under the motto ‘The DR has it all’. The government also operate a tourist website to promote tourist attractions inland such as plantation tours, national park tours, cigar and rum experiences and cultural events.

The tourism industry has a positive effect on economic growth which also activates other economic sectors that can benefit from tourism adding value to them too (Lin *et al.*, 2018; Wu *et al.*, 2017). The tourism and hospitality sector is seen as a powerful socio-economic driver of the twentieth century and political development in the destination countries by its fast growth, foreign exchange incomes and the undeniable ability to create both direct and indirect employment. The industry generates wealth and employment in many sectors and subsectors of industries related to tourism such as the agriculture sector (Castilho *et al.*, 2021; Khan *et al.*, 2020).

Tourism drives the demand for agri-food products, particularly in the DR hospitality industry, supporting sustainable agri-food development (Pérez-Pineda *et al.*, 2017). Hotels are a significant source of food contributing to the national economy, and consumer protection and

food safety is equally important to all food businesses (Calcador, 2017). Consequently, food and beverages generate large demand for agri-food products from local producers, food retailers and importers. The tourism sector bought approximately $US 900 millions of local products between 2018 and 2019 supplying Dominican food products to visitors. These figures are higher than exports of these products outside the DR. Hotels and restaurants account for a significant proportion of imports, with 49% from the USA and 10% from European countries (United Nations Environment Programme, 2019). Imports, for use in hotels and restaurants, include premium red meat, poultry, cheeses, wine, frozen potatoes, vegetables, fresh fruit, and seafood distributed mainly to all-inclusive hotels. The local agricultural sector supplies 85% of all fresh primary products required by the tourism industry. In 2017 total food and beverage consumption stood at over $USD 490 million (OECD/UNCTAD/ECLAC, 2020). However, this is expected to keep on increasing with more hotels being built.

The hospitality sector encompasses a wide range of sectors, such as hostels, restaurants, and attractions. In this study, hospitality refers to hotels and restaurants on all-inclusive premises. Hotels are one of the primary elements in the tourism industry in a country which supports its positive performance through the satisfaction of tourist needs for accommodation, service and gastronomy. The DR offer a sea-sand-sun tourism experience which operates under the 'all inclusive' business model with few opportunities to offer other complementary types of tourism. This business model has been operating in the DR since the late 1980's when Balearic hoteliers started their ventures in the tourist destination islands of the Caribbean (Payeras *et al.*, 2012; Yusuf and Guelph, 2014). Some of the world's largest multinational hotel chains operate in the country. These include diversified foreign investments by a group from Spain; French and American franchise hotels and a small minority from national ownership (Baik and Jordan, 2010; Conner, 1994; Jacob and Groizard, 2007). The benefit of the all-inclusive is that it attracts families, couples, and retired people with a comprehensive 'free' package of resort-based attractions and activities. It also increases the average tourist expenditure and length of visitor stay (Fawcett, 2014; Issa and Jayawardena, 2003).

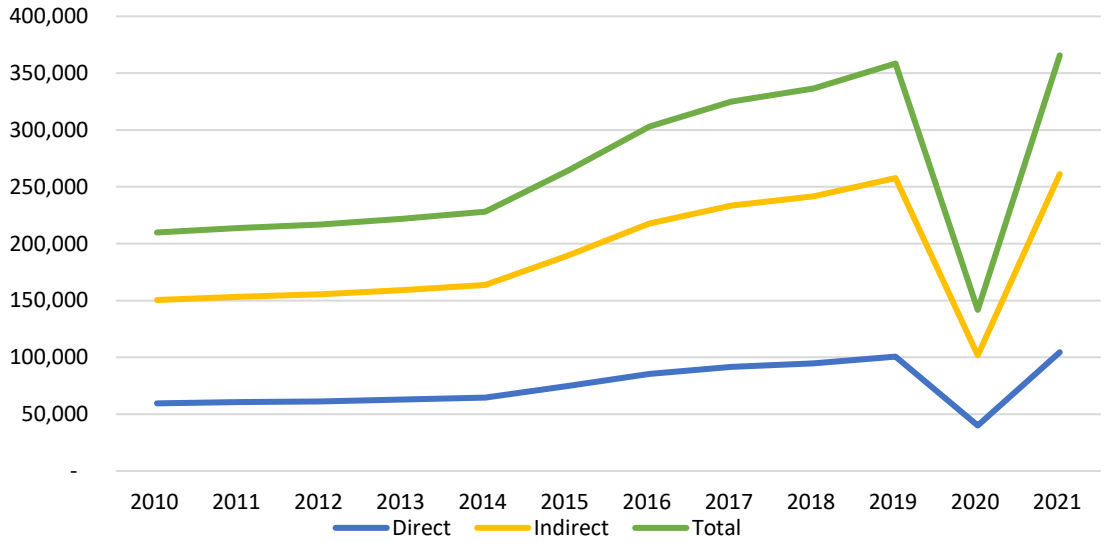



Adapted from: (Campos, 2014)
*Figure 1.5 Type of accommodation used by international visitors*

In 2014 the type of accommodation most used by most international visitors was all inclusive resort hotels where 71.7% of visitors preferred these resorts. Hotel accommodation accounted for 11.3% and 10.6% stayed in their own homes. Other types of accommodation such as rented homes and hostels or shelters represent 2.7% and less than 1% respectively (Figure 1.5) (Campos, 2014). Visitor nationality and its association with the all-inclusive hotels showed 87.9% of the European visitors stayed in all-inclusive lodging, followed by 82.1% of South Americans, 76.7% of North Americans and 62.1% of Central Americans and Caribbeans (Campos, 2014). As foreign visitor arrivals flourished in the 90s, the construction of hotels and room capacity significantly increased to 830 hotels with 83,000 hotel rooms being registered (BCDR, 2022; Pérez-Pineda *et al.*, 2017).

Revenue from tourism is addressing social and economy development issues worldwide and tourism organisations have stated that tourism and hospitality are sectors of significant importance due to their direct socio-economic contribution to the Sustainable Development Goals (SDGs) (Shereni, 2019; UNWTO, 2017). In the DR the diversity of hotels, restaurants and the bar sector generate a range of employment opportunities. In 2016, the total employment rate for the DR was 4.26 million with 6.8% of the work force working in economic activities associated with hotels and restaurants (Protep 2, 2019). Other sectors such as construction, agricultural and commercial also provide job opportunities but tend to be more volatile year to year than the pre-COVID-19 tourism sector (Alvarado *et al.*, 2017; United Nations Environment Programme, 2019). Figure 1.6 illustrates that tourism activities in 2018 (including sub-sectors such as hotels, restaurants, and bars) generated 94,704 direct jobs and 241,775 indirect jobs, collectively 336,479 jobs, approximately 8% of total DR employment

(Alvarado *et al.*, 2017). In this sector, total employees have increased over the years in parallel with the growth of international tourist arrivals in the country creating direct and indirect jobs because of the tourism related activities. Figure 1.6 shows that tourism was severely affected by the COVID-19 pandemic as evidenced by the sharp reduction of employment activities by 60% of the total jobs in tourism in 2020. According to the World Travel and Tourism Council (WTTC), tourism and related activities will play a key role in driving the socio-economic recovery of the Caribbean region post COVID-19 (WTTC, 2022).




Adapted from: (WTTC, 2022).

*Figure 1.6 The direct and indirect effect of tourism in sustaining the employment rate in the DR between 2010-2021.*

The DR's goal on tourist arrivals for 2020 of 10 million tourists was hindered when international human mobility was reduced to almost zero during the COVID-19 pandemic. COVID-19 is a highly contagious health-related crisis which affected tourism industries and sub-industries. Millions lost their jobs and the pandemic impacted on food security, agricultural system, and food industry. In the case of the DR, the COVID-19 pandemic worsened the economy. Estimates for 2020 indicated that tourist expenditure in the country was over $US 6 billion less which represents the highest losses in the Caribbean region and Latin American. Between one and two million jobs were lost which increased the unemployment rate to between 27% and 35%. This decreased family incomes mainly for women, as the country's primary workforce in the industry, also affecting lifestyle conditions (De La Paz, 2022; Winkler and Montenegro, 2021). The health crisis in the country, caused by COVID-19, also had a significant impact on the generation of foreign currency in the tourism sector. Additionally, the COVID-19 pandemic and the associated restrictions reduced FDI and hotel occupancy rates in particular, by up to

35% in hotel rates. Therefore, a full recovery in both hotel occupancy rates, and investment cannot be expected until the whole tourism sector recovers (López Alberto *et al.*, 2021).

Indeed, the tourism and hospitality sector's competitiveness and its capacity to generate economic resources can be used to alleviate social inequities as the impact of tourism on development of the economy of the country is high. However, the industry and its capacity to address social, cultural and economic development faces a high vulnerability too (Jiang and Ritchie, 2017; Ritchie and Jiang, 2019), due to external and internal risks such as natural disaster (e.g. hurricanes and earthquakes) (Park and Reisinger, 2010; Rittichainuwat *et al.*, 2018; Sheller, 2021); man-made disaster (e.g. political instability) (Balli *et al.*, 2019); terrorism and war (Fuchs *et al.*, 2012; Walters *et al.*, 2018); crime (Giusti and Raya, 2019; Tasci and Sönmez, 2019). And health risks (e.g., epidemics, foodborne disease) (Arbulú *et al.*, 2021; Indar *et al.*, 2020; Ma *et al.*, 2020; Rosselló *et al.*, 2020).

Globally, infectious disease outbreaks affecting humans and animals such as severe acute respiratory syndrome (SARS), swine flu, the foot and mouth epidemic and avian influenza such as H1N1 and COVID-19 have negatively impacted the tourism industry across the world and have led to economic loss (Gidebo, 2021). Consequently, the impact of infectious diseases on the tourism and hospitality industry can be seen mainly through the decline of the flow of international tourists and the economic loss this entails. For example, the Middle East Respiratory Syndrome (MERS) outbreak dramatically decreased the tourist influx into affected countries, leading to an economic loss of US$2.6 billion in tourism revenue (Joo *et al.*, 2019). In some Asian countries, SARS generated losses over US$20 billion and in the United Kingdom (UK) in 2001, the foot and mouth disease outbreak impacted tourism revenue by £7.5 billion (Elziny and Abd El-Kafy, 2020; Rosselló et al., 2017). These national and international disease outbreaks have not only caused significant economic damage to the global tourism industry but also have had an impact, burdening public health systems.

In the DR, tourism and hospitality have been affected by natural disasters such as floods (Gómez De Travesedo and Saenz Ramírez, 2009); and tropical storms and hurricanes (Erman *et al.*, 2021; Granvorka and Strobl, 2013) which are recurrent within the country. Health risks can occur such as epidemics and foodborne disease for example, gastroenteritis outbreaks in 2004 in travellers staying in all-inclusive hotels (Hernando *et al.*, 2007). The Cholera epidemic in 2011 caused billions of US dollars in losses in tourism (OPS, 2012). In 2019, food poisoning-like illness at various resorts in different part of the country (Plante, 2019; Romero and Bogel-

Burroughs, 2019) led to a foreign exchange reduction due to travellers cancelling their holiday travels (Ruiz, 2019).

Global travel, commercial trade and international tourism also increases the threat of travel-related illnesses and outbreaks of infectious diseases (Chen *et al.*, 2020; Force *et al.*, 2018; Gössling *et al.*, 2020; De Vries *et al.*, 2021). Infections associated with the COVID-19 pandemic impacted tourism activities in accommodation and food services establishments (Aday and Aday, 2020). Indeed during the international 'lock-downs," food service establishments ceased face-to-face trading. National, food surveillance systems reported fewer food-related disease outbreaks in 2020, including those associated with international travel when compared with the previous year (Ray *et al.*, 2021). Studies examining the impact of other infectious diseases incidents (e.g., SARS), and more generally with foodborne disease outbreaks highlight that hygiene, cleanliness, and safety protocols are the most important measures in the hospitality and tourism industry to reduce health risks (Lee *et al.*, 2012; Lo *et al.*, 2007; Tew *et al.*, 2008). Similar to COVID-19, the adopted measures and improvements in hand hygiene, food safety behaviour, and food handling potentially reduce the incidence of food contamination (Love *et al.*, 2022). International tourism is a route for communicable disease outbreaks including those related to food, and the hospitality industry (e.g., hotels) is primarily affected (Elziny and Abd El-Kafy, 2020). In the DR, the increase in tourism and hospitality has led to the country's economic growth. There is a need for appropriate operational practices at all steps of the agri-food chain to reduce the occurrence of foodborne diseases (FBD) and FBD outbreaks. However, whilst the tourism sector is a great beneficiary of this globalised world the downside is that tourism is also influenced by social crisis, environmental challenge, epidemics, and FBD (Sharif et al., 2021), the latter key focus of this PhD study.

## 1.2. Problem statement

International tourism is the main economic engine fuelling the economy in many countries and revenue was, prior to the COVID-19 pandemic, increasing steadily in the DR every year. As tourism, as an economic sector, grows international travel also increases the risk for travellers of acquiring infectious diseases. Stoney (2016) states that among other less economically developed countries, the DR is frequently reported as a high-risk destination for FBD. One of the most common symptoms that travellers can experience is known as Travellers' diarrhoea (TD) which is caused by contact with drinking water and food that may contain harmful organisms that travellers are not accustomed to. The TD affects a huge percentage of tourists regardless of if they are visiting developed or underdeveloped countries (Izadi *et al.*, 2014;

López-Vélez *et al.*, 2022). The health impact of FBD caused by biological hazards such as bacteria, viruses, fungi, and parasites can be much more severe (Leshem *et al.*, 2016; Marques *et al.*, 2017; Sane *et al.*, 2015). Less developed economic regions are prone to problems with food or water related to FBD due to factors such as poor environmental sanitation, contaminated food and water supplies (Bisht *et al.*, 2021; Fletcher *et al.*, 2009). Enteritis and other diarrhoeal diseases are among the top five causes of mortality in Latin American and Caribbean countries' populations (Havelaar *et al.*, 2015; Olson *et al.*, 2019). The most common pathogens reported by travellers to the Caribbean involve Norovirus, S*almonella, Shigella, Giardia, Staphylococcus, and E. coli* (Indar and Perez, 2015).

International travel has become one of the routes to spread FBD transnationally between populations (Angelo *et al.*, 2017; Elziny and Abd El-Kafy, 2020). Less developed economic regions are prone to problems with food or water related to FBD due to factors such as poor environmental sanitation, contaminated food and water supplies (Bisht *et al.*, 2021; Fletcher *et al.*, 2009). Additionally, inadequate food handling during food processing, production, storage and the weak enforcement of regulatory standards are linked to food safety issues (Faour-Klingbeil and Todd, 2020). Particularly in the Caribbean, food travel related risk is linked to common deficiencies in food production practices (Guerra *et al.*, 2016). In addition, countries in the Caribbean face weak governance structures including the lack of resource for investigation documentation, laboratory detection and surveillance (Guerra et al., 2016; Hull-Jackson and Adesiyun, 2019; Lee, 2017).

### 1.2.1. An overview of some specific foodborne outbreak in the DR

Information regarding FBD outbreaks in the DR is a major element of the activities of the National Epidemiological Surveillance System (SINAVE) carried out by the Ministry of Health. Since 1998, FBD cases are subject to mandatory notification and due to this resolution, the DR has a satisfactory record of FBD outbreaks and cases. From 1998 to 2002 SINAVE registered 267 FBD outbreaks and 2,623 cases. The common setting identified in the FBD outbreaks was restaurants and with 20% of cases, the mode of transmission was contaminated food, of which fish was responsible for 61% of all the outbreaks cases reported (Jiménez, 2009). The information collected between 2004 and 2008 included reports for 60 FBD outbreaks with a total of 64,123 cases of FBD. The study found the highest levels of FBD outbreaks were reported between 2004 and 2005, with 17 and 13 outbreaks, respectively. Consumption sites involved in the outbreaks were homes (43%) and restaurants (23%) with pathogens such as

*Escherichia coli*, *Staphylococcus aureus*, and *Entoamoeba histolytica* being the most frequently identified etiological agents involved in the FBD outbreaks.

Another study analysed the data from national epidemiological surveillance for the period 2004-2010 with 103,102 cases of FBD with an average of 14,729 cases per year (Peralta, 2011). The main sources identified were seafood (34%), water (18%), dairy products (15%) and meat and poultry (9%) among others. However, in 23% of FBD outbreaks, the implicated food could not be specified (Peralta, 2011). Despite FBD cases being a mandatory reporting subject in the country, information available from the published epidemiological weekly reports, from the Ministry of Health, is still limited. The main drawback is that these official reports do not always contain a very detailed and specific information of FBD outbreaks such as the place of the outbreak, the diagnosis, or mode of transmission and etiological agent. Some of the scientific reports of FBD cases and outbreaks in the country appear after the epidemiological investigation is undertaken in a foreign country (as they relate to travellers), or the potential for an outbreak is detected through a surveillance system from an infected traveller returning home.

Through a personal communication, the findings of an unpublished literature review carried out by Lupin (2015) which found that from 1975 to 2015 food safety incidents and FBD outbreaks related to the DR affected mainly travellers and Dominican immigrants. A total of 120 food safety cases were reported from which 71% of the epidemiological outbreak's investigation were performed by international governments and agencies in the following countries: United States, Brazil, Canada, France, Germany, Spain, Norway and Italy. The main food safety hazards identified in this review e.g., bacteria, viruses, parasites, etc. are summarised in Table 1.1. Findings of this review (Lupin, 2015) identified that 45% of the food safety cases involved bacteria such as *Salmonella* spp*., E. coli, Campylobacter* spp., *Bacillus cereus, Staphylococcus aureus, Shigella* spp*., Clostridium perfringens, Vibrio cholerae, Brucella* spp. and *Salmonella typhi* associated to FBD and outbreaks linked to the DR. Parasitic hazards such as *Entamoeba histolytica, Giardia, Toxoplasma gondii, Angiostrongylus* and *Cyclospora cayetanensis* accounted for 25.5% of incidents, followed by fish toxin biological hazards at 12.5%, predominantly ciguatoxin. Chemical hazards were identified in lower proportions.

*Table 1.1 The number of recorded food safety cases in the DR from 1975 to 2015.*

| Identifying Identified | Type of Hazard | Number of cases per hazard | Heavy metal/ Veterinary residues | Number of etiological other agents identified in each case |
|---|---|---|---|---|
| **US**<br>**Brazil**<br>**Canada**<br>**France**<br>**Germany**<br>**Italy** | Bacteria | 55 | | 11 |
| | Viruses | 11 | | 6 |
| | Parasites | 31 | | 6 |
| | Biological agent | 15 | | 12 |
| | Chemical hazard | 5 | Lead | 2 |
| | Antimicrobial-resistant | 3 | Quinolone residue | 2 |
| **Total** | | **120** | | **39** |

Adapted from (Lupin, 2015).

Epidemiological investigations and laboratory tests confirmed Norovirus as the etiological agent of concern in two significant FBD outbreaks in different hotels located in the most popular tourist regions in the country - Punta Cana and Puerto Plata (Doménech-Sánchez et al., 2009).

### 1.2.2. Food poisoning cases in the DR travel-related

FBD can travel far and wide across different countries and be transmitted by an infected tourist (Osman and Preet, 2020; Pandey *et al.*, 2021; Tuite *et al.*, 2020). Due to poor hygiene practices and food safety controls, hotels can put their customers at risk of developing FBD as shown in Table 1.2.2. As an example, the multinational cholera outbreak which originated in Haiti in 2011 was 'exported' from the DR to other countries by travellers returning to the United States, Spain, Mexico, and Venezuela. Also, locals were infected were locals who attended a large wedding reception at a luxury tourist resort in the (Jiménez *et al.*, 2011; Loharikar *et al.*, 2015). In these outbreaks, the pathogens had been transmitted mainly by contaminated food (e.g., seafood), water, and human-to-human interaction. Tourists, when interviewed, also identified poor food handling and improper hygiene practices as contributing factors that led to the FBD outbreaks. Tourist health risks are often associated with food safety violations such as cross-contamination, and unhygienic food service practices (Lee *et al.*, 2019; Walsh and Leva, 2019).

*Table 1.2.2 Several important FBD outbreaks affecting locals and international visitors in hospitality premises in the DR.*

| Year | Region | Causal agent | Cases | Source of contamination | Settings | Reference |
|---|---|---|---|---|---|---|
| **2002** | Punta Cana | Coliform bacteria<br>*Entamoeba Histolytica*<br>*Giardia*<br>*Ecchinoccoccus*<br>*Salmonella* | 216 | Water | Hotel | (Páez Jiménez *et al.*, 2004) |
| **2005*** | Bahia Principe | Norovirus | 20 | Not specified. By water, food or some other method | All-inclusive resort | (Canadian Press, 2015) |
| **2005** | Punta Cana and Puerto Plata | Norovirus | 773 | Seafood and water | All-inclusive resort | (Doménech-Sánchez *et al.*, 2009a) |
| **2007** | Foreign country | Norovirus | 75 | Airplane | All-inclusive resort | (ProMED, 2007a) |
| **2007** | Puerto Plata | Norovirus | 600 | Not specified | All-inclusive resort | (ProMED, 2007b) |
| **2007** | Puerto Plata | Norovirus | 800 | Seafood and water | All-inclusive resort | (Doménech-Sánchez *et al.*, 2011) |
| **2007*** | Bahia Principe | *Shigella, Salmonella, Giardia* and *E. coli* | 514 | Contaminated food or water | All-inclusive resort | (Meikle, 2009) |
| **2010** | La Romana | *Vibrio cholerae* | 11 | Food and water | A hotel wedding | (Loharikar *et al.*, 2015; Newton *et al.*, 2011) |
| **2013*** | Punta Cana | Not mentioned | 1 | Unhygienic practices and handling of food | All-inclusive resort | (Elliot, 2016) |
| **2018*** | Punta Cana | Not mentioned | 1 | Food poisoning | All-inclusive resort | (TripAdvisor, 2018) |

*Note *: Information on these outbreaks usually anecdotal (e.g., website, blogs, etc.)*

Despite the significant impact of FBD (e.g., food poisoning-like illnesses) on the hospitality industry's performance and its socio-economic development, overall, in the DR, even as a heavily tourism dependent country, very little research has investigated FBD outbreaks associated with the hospitality sector. Moreover, the few related studies available focused on critical controls points in food prepared in households (Michanie *et al.*, 1987) and in street-vended food (Bryan *et al.*, 1988). These studies are out-of-date and limited in scope; therefore, these studies do not provide insight into the current reality related to FBD outbreaks in the hospitality sector in the DR.

Even when tourists acquire a FBD in the country of their tourist destination, they usually do not notify the local health authorities, due to the absence of specific surveillance programmes, poor collaboration between the people involved, limited resources, and poor microbiological confirmation. Travellers often seek medical attention when they return back to their country of origin; therefore, it may be too late to obtain laboratory samples, or they simply do not go through their national health system. Moreover, the lack of a structured system to report cases means that the data associated with most FBD outbreaks end as being anecdotal (Nyarugwe *et al.*, 2020). The limited information available on FBD and outbreaks in the DR is from anecdotal evidence which is not sufficient to estimate the proportion of all the FBD cases and to assess the further impact on health and the socio-economy burden in the country. The literature identifies factors such as sparse reporting of cases, under-reported cases, under-diagnosed cases and weaknesses in the health and reporting surveillance systems. The lack of technical resources, transparency, and commitment is the main failure in the reporting of FBD in less developed countries (Fung *et al.*, 2018; Lencucha and Bandara, 2021; Torrens *et al.*, 2015). Additionally, there is no culture for seeking medical attention for FBD-related symptoms in these countries (Hull-Jackson and Adesiyun, 2019; Mun, 2020). Consequently, FBD incidence in a low-income country like the DR is difficult to estimate because of the deficiencies in their notification systems (Hull-Jackson and Adesiyun, 2019; Jiménez, 2009).

Food safety surveillance, reporting and epidemiological investigation are elements of the national food safety system in the country. Other elements such as the law, regulations, regulatory frameworks, and food management control will be discussed in the next chapter to provide an overview how management controls in the country operate at a national and local level to ensure public health. The existing literature suggests that the DR could be considered as lacking an effective system to record and investigate FBD (Guerra *et al.*, 2016). Therefore, the implementation of appropriate mechanisms at regulator level, and the implementation of

appropriate operational food safety practices, strategies, management, and initiatives regarding specific pathogens within the hospitality sector have become more difficult (Jaffee *et al.*, 2019). Food safety and public health interventions should be tailored to specific risk factors contributing to the particular FBD agent of concern. Hence, more research is needed especially in the DR's hospitality sector to gain more understanding of the common attribution of contributing causes of FBD, and the flaws in the contemporary operational safety practices and systems, including those particularly focused on FBD. It is important to distinguish between tourism and hospitality. Tourism deals with travel and leisure, tour operators, package holidays and cruises while the hospitality sector a subsector of tourism encompasses a wide variety of companies and suppliers providing accommodation, food and beverage and recreation services (Jones and Comfort, 2020).

The hospitality sector is an example of a complex system that encompasses government entities, regulators, private businesses, local enterprises, managers and staff interacting with process, conditions and the effect of human factors. In the hospitality sector, specific stakeholders encompass government, local regulators, hotels, tour operators, foodstuff providers, hotel staff more generally and specially food handlers. This group participating individually, or collectively, across the food system can influence the outcomes and food safety performance of any given organisation. Here food safety performance is considered through FBD cases and outbreaks. Indeed, the degree of stakeholder participation is a determinant of the ability to deliver on food safety/public health outcomes (Nayak and Waterson, 2016). System failure [incidents] may arise in complex socio-technical systems, as a result of a loss of control over a process or activity (Salmon *et al.*, 2012) Within the all-inclusive hospitality sector in the DR, onsite foodservices (e.g., restaurant, hotels) are the major source for FBD, if food safety and hygiene practices, and wider operational practices e.g. those concerning water and waste system management, are not met (Baser *et al.*, 2017; Clark *et al.*, 2019; Gursoy, 2019). The food served and enjoyed by customers in hotels goes through a complex process of transportation, storage, and handling; however, along this process there are plenty of opportunities in which the food could get contaminated. The lack of clean water supplies, the use of untreated or partially treated wastewater, the absence of food inspection, the lack of appropriate equipment, refrigeration and poor hygiene in some hotels are the main food safety concerns (Korukire *et al.*, 2018). Unsafe food can affect the reputation and patronage in the hospitality industry.

A systems-based analytical approach, including consideration of both human factors and organisational aspects, emphasises stakeholder(s)' participation and influence at given system-levels and their role in the chain of events that can lead to a food safety/public health incident (Hamim *et al.*, 2020a; Nayak and Waterson, 2016; Song *et al.*, 2020). In this regard, Stefanova *et al.* (2015) stated that it is more practical to adopt an approach which helps to analyse multiple risk-contributing causes simultaneously than focusing on a single factor alone. Consequently, this is the research gap the current study intends to address by evaluating from a wider, holistic perspective FBD outbreaks and associated practices in hospitality premises in the DR. The following section states the aim and objectives of the research.

### 1.3. Research aim and objectives

The aim of this research is to assess the effectiveness, sensitivity, and appropriateness of systems-based approaches to explore and reflect on FBD outbreaks associated with the hospitality sector. The study will inform policy development, especially in developing economies such as the DR.

The specific research objectives are:

- To critically review selected sources and extract the available information related to the FBD outbreaks in the tourism and hospitality sector with particular focus on the DR.
- To apply systems-based methodological approaches to identify the contributory factors that influence food safety management, hygiene practices and operational practices in the hospitality sector. Furthermore, this objective also encompasses a critical assessment of the multiple contributory factors, and to try to reveal their interrelationships and their impact on the FBD outbreaks.
- To use a stakeholder investigation to evaluate expert opinion about factors, such as hygiene, management and food safety practices, and in combination with the findings of the previous phases of the study to propose practical recommendations for prevention and reduction of FBD outbreaks in the hospitality sector of the DR.

## 1.4. Significance of the Study

This project has several expected contributions to current knowledge to help explain the occurrence of FBD outbreaks in the hospitality sector, inform effective governance in the DR and improve food safety practices. This study applied an exploratory sequential mixed-methods approach contributing to the food safety-related theoretical knowledge as no prior research has been done in this area in the DR. Adopting a mixed-methods provided a more comprehensive approach to assessing FBD outbreaks from different socio-technical perspectives. The quantitative and qualitative combinations of methods were a pragmatic approach in a sector and country where limited information on food safety and hygiene practices, records, and audit documentation exists. This study provides scientific-based evidence and insight into the current state of FBD outbreaks in the hospitality sector in the DR. Before this study, the evidence relating to the DR was primarily anecdotal. Consequently, the appropriate adoption of operational controls to reduce the occurrence of FBD in the DR might not be appropriate. Thus, future research can use the findings from this study to develop future investigations to improve operational and food safety practices in hospitality settings in the DR.

One possible methodological contribution includes the use of a system-based approach which takes knowledge further about FBD outbreaks by providing a more specific description of the factors and preconditions influencing an outbreak through the systemic approach breaking down an FBD outbreak using levels represented in a socio-technical system. The findings highlight those initiatives and strategies to reduce FBO outbreaks in hospitality should focus on food safety and management practices with specific emphasis on water systems. How in practice effective governance of potable water and waste water systems is enacted from the higher level (government) to the lower level (individuals) will directly influence the likelihood of future FBD outbreaks. In terms of practical applications, the study results will provide insights into governance aspects and the appropriateness of operational and food safety practices. For instance, the Dominican government can formulate a national foodborne control programme with operational and food safety guidelines that must be observed on the hospitality premises reduce the likelihood of FBD outbreaks. Appropriate governance includes the multi-governmental agencies in the DR overseeing that food served in hotels is safe and that they comply with national regulations. In cooperation with the private sector, hotel owners, and managers, food safety performance can be enhanced by improving food safety staff training, manuals, signposting through artefacts and appropriate food safety layout design. Furthermore, the recommendations on FBD minimisation strategies in the entire socio-

technical system that emanate from this study will be essential to ensuring the resilience of the hospitality sector in the country.

## 1.5. Thesis Structure

A graphical overview of how the current research structured is shown in Figure 1.7. which illustrates the relationships between the research objectives, and the research questions developed to achieve each research objective. Additionally, the framework outlines the thesis's structure and how each chapter is related.

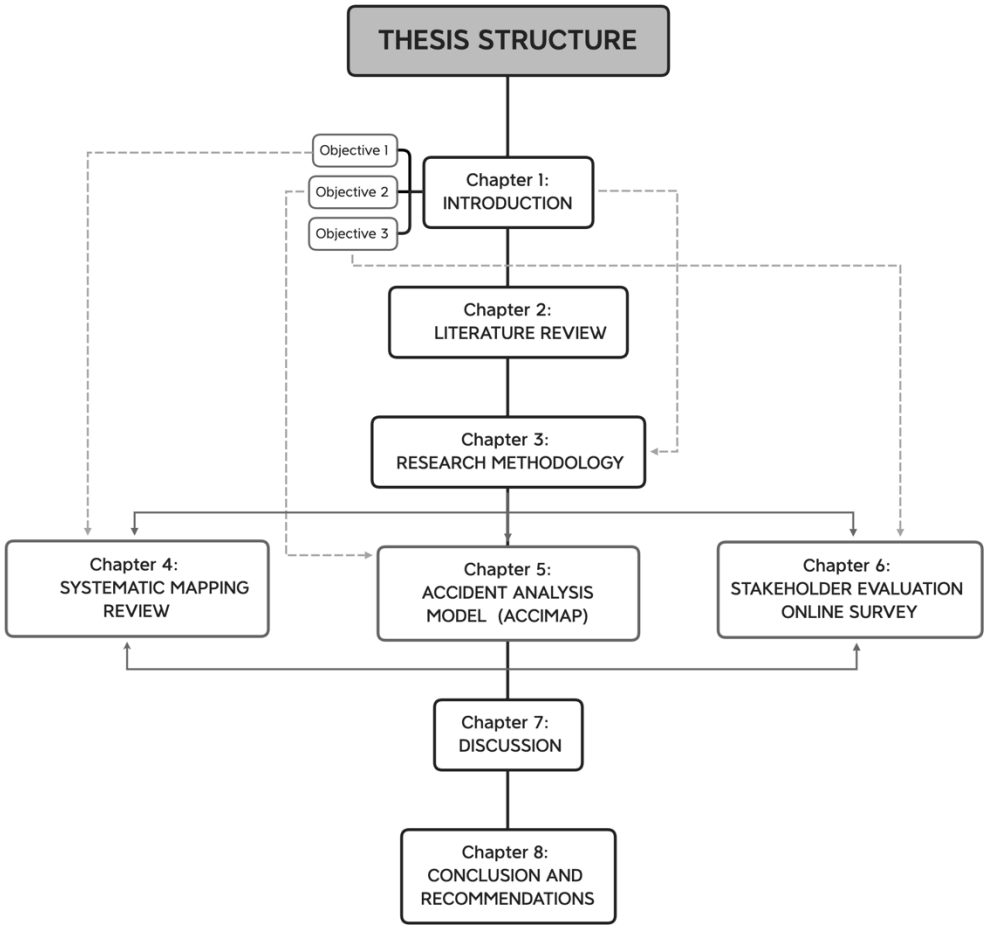



*Figure 1.7 Flow of Research Framework.*

This PhD thesis is organised into six chapters. **Chapter one** gives a brief introduction to the background and the research gap this study seeks to address. It specifies the research aim and objectives and positions the contribution of the study to the research area. **Chapter two**

presents a comprehensive review of the relevant terms and topics around food and the hospitality sector as part of a wider food system, hospitality related FBD outbreaks, food safety regulation, hygiene practices and operational practices in the context of the study. The chapter also explores and critiques the use of systems-based and systemic accident/incident analysis in a range of industries with specific emphasis on foodborne outbreaks. **Chapter three** justifies the choice of a mixed-methodological approach, three phases of data collection involving the quantitative and qualitative studies applied strategically for gathering and organising the available information within the constraints of the COVID-19 pandemic and provides details on how the phases of the methodology are presented in the results section. An alternate format which corresponds to the journal requirement of two published articles in the British Food Journal (systematic review) and Food Control (systems-based analysis) was used respectively for the **Chapters four and five**. Findings of a stakeholder investigation examining professional perspective on the relevant hygiene and food safety practices that could be adopted in the DR is present in **Chapter six**. **Chapter seven** brings together a general discussion focused on the research aim and objectives and addressing the research questions that have been explored. **Chapter eight** provides the conclusion and provides practical and specific recommendations based on the findings of the three methodological phases of the study.

### 1.6. Summary

The chapter reflects on the DR tourism and hospitality industry. This sector in particular has experienced economic growth due to increased investments and consistent patronage from local and international visitors alike, albeit that this was severely affected by the COVID-19 pandemic. Tourism development in the DR has come as a result of the interaction between the various stakeholders who play a fundamental role in the promotion, organisation, development and activity of the industry. However, as previously outlined, the tourism and hospitality industry are highly vulnerable to incidents such as FBD outbreaks and the controls that can be put in place to mitigate infectious diseases which can significantly hinder income generated by subsectors of the tourism industry, such as restaurants, foodservice and accommodation providers in a country. However, the intention of this study is to identify and evidence, from a holistic perspective through the adoption of a mixed-methods approach, how the approaches used can contribute to improve operational and food safety practices in the hospitality sector in the DR. Having identified the research gap, the next chapter, the literature review (Chapter 2) presents a comprehensive literature review critiquing the existing knowledge base.

Sustainable tourism development is driven by the interconnection of all the actors in the public and private sectors who need to embrace the functional links between enterprises operating in the tourism and hospitality sector at all socio-technical levels. The hospitality sector is an element of a wider complex socio-technical system. It means that the hospitality sector is a system comprising various components of social, human, organizational, and technical nature, which are an intrinsic part of their design and structure. Knowing all the actors their roles and interconnectedness will help to identify the challenges and how actors can work together to ensure proactive, preventive hygiene and public health measures to improve local population and visitor health. This is also vital in any country to generate competitiveness and productivity. The next chapter also presents the importance of applying system level, rather than linear, accident analysis as a model to assess FBD outbreaks from a socio-technical system perspective. The systems thinking approach included actors, processes, and governance structures assessing more holistically and comprehensively any systemic failures that might occur and their implications.

# CHAPTER TWO: LITERATURE REVIEW

## 2. Introduction

As indicated in the previous chapter, the hospitality sector is complex. This chapter will provide a general overview of this complexity by showing firstly the regulatory framework of the government institutions involved in the tourism sector and the DR's national food safety regulation in order to understand the hierarchical structure and how the different governments and agencies interoperate to assure the controls are in place to minimise FBD outbreaks in hospitality settings. Furthermore, the narrative critically discusses the application of system accident analysis as a model to assess FBD outbreaks more holistically and comprehensively in order to identify systemic failures. The chapter includes an analysis of approaches to systemic accident analysis and different models are critiqued in how they can be applied in the FBD context for appropriate risk and safety management.

### 2.1. Dominican Government Regulatory framework

Food safety regulation became more important, was implemented by new laws in Caribbean islands after 1990's and was primarily motivated by the intensification of international trade (Lu *et al.*, 2021). It has been observed that international trade and food commodities influence the development of more detailed national and local food safety regulations which adopt the contemporary concepts of food safety (Henson and Jaffee, 2008; Mohammed and Zheng, 2017). In the DR, economic diversification towards tourism and agri-food export has placed new political demands and concerns on government and local health authorities to enhance and maintain food safety standards in the country. Oloo *et al.* (2018) stated that international standards such as those agreed by the Codex Alimentarius Commission (CAC), International Organisation for Standardisation (ISO) and the World Organisation for Animal Health (OIE) and Phytosanitary Standards (SPS) have been widely adopted since the 1990s (WTO, 1996). The above-mentioned international standards deal with risk management measures and encourage the production of high quality and safe commercialised global markets. In addition, Hazard Analysis Critical Control Point (HACCP) is a mandatory requirement of the countries to which DR produced food is exported; and implementation of associated prerequisite programmes is required.

There was a dynamic trend in the adoption of international standards by the Dominican government and its regulatory agencies. As a result, the DR became a participant in the following trade agreements: (i) the Dominican Republic, Central America and the United States Free Trade Agreement (DR-CAFTA); (ii) The Economic Partnership Agreement between the European Union and the CARIFORUM nations (EPA); (iii) Free Trade Agreement between the Dominican Republic and the Caribbean Community (CARICOM-RD); and (iv) Commercial Treaty between the Dominican Republic and the Republic of Panama (Partial AAP Scope); which all utilise Codex Alimentarius Commission (CAC) standards (Adoexpo, 2020). These commercial agreements were the main factors for the DR's success in accessing some food business sectors of developed markets in the United States (US), the UK and the European Union (EU).

Food safety in the DR is a shared responsibility between the private sector, consumers and the State. The private sector must produce safe food, consumers must demand and acquire safe food, and the State must develop the laws, regulations, standards and resolutions. It must also ensure that the production sector complies with the level of protection of public health established in the legislation. Numerous laws and regulations govern the foodservice sector in the DR. These relate to the production, processing, storage, retail, packaging and labelling of food products including the General Law on Health, General regulation for risk control in food and beverages, and regulations on sanitary inspection of meat and meat products for export and food sanitary standards.

### 2.1.1. National food safety control and system and regulatory agencies

The overall legal responsibility for food safety in the DR sits within four government ministries: the Ministries of Presidency, Health, Agriculture, and Industry and Commerce. Key strategies from these ministries included surveillance, inspections, training, public education, and risk analysis. Within these ministries are some key units or divisions (CONASSAN, DIGEMAPS, SIDOCAL, CONSATUR, DIA, DIGEGA and Pro-Consumer these government bodies have a direct responsibility for regulating food safety. Laboratory services such as the National Laboratory of Public Health Dr. Defilló, (LNSPDD) and The Central Veterinary Laboratory (LAVECEN) are in place. These laboratories provide support for the regulatory epidemiological surveillance processes, regulatory functions and providing support for state policies on animal health, safety, food safety and biological production. In this regulatory framework

inspection/visits are based on checklist systems to determine compliance with specific items outlined in the appropriate regulations for each responsible agency.

In 2012, the Dominican government harmonised its national quality infrastructure system (QIS) under a unique framework. The Law 166-12 creates the Dominican System for Quality (SIDOCAL). The Dominican Council for Quality (CODOCA) is the highest authority of SIDOCAL in charge of formulating and coordinating the policies and guidelines related to the Quality System. It defines the quality policies that are of national interest in the areas of metrology, standardisation and technical regulation, testing, accreditation and certification. The CODOCA overseas the work, technical functions and competences of two institutions: the Dominican Institute for Quality (INDOCAL) which is in charge of metrology, standardisation and conformity assessment, and the Dominican Accreditation Body (ODAC) (SIDOCAL, 2022).

The regulatory food safety management system in the country is still in a development phase when the most comprehensive legislative document on food and nutrition security, in the DR was issued in 2016. This Act supports the creation of the National System for Food and Nutrition Independency and Safety (SINASSAN) which is responsible for the development of policies and plans concerning food security, nutrition and food quality. This institution is governed by the National Council for Food and Nutrition Security (CONASSAN) which is a unit of the Ministry of the Presidency (SINASSAN, 2022). This regulation requires an integration between the different actors in the food supply chain. It outlines the base for strengthening partnerships and delivering effective results toward national food safety strategies. According to Morse (2018) the achievement of these food safety related strategies requires effective integration at national level of a wide variety of aspects considering food security, nutrition, health, economic development, agriculture, and tourism activities.

### 2.1.2. Food safety framework in the hospitality sector

The Dominican government has an active governance process in the tourism and hospitality sector and direct involvement in tourist projects, development strategies, investments, incentives, and partnership strategies with private enterprise. An inter-sectoral collaboration between the Ministry of Health and Tourism seeks to address both food safety and public health by supervising, monitoring, and evaluating food safety and hygiene practices and compliance on premises such as hotels, restaurants, and entertainment centres. In addition, the epidemiological surveillance seeks to control and prevent communicable diseases, especially

those transmitted by food, vectors (insects, rodents) and sexually transmitted diseases (Decreto No. 15-5, 2022).

The food safety regulations in the DR establish that any proprietor of a food premises must take all appropriate steps and protection measures to ensure that food is handled properly. This regulation is intended to protect food from becoming contaminated and prevent the transmission of disease to other food handlers or customers. Food safety authorities in the DR promoted the adoption of pre-requisite programmes (PRPs) such as Good Agricultural Practices (GAP), Good Manufacturing Practices (GMP) and Good Hygienic Practices (GHP) including the use of food processing technology (Machado-Moreira *et al.*, 2019). PRPs such as GHP, staff training and documented standard operating procedures provide the formal foundation for, and assist in, the successful implementation of HACCP (Ricci *et al.*, 2017). HACCP-based systems are important for all food businesses along the food chain. Additionally, the adoption of private standards (e.g., Food Safety System Certification 22000 (FSSC 22000), International Featured Standards Foods (IFS Food), Safe Quality Food (SQF) which are common in the food industry but especially relevant in the hospitality sector is important, where most of the hotels are part of international tourist chains. As a result, the hybridisation of food safety governance has emerged which is an open window to adapt public, private or semi-private standards and certification systems to assure quality and safety by different actors (Verbruggen and Havinga, 2017). Manning and Kowalska (2021) elaborate that there is a positive contribution to ensure public health by hybrid public-private food safety governance models despite the challenges and the encountering of self-interest between actors. The inter-collaboration can enhance the country's national food safety system that is then capable to deal with the current food safety challenges.

In the DR, the hygiene and quality assurance systems implemented in hospitality and tourism companies are mainly based on self-assessment (65%) and inspection by regulatory bodies (60%). A small number of companies comply with international certifications of quality and tourism excellence (20%), certification in sustainable tourism (15%), ISO standards (11%) and other standards linked to recommended procedures by business associations, and parent company regulations (Protep 2, 2019). Other certifications in the hotels are related to environmental management such as waste recycling, waste management, clean air, energy and water conservation, environmental health and building permits. According to Hsieh (2012), environmental management and certifications generate benefits for the hotels by creating a

positive brand image for the stakeholder and declaring an engagement with environmental issues.

Pies *et al*. (2020) stated that hybridisation occurs due to an innovation in the food safety governance structure. Food safety governance innovation in the country have occurred by international influence to meet the international governmental organisations demands and to facilitate global trade. In the hospitality sector the change in governance structure is notably seen in some foreign management hotels, restaurants and fast-food chains which needs to comply with international standards, and have harmonised their entire business operation, and certified their management process by third party certification body.

Private certifications in the DR are provided by several international companies which assess the compliance of hotel premises for hygiene, food safety, environmental and sustainable tourism. In the country, 73 hotels premises are certified with Cristal international standards. The certifications are awarded by Check Safety First a UK company that professionally evaluates hotel establishments and food and beverage services, in order to verify compliance with food safety and quality management systems in different areas (Cristal Standards, 2022). AAA DIAMOND certification which evaluates the compliance with certain requirements which also includes hygiene aspects. Based on the compliance level of the establishment it is awarded from 1 to 5 diamonds. In 2019, the DR had one hotel with 5 diamonds and 23 with 4 diamonds. Servsafe is an international certification body. They offer several certifications of and training for food handlers employed in foodservices, following the guidelines and recommendations of the food code of the United States Food and Drug Administration (USFDA). A higher compliance than other food business can be achieved if similarly, government authorities adopt a hybrid of the traditional inspection checklist including a risk-based approach to maintain context appropriate food safety management systems (FSMS) which can support improved food safety across the sector.

Another aspect that hybridisation might improve is the communication and information flow between private and public organisations especially in the sharing of food safety information. Previous sections in this chapter have been outlined the shortage of information of reported and published FBD outbreaks, epidemiological surveillance, information on contamination in foods and a general lack of communication at both policy and practice levels. For instance, there is a significant paucity of data about the hygiene and food safety practices and policy information of the hotels in the tourism industry in the DR. Data gathered information available

on the internet about the hygiene and food safety practices and policies information. Table 2.1 shows that from the multiple international hotel chains in the country located in different regions in the country. In 2019, when the web search was undertaken most of the hotel's webpage reviewed did not offer or provide information about the hygiene and safety practices embedded in the hotel's premises.

*Table 2.1 The availability of information related to the hygiene and food safety practices on the websites of some prominent multinational hotels in web search undertaken on 28th March 2019.*

| **Multinational hotels** | **Geographical location** | **The availability of information related to the hygiene and food safety practices** |
|---|---|---|
| Amresorts<br>Dreams Resorts and Spa | Punta Cana | No |
| Bahia Principe | Samaná<br>La Romana<br>Punta Cana | Yes |
| Barcelo Hotels and Resorts<br>Occidental Hotels and Resorts | Punta Cana | No |
| Be Live Hotels | Santo Domingo La Romana<br>Puerto Plata<br>Punta Cana | Yes |
| Club Med | Punta Cana | Yes |
| Intercontinental Hotels and Resorts<br>Crowne Plaza<br>Holiday Inn | Santo Domingo | No |
| Hilton | Santo Domingo | No |
| Hodelpa | Playa Dorada<br>Puerto Plata<br>Juan Dolio | No |
| Iberostar | Bayahibe<br>Puerto Plata<br>Punta Cana | No |
| Palladium Hotels Group | Punta Cana | Yes |
| Radisson | Santo Domingo | No |
| Sheraton Hotels and Resorts<br>Marriot<br>Renaissance Hotels<br>Marriot | Santo Domingo | No |
| Sol Melia Hotels and Resorts | Bavaro<br>Punta Cana | No |
| Viva All Inclusive Wyndham Resorts | La Romana<br>Cabarete<br>Las Terrenas<br>Puerto Plata | No |

Communication among customers, stakeholders, private and public agencies is critical to deliver and share information about food safety issues and emerging risk to traveller, customers, food handlers and health officials. The more effective, iterative exchange of information concerning risk will provide better food safety management, controls and a preventive approach.

## 2.2. Barrier and limitations of the current methods in place for evaluating food hygiene and food safety

Song *et al*. (2020) state that effective food safety risk management comes from understanding the risk and hazards related to a food safety incident and the means for their control. In addition, the HACCP-based FSMS has been considered as a fundamental system to control FBD and for effective management of food safety (da Cunha *et al.*, 2022). In the DR, there is a need for the adoption of HACCP based FSMS in food businesses and other private standards as a prerequisite to supply/operation and this must be enforced by food safety regulators (MSP, 2022). This is especially true in hotels and restaurants where the majority of the visitors stay and where food is prepared and served, and effective food safety practices and management control are required to prevent incidents from occurring. However, in general, less developed economies struggle to develop, adopt and enforce food safety legislation and PRPs along the food chain, this is challenging as they are of systemic importance to the effective implementation of HACCP (Lee *et al.*, 2021). Even in food businesses where some of these barriers have been overcome and steps are taken and prioritise HACCP-based FSMS is prioritised, food safety failures are still an issue (Wallace, 2014). This problem is worsened in the situation where barriers to HACCP and FSMS adoption exist. This is the case of the DR where the availability of time, economic resources and knowledge about the system were identified as major barriers faced by food businesses that prevent adoption (Tavárez, 2020). The lack of appropriate and sufficient food safety practices, due to flaws in PRPs and HACCP adoption weakens the foundations of the FSMS enabling the growth of food pathogens, cross-contamination and improper food handling practices, all determinant antecedent reasons for FBD outbreaks (Putri and Susanna, 2021). International standards certification based on the HACCP principles (e.g. ISO 22000) are widely approved approaches that can be used for the effective development of FSMS with significant competitiveness advantages for the food companies by compliance with national and international standards (Kotsanopoulos and Arvanitoyannis, 2017; Manning *et al.*, 2019; Yang *et al.*, 2019).

While barriers to FSMS implementation are particular for each food business, they are generally are related to lack of knowledge, staff and technical aspects, business demand, human factors, financial resources and pre-requisites of the HACCP system (Casolani *et al.*, 2018; Lee JC *et al.*, 2021; Yang *et al.*, 2019). These barriers can hinder implementation of food safety controls in a food business. Consequently, this failure to embed effective food safety management practices has a negative impact on the overall values and behaviours towards food safety and in the development of FSMS (Nyarugwe *et al.*, 2020). In the DR, food safety control strategies do not operate within nationwide strategies; conversely different ministries and agencies take action at a different stage of the food safety chain. In less developed economies, food safety governance is challenged by limited inter-ministerial collaboration, the lack of clear delineation between ministries and overlapping activities between the ministries, and their agencies (Guerra et al., 2016; Hull-Jackson and Adesiyun, 2019; Morse, 2003). Food businesses in the hospitality sector and their compliance with the food safety regulations and management systems is a complex issue. However, national food safety strategies should be focused on an active preventive approach to mitigate food safety risk, science-based risk management, transparency and openness to manage and communicate food safety.

Conversely, even in businesses that have well implemented, verified and audited FSMS, in the food industry, repeated recalls and FBD outbreaks have occurred and remain a significant concern for governments, health authorities, private business and consumers (Faour-Klingbeil and Todd, 2020; Nayak and Waterson, 2019; Rustia *et al.*, 2021) Notable outbreaks linked to meat, beef and peanut associated with *Listeria* outbreaks (Howell and Miller, 2010), *Salmonella* outbreaks (Irlbeck *et al.*, 2013) and *E. coli* outbreaks (Curry, 2013) are reported in the literature (Manning, 2017; Nayak and Waterson, 2017; Powell *et al.*, 2011; Vashisht, 2018). These incidents are examples that there are underlying factors contributing to food safety practice failures within an organisation, often with tragic consequences to consumers and the organisation. It raises concerns about HACCP's reliability alone in developing and implementing a fully effective FSMS. Researchers agree that HACCP-based FSMSs seems to be insufficient to completely mitigate the risk of FBD (Kafetzopoulos *et al.*, 2013; Wallace, 2014).

The underlying factors contributing to failure in the food safety practices can be related which a range of factors and which also involved the stakeholders that play a role in in providing food which is safe for consumption. These include every activity along the food chain which include

regulators, hygienic and safe transportation, the appropriate use of chemicals and pesticides, microbial growth conditions, food safety management systems in food businesses, and storage conditions. Conversely, a system-based approach underpinned by a theory which avocates a holistic point of view towards ‘accidents’ such as FBD outbreaks is of value. The complexity among individual behaviours and their interactions with the events that contribute to an 'accident’ in a sociotechnical system should be recognised as the purpose of of the sytems-based approach is the uncovering of the contributory factors leading up to an accident (Waterson *et al.,* 2017; Wang *et al.,* 2018).

## 2.3. System accident analysis in complex socio-technical system

### 2.3.1. System thinking

Systems thinking is an approach that sees all the interrelated elements in a given environment, combines them in a holistic framework and considers the system as an inseparable entity in the analysis (Horvat, 2019). Systems thinking perspective, views a system as made up of interrelated components that work together to achieve a common objective (Arnold and Wade, 2015; Dekkers, 2015). Therefore, this perspective helps to practitioners to understand better how system works and the role that people play in the system which enables them to work more productively and proactively (Nayak, 2018). In contrast, the traditional accident analysis approach was, as previously described, focused on analysing an individual unit of a system (Salmon *et al.*, 2014). This alternative holistic approach in systems accident analysis is broadly accepted because it is considered as superior in identifying and understanding the potential interrelations and multiple causal and contributory factors. Contemplating the causal and contributory factors is both obligatory and necessary in order to identify their occurrence and to assess their impact on the particular accident that has occurred.

Modern operating systems are comprised of a variety of components of social, human, organisational, and technical nature which are an intrinsic part of their design and structure. The interactions of these components can produce emerging dangerous phenomena across the sociotechnical system of people and systems (Salmon *et al.*, 2013; Stanton *et al.*, 2012). A more simplistic and reductionist view focuses attention on either human errors or technical aspects (Fan *et al.*, 2015) and how an undesirable outcome, like an accident, happens in a system or organisation (Karanikas et al., 2020; Newnam et al., 2017; Read et al., 2013). This leads, rather than being systems-based, to an analytical approach of isolated cause-effect

models or linear models which are trying to identify the responsible single point of failure or individuals or to put the blame on someone who at the time of the accident was performing the operational activity or was involved in some closely related primary tasks (Salmon *et al.*, 2021; Underwood and Waterson, 2014). Cooke (2003) tried to introduce a more cohesive approach to accident analysis and argued that individuals, procedures or devices should not be considered as a single point of failure, or as the main reason for the accident, but the accident should be assessed within the entirety of the socio-technical system.

Accident analysis models based on systems thinking is an approach that is receiving recent attention in the food safety literature (da Cunha *et al.*, 2022; Wiśniewska, 2022) These models can assist in the response to complex food safety-related issues as they can be used to develop in-depth analyses of the systems in which an issue occurs and identify what factors of the systems interact to create the food safety failure, or FBD outbreak. Moreover, they improve understanding of the underlying causes in the food safety context leading to a given failure [incident] by extending perceptions of a given situation beyond the direct causes to identify how safety can be built more holistically into a given system (Hamim *et al.*, 2020a; Stefanova *et al.*, 2015). In addition, these models can provide valuable insights into the contributing factors and also in identifying systemic failure where proactive interventions and measures can be applied to improve the existing FSMS.

Moreover, accidents in high profile industries such as transportation, water distribution, public health and space exploration have triggered research and efforts in the area of safety management. Researchers and investigators are adopting the socio-technical system approach to investigate and analyse accidents through the scope of a specifically designed theoretical lens (Salmon *et al.*, 2012; Waterson *et al.*, 2015). Consequently, new concepts and theories have been underpinned by a system thinking philosophy (Hulme *et al.*, 2019). In this regard, (Fleetwood *et al.*, 2019), (Jespersen and Huffman, 2014), and (Nayak and Waterson, 2016, 2017, 2019) point out that common to the aforementioned *Listeria, Salmonella* and *E. coli* outbreaks was a 'human element' that contributed to failure, regardless of specific management failures, technical deficiencies and/or inadequate sanitisation procedures. In summary, in these incidents people's behaviour or the food safety culture (FS-culture) e.g., the unseen central values prevailing in a business toward food safety (Griffith et al., 2010; Yiannas, 2008) contributed to the incident. In a food business a negative or poor FS-culture is a clear risk that could lead to foodborne illness and worldwide FBD outbreaks (Jespersen and

Huffman, 2014; Vashisht, 2018). Consequently, FS-culture is considered to be a new emerging and a serious factor affecting food safety performance (Wiśniewska *et al.*, 2019)

Business commitment to providing safe food by the implementation of food safety practices and FSMS will help to build a positive FS-culture. Moreover, the assessment of FS-culture has become increasingly relevant to identify the current attitudes towards food safety in a business, and to improve or strengthen it. In this aspect, authors have stressed the importance of recognising the interconnection of human behaviour within the culture of the organisation (Fleetwood *et al.*, 2019; Griffith, 2006). (Griffith et al., 2010) suggests that it is of value to assess organisational FS-culture rather than just consider traditional food safety risk factors involved in food safety incidents. However, FBD outbreaks in the food service sector can also be due to errors in the wider food chain (Soon *et al.*, 2020). The adoption of FSMS and the promotion of a good FS-culture faces many challenges in a complex sociotechnical system. Therefore, the identification of the root causal and contributory causes of a FBD outbreak is critical to provide more effective controls to mitigate the occurrence of future FBD outbreaks (Lee *et al.*, 2021).

In this regard, Nyaguare *et al*. (2016) stated the importance of the systems approach to support and enhance more effective HACCP-based FSMSs. It offers a holistic approach to addressing the hospitality sector's prevailing FS- culture. Furthermore, human error, such as unintentional errors, lapses, or omissions, is viewed as a systemic human feature associated with humans' tasks and their work environments that could led to the emergence of food safety hazards (Wiśniewska, 2022). This rationale has led to a shift in the paradigm to assess food safety issues beyond the conventional reductionist, linear approach associated with the blame culture considering the prevailing FSMS and the FS-culture and being limited in representing the full picture. The shift is towards considering the socio-technical aspects of food safety management as a whole, in order to identify and analyse the factors and interactions of all stakeholders involved in the specific sociotechnical system. The systems-based safety approaches have been originally applied in other industries rather than the food industry, for instance, high-profile industries such as aviation, healthcare, nuclear plant, coal, and oil mining (Akyuz and Celik, 2015; Altabbakh *et al.*, 2014; Igene *et al.*, 2022; Kee *et al.*, 2017; Qiao *et al.*, 2019; Salmon *et al.*, 2010, 2012; Waterson *et al.*, 2017) In these applications, system accident analysis has had significant success in accident investigation due to its ability to evaluate, analyse and recognise patterns in the interdependencies and interactions that occur in the above-mentioned high-

profile industries (Dolansky *et al.*, 2020; Goode *et al.*, 2014). The following section will provide an overview and describe in more detail the application of accident causation models.

## 2.4. Classification of accident causation models

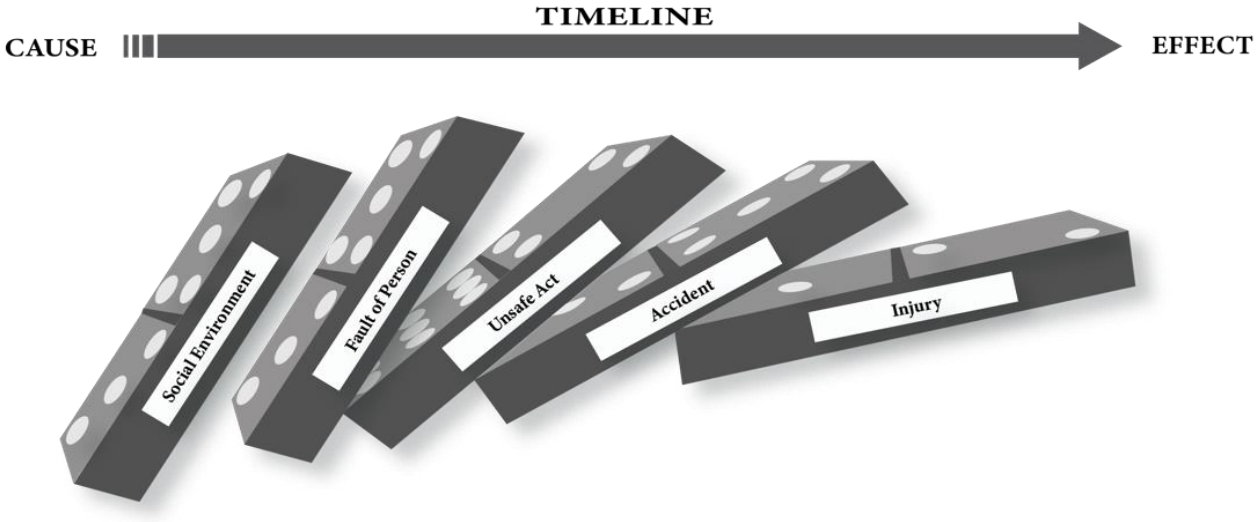
Each approach proposes a specific theory to provide insights into the errors or chain of events causing the accident (Grabbe *et al.*, 2020; Stefanova *et al.*, 2015; Waterson *et al.*, 2017; Yousefi *et al.*, 2019). There are several classifications of accident models and analysis approaches which are in general based on their characteristics related to the particular time of appearance and development of the models and the area of their application. Accident model analysis are classified into sequential, epidemiological and systemic analysis techniques (Al-shanini *et al.*, 2014; Fu *et al.*, 2020; Ge *et al.*, 2022; Grabbe *et al.*, 2020; Jacobsson *et al.*, 2009).

### 2.4.1. Sequential accident analysis

Among the oldest accident models are also the sequential accident model. This was one of the first accident analysis describing the accident as a chain of events occurring in a particular time sequence (Grabbe *et al.*, 2020). Other examples for traditional sequential models are Analysis Fault Tree (FTA), Analysis Event Tree (ETA), Analysis Failure Modes and Effect Analysis (FMEA) which considered the causes leading to an accident as a linear sequence of events (Delikhoon *et al.*, 2022) Over the years these methods have been updated and developed and relocated the emphasis and identification of failures from individual faults towards the defects in the management system (Yousefi *et al.*, 2019) For instance, the traditional root cause analysis (RCA) is a structured framework for safety investigation showing in detail the reasons and pre-requisites for the occurrence of the ‘accident’ (Wangen *et al.*, 2017). The main goal of using this method is to identify the primary ‘root’ cause of hazards, events or problems have originally been used in psychology and systems engineering (Wu *et al.*, 2008). Domino Theory is a sequential accident model. It was proposed by Heinrich in 1931 (Heinrich, 1931) and further redefined by other researchers in (Jacobsson *et al.*, 2009).

### 2.4.2. Domino theory

Domino theory is based on the assumption of a clear cause and effect event. Figure 2.1 shows the five sequential causations present in the accident model (Social environment, fault of person, unsafe act, accident, injury).




Adapted from: (Peerally, 2021)
*Figure 2.1 Heinrich's Domino Model of Accident Causation.*

The main focus of system analysis methodology is on the actual accident, which is defined in the related safety literature as an unexpected and sudden event that leads to an undesired outcome such as loss, damage, injury or ill-health (Li *et al.*, 2019; Wienen *et al.*, 2017). System analysis views an accident as an independent or unplanned and sudden event resulting from an undesirable change in the existing environment or from unsafe behaviours of individuals involved in the event. Similarly, in the food context, poor operational behaviour in terms of towards food safety at any stage in the food chain can lead to a food safety incident or FBD outbreak. Furthermore, the analysis also considers the importance of interactions of multiple factors which further expand the apparent context of the accident itself (Cooke, 2003; Fu *et al.*, 2017; Goode *et al.*, 2016; Underwood and Waterson, 2014; Wienen *et al.*, 2018).

Models, tools, and techniques in the sequential classification, as with the above-mentioned, can help to answer and understand who and why in this case the FSMS or regulatory breach that led to the food safety incident. Yousefi *et a*l. (2019) states that understanding the reasons associated with accidents can help in performing the analysis and could also provide guidance

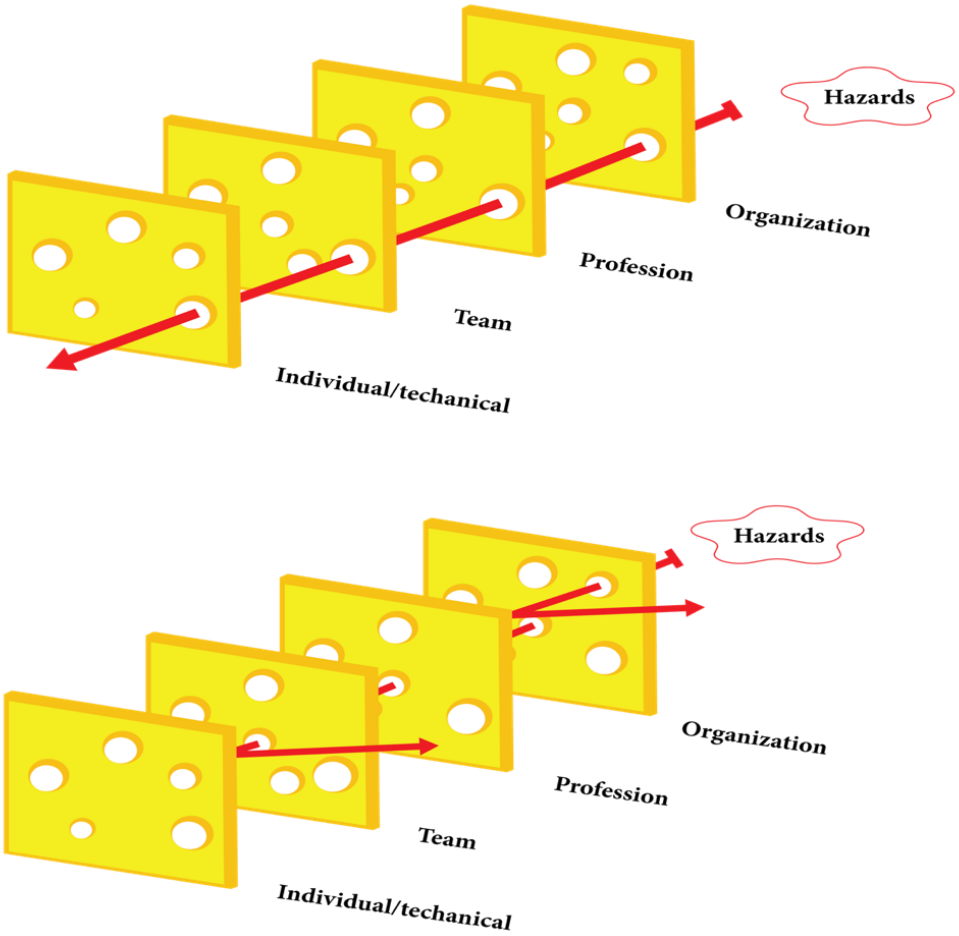
for preventing accidents in the future. According to Rasmussen (1997), accidents are an inevitable part of any operating system; they can happen at any stage during routine work practices and can be caused by various actors working at different levels of the system. The probability of an accident is also affected by the fact that any operating system is a set of multiple components that not only have an ultimate goal, precise purpose or particular task but also interact with each other (Karanikas *et al.*, 2020). These models and techniques provide recommendations and suggest solutions for preventing the occurrence of adverse situations in the future (Meyers and VanGronigen, 2020). In general, the advantage of these systems-approach based-methods lie in their simplicity, the sequential steps of analysis of the accident and their applicability in many areas. The successful development of systems-approach based methods has led to their improved maturity and they are regarded as being well-established models (Wienen *et al.*, 2017). However, (Grabbe *et al.*, 2020) argue that these models are not always suitable nor very effective in the explanation of some accidents especially when they occur in a more complex system.

## 2.5. Epidemiological accident analysis

In the epidemiological accident analysis approach, methods change the focus from human factors to the organisation (Grabbe *et al.*, 2020; Waterson *et al.*, 2017). In this integration of human factors, the accident is described in terms of human behaviours and actions. Methods in this classification seems to improve the understanding of accidents in more complex systems. Epidemiological accident models have their roots in the field of disease epidemiology (Qureshi, 2007). This model tries to explain accident causation using the analogy of scientific, systematic, and data-driven study of the distribution (frequency, pattern) and determinants (causes, risk factors) of health-related states and events. The best example of the epidemiological model is the **Swiss Cheese Model (SCM)** proposed by James Reason in the early 1990s.

### 2.5.1. Swiss Cheese Model (SCM)

The SCM is a type of a graphical model in which the barriers of the system which prevent the losses are presented as slices of cheese and the holes in the slices indicate the failures, errors, or weakness in the system (Figure 2.2) (Larouzee and Le Coze, 2020).




Adapted from: (Peerally, 2021).

*Figure 2.2 Reason's Swiss cheese epidemiological model.*

Graphically, when the accident occurs the interaction of several root cause factors is presented as one major hole which appears when the individual holes from different slices align. It is enough however, for only one slice (or aspect of the sociotechnical system) to remain as a barrier against the emerging holes to prevent the evolution of the existing hazard into an actual accident (Yousefi *et al.*, 2019).

A significant contribution to the development of the epidemiological accident analysis models has come from Professor Reason (Reason, 2007). He was the first to introduce the term *latent condition* which is explained as factor/s that exist in a system, usually undetected for a long time, but they create certain pre-requisites for the occurrence of an accident. However, the latent condition cannot directly trigger the accident by itself but suggests the existence of some suspicious deviations in the system (Jacobsson *et al.*, 2009). The combination and interaction

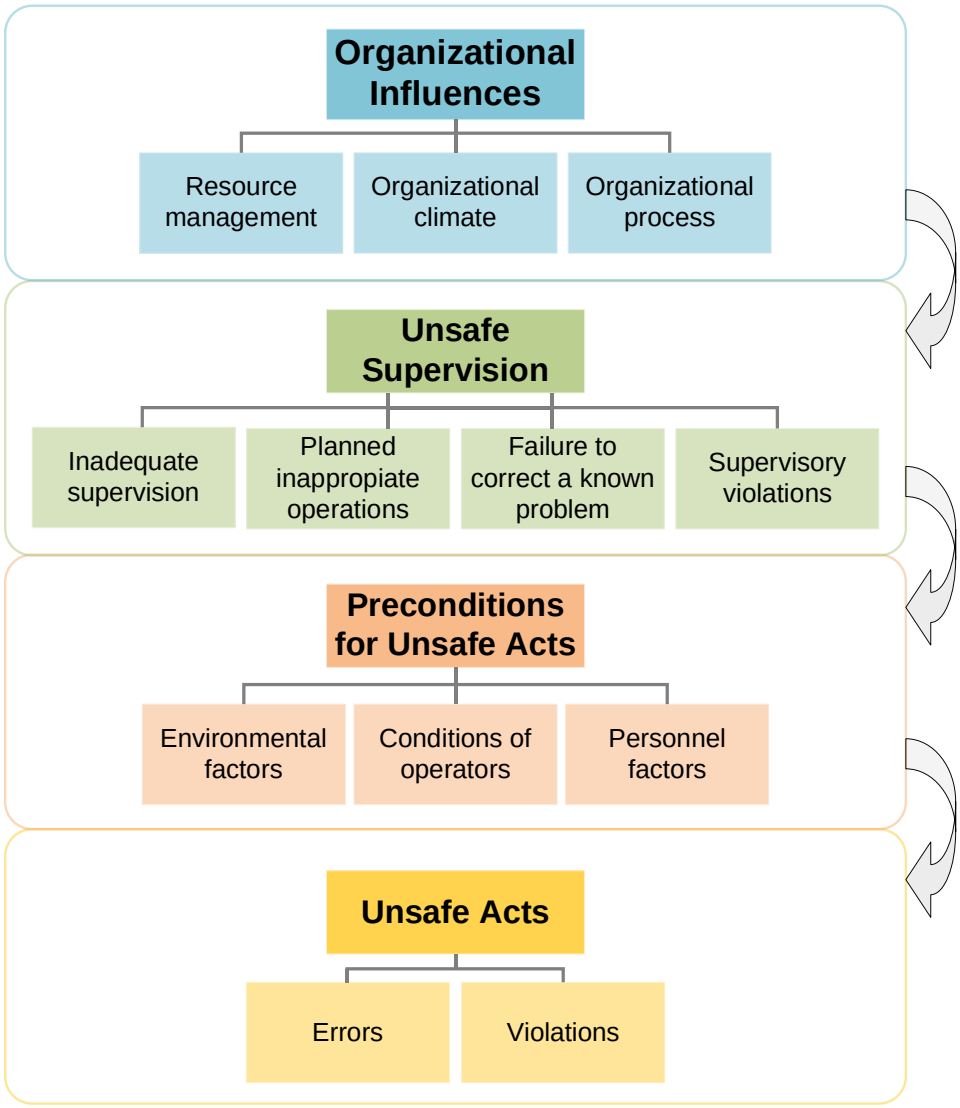
of difrerent factors thus combine to create the conditions for the accident (Stefanova *et al.*, 2015; Zhang *et al.*, 2018). Recently, food safety researchers have used this SCM to illustrate the barriers and weaknesses of individual behaviours in an organisation, outlining their importance to FSMS realities (Wiśniewska, 2022). In addition, da Cunha *et al.* (2022) proposed the SCM as a new perspective on food safety and explore the SCM to manage food safety risk and to educate people about food safety. A critique of the SCM is that beside the emphasis on human factors and the identification of active and latent faliures in a system this model fail to represent the dynamics of a system and how these factors are associated and interconnect, therefore as a model, it do not fully capture the nonlinear interactions that can occur (Thoroman *et al.*, 2020a; Waterson *et al.*, 2015). As a result, the interactions among factors and stakeholders across the sociotechnical system that exist in complex systems such as the food industry can not be conveyed in the depth requiered with this SCM as the dynamics of the model can oversimplifying the incident. Moreover, latent conditions and active errors may not be well characterised because they hay be distance from the locus of the actual incident; therefore, in a preventive model would not necessarily be possible to identify the latent conditions and potential failures and then create a defence layer.

Other models in this epidemiological accident analysis classification are based on the same principles established by Reason's SCM, as a result, they do not give a precise categorisation of the factors or the latent conditions which are the reasons for the accident. In order to overcome these limitations, the model analysis approach was upgraded by including a classification scheme of failures (Shappell and Wiegmann, 2000).

### 2.5.2. Human Factors Analysis and Classification Scheme

The Human Factors Analysis and Classification Scheme (HFACS) shown in Figure 2.3applies four levels of analysis and ranks the failures as follows: (i) dangerous acts; (ii) the preconditions for dangerous acts; (iii) dangerous supervision; and (iv) organisational influences. This classification is important because it helps the entire analysis process and the analyst to classify the identified failures with more accuracy and clarity. In this modified approach the human factor is considered as the main and most important reason for the accident in the operating system (Hulme *et al.*, 2019; Li *et al.*, 2019; Salmon and Lenné, 2009). According to Grabbe *et al.* (2020) the introduction of the human factor into the investigation and the analysis greatly improves the understanding of accidents and contributes to the application of the

method in more complex accident scenarios. However, the HFACS has the same disadvantage as the SCM as it considers the causality of events or accidents as being linear. The links between different stages of the accident are still loose and thus the method does not fully represent the dynamics of the system being analysed.




Adapted from: (Diller *et al.*, 2014).

*Figure 2.3 A detailed scheme from the Human factors analysis and classification systems (HFACS) model.*

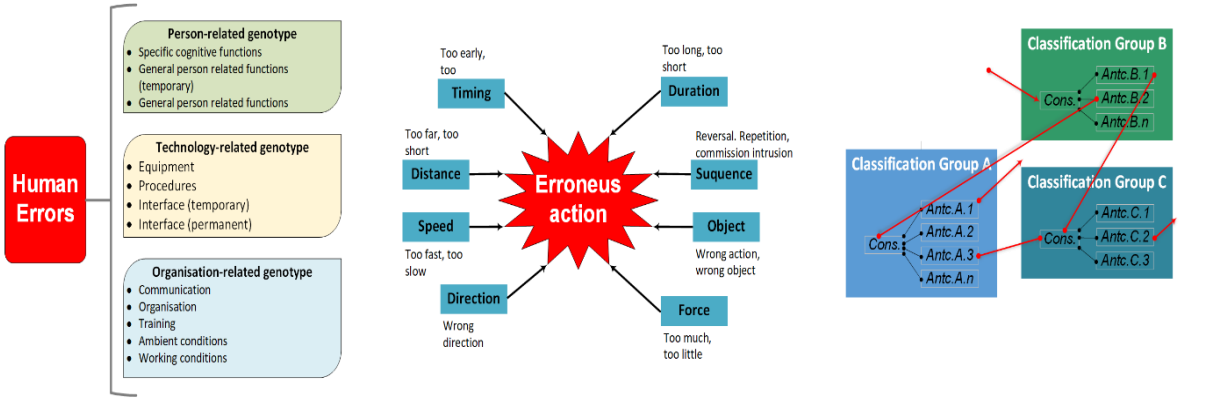
The next stage of development in accident analysis modelling has focused on the development of more robust models which have tried to overcome the limitation of the traditional accident analysis, especially their linear approach to the accident due to the low effectiveness of considering linearity when accidents occur within the dynamic socio-technical system that is often under investigation (Leveson, 2012).

## 2.6. Systemic analysis techniques systematic models

A holistic approach to accident analysis can be adopted to describe an accident as a complex and interconnected network among the major system components of a technical, human, organisational, and managerial situation (Delikhoon *et al.*, 2022; Grabbe *et al.*, 2020; Underwood and Waterson, 2014). This holistic approach is broadly applied in the systemic accident analysis models which are considered to be the most advanced contemporary models. Contemporary models have been developed, improved, and used by many researchers (Fu *et al.*, 2020; Grabbe *et al.*, 2020; Thoroman *et al.*, 2020a; Waterson *et al.*, 2017; Yousefi *et al.*, 2019)

### 2.6.1. The cognitive reliability and error analysis method (CREAM)

In the cognitive area of systemic models, the work of Hollangel focused on cognitive reliability and as a result the cognitive reliability and error analysis method (CREAM) was proposed (Hollnagel, 1998). This model assesses the causes of accidents using a retrospective analysis.




Adapted From (Fu et al., 2020)

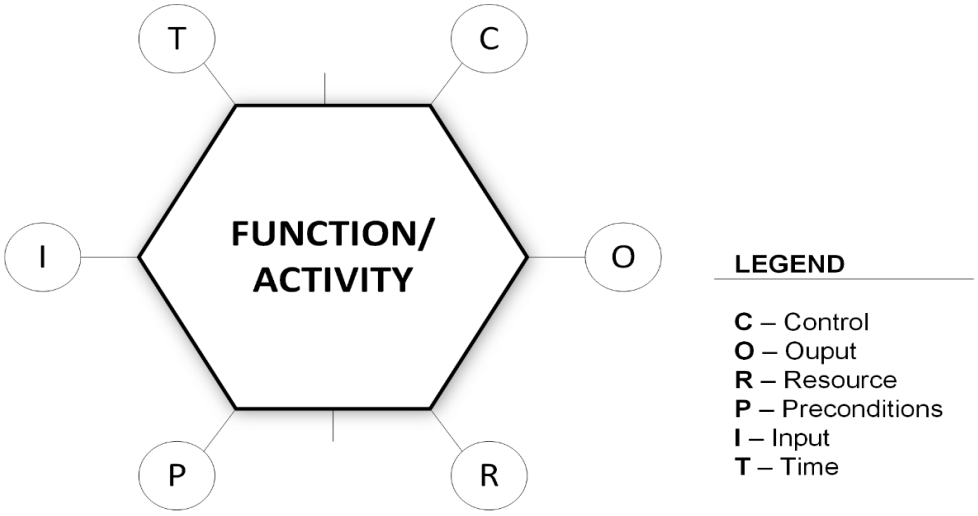
*Figure 2.4 The list of factors considered by the cognitive reliability and error analysis method (CREAM).*

The CREAM method was first used in the analysis of accidents in the area of nuclear installation control processes (Hollnagel, 1998). Figure 2.4 shows the CREAM method which divides human error causes into three categories and twelve subcategories. The complete analysis also involves a scheme for the dimensions of error modes and another one presents the

principles of consequent- antecedent relations. (Fu et al., 2020) argue that the CREAM model is laborious and not convenient for the analysis of large accidents and statistical appraisal. Hollnagel also developed the Driver Reliability and Error Analysis Method (DREAM) which is an adaptation of CREAM intended for the analysis of traffic accidents (Laaraj and Jawab, 2018; Phan et al., 2010). A simplified version of CREAM was introduced by He et al. (2008). This new version, proposed by the authors, includes two types of analysis: (i) the basic method; and (ii) the extended method. The combination of basic and extended methods was used in assessing human reliability in a nuclear power plant (He et al., 2008) Likewise, by utilising CREAM introduces a qualitative and a quantitative method to analyse communication errors between the nuclear power plant workers at different managerial levels (Lee et al., 2011). A different approach has been proposed by (Konstandinidou et al., 2006) in which the authors assess the data from the analysis by using CREAM and combining it with a fuzzy logic approach in order to determine the error probability.

### 2.6.2. The Functional Resonance Accident Model (FRAM)

In 2004, Hollnagel introduced The Functional Resonance Accident Model (FRAM). The FRAM analysis is also a type of graphical model in which the basic unit is a two-dimensional hexagon shape. Operations are examined in detail according to six aspects Figure 2.5: input, output, precondition, resources, time, and control placed on each of the vertices of the hexagon (Hollnagel, 2017; Lee and Chung, 2018).



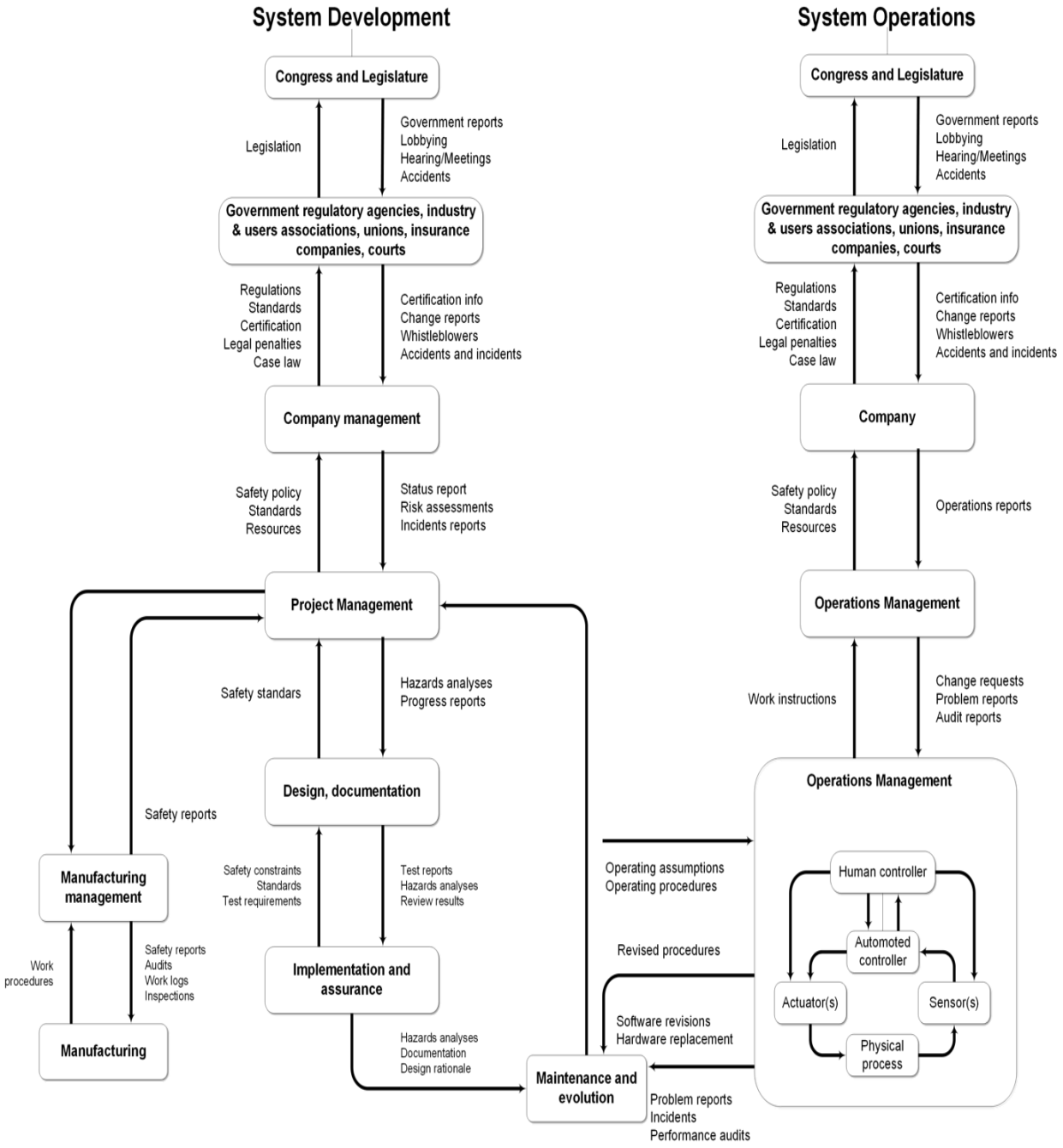

Adapted From: (Tveiten, 2013).

*Figure 2.5 The geometry of the operational unit in the functional resonance analysis methods (FRAM).*

The FRAM is a qualitative accident model that takes into account the non-linear dynamics of events. It is based on the concepts of normal performance and describes how functions of the system components may resonate and create hazards that can run out of control and lead to an accident (Herrera and Woltjer, 2010). The FRAM has been applied in the analysis of several investigations related to mid-air collisions (De Carvalho, 2011) and in cases of sepsis in healthcare facilities (Raben *et al.*, 2018). Anvarifar *et al.* (2017) adapted the FRAM and used it for qualitative risk analysis in a programme related to the multifunctional flood defences situated in the Netherlands. The authors tried to represent the complexity of relationships between the functional components (individuals, devices, and organisational levels) in the socio-technical context. According to Huang *et al.* (2019) FRAM is a valuable tool for the assessment of industrial safety which is mainly due to its holistic approach and the ability to provide a framework to examine system operations in detail.

### 2.6.3. Systems Theoretic Accident Model and Processes (STAMP)

Nancy Leveson (2004) proposed a Systems Theoretic Accident Model and Processes (STAMP). From the general theory of STAMP, two more methods have been developed by Leveson (2012). The Systems Theoretic Process Analysis (STPA) is a hazard analysis technique. This method in a prospective way is used to identify hazards in the system. The Causal Analysis is based on STAMP (CAST) which is an accident analysis technique that assess retrospectively and in-depth about the reason for an accident to happen (Helferich, 2011; Yousefi et al., 2019). The STAMP is an accident causation model that treats safety as a control problem. It defines the system as a structure (Figure 2.6) that includes both control and feedback loops in the different levels of the system (Leveson, 2004; Stanton et al., 2012). In this model an accident is not considered as a series of events but is viewed as the result of a lack of constraints implemented in the systems design and its operations (Leveson, 2004).




Adapted From: (Salmon *et al.*, 2012)

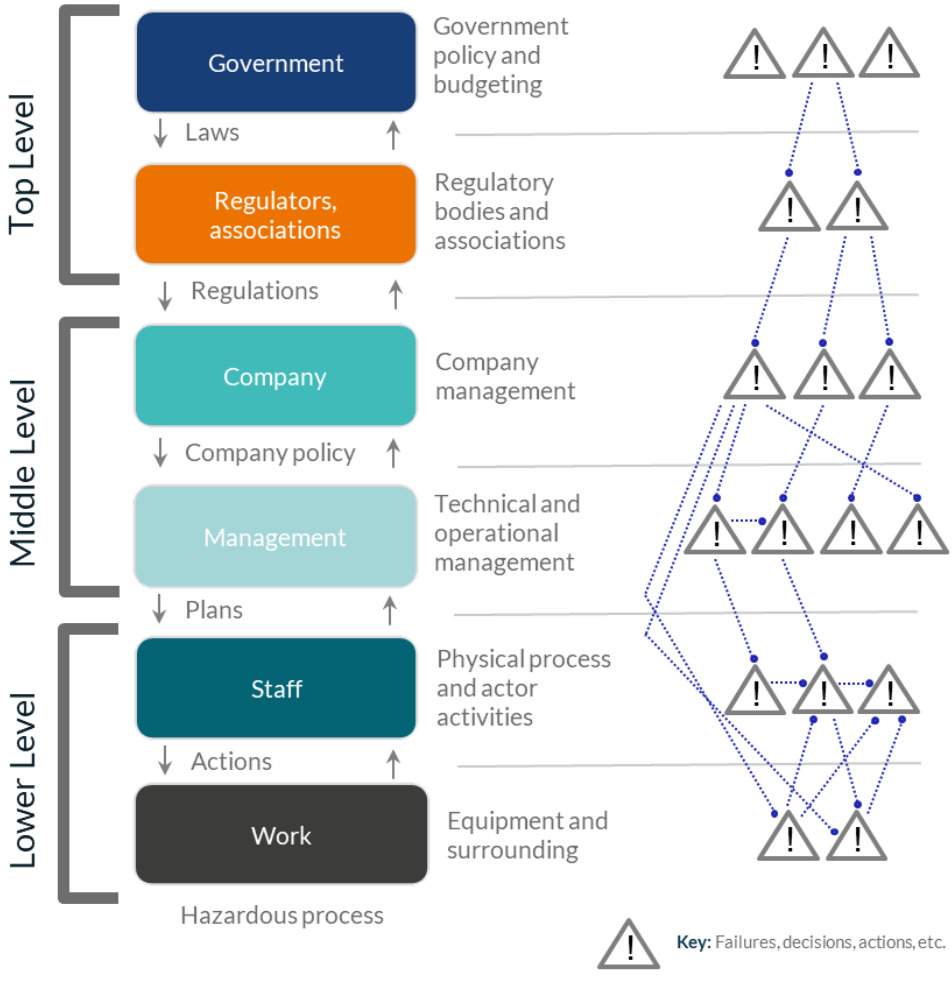
*Figure 2.6 The hierarchy of control levels, examples of the adopted documents, and typical control loops in the STAMP model.*

The model has been applied to road safety in order to identify the fragile elements in the control structure of the road system (Salmon *et al.*, 2016). Ouyang *et al.* (2010) and (Song *et al.*, 2012) also applied STAMP to analyse a major railway accident in China and succeeded in revealing the causes. Furthermore, the authors suggested measures for improvement in the system with the aim of preventing similar accidents in the future. However, (Ferjencik, 2011) considered

STAMP analysis as laborious due to the extensive number of steps which are involved in the procedure that have to be undertaken. In this aspect, Leveson (2012) made a significant contribution towards a more simplified procedure by providing detailed guidance for the analysis and thus the reliability of the STAMP model has been significantly increased.

### 2.6.4. Accident Map model (AcciMap)

Another notable Systemic Accident Model is the Accident Map model (AcciMap) proposed by Rasmussen (Rasmussen, 1997; Rasmussen and Svedung, 2000) and it includes a risk management framework which recognises the importance of socio-technical factors in safety management processes (Rasmussen, 1997).




Adapted From: (Igene *et al.*, 2022).

*Figure 2.7 Representation of the levels, processes and relationships throughout the complex sociotechnical system according to AcciMap framework.*

The AcciMap approach assesses the interactions of the events and the decisions which resulted in an accident and detects the unexpected, an uncontrolled relationship between the system's constituent parts (Branford *et al.*, 2009; Igene *et al.*, 2022; Stanton *et al.*, 2012; Underwood and Waterson, 2013a). The AcciMap shown in Figure 2.7 uses a graphical representation for the system failures, decisions, and actions involved in the accident. It allocates them to six organisational levels which are presented as follows: (i) Government policy and budgeting; (ii) Regulatory bodies and associations; (iii) Local area government planning and budgeting; (iv) Technical and operational management; (v) Physical processes and actor activities; and (vi) Equipment and surroundings (Hulme et al., 2019; Newnam et al., 2017; Svedung and Rasmussen, 2002). According to (Underwood and Waterson (2014) and Salmon *et al*. (2020) AcciMap is one of the most popular approaches among the systemic accident analysis models. It has a wide application across many areas and has been used to assist accident investigations and accident analysis in different scenarios. The following is not an exhaustive list, but presents examples of some areas of AcciMap application: the maritime and ferry accident (Jiang, 2016; Lee *et al.*, 2017; Murray *et al.*, 2017), road traffic collision, road users (e.g. pedestrian) and vehicles, (Hamim *et al.*, 2020b, 2020a, 2022; Mcilroy *et al.*, 2020; Murray *et al.*, 2017; Read *et al.*, 2013; Stanton and Salmon, 2020; Stefanova *et al.*, 2022), oil and gas industry (Tabibzadeh and Meshkati, 2015), mining (Stemn *et al.*, 2020), aviation (Branford, 2011; Thoroman et al., 2018, 2020), led outdoor activities (Salmon *et al.*, 2017), and police armed response - fire shoot (Jenkins *et al.*, 2010; Stanton *et al.*, 2012).

The above referenced systemic accident analysis models: STAMP, HFACS, FRAM and AcciMap are the most commonly cited for accident investigation and analysis research (Underwood and Waterson, 2013a). The study of (Delikhoon *et al.*, 2022) revealed that, from 63 publications selected and reviewed, 25 articles applied AcciMap. The studies used AcciMap to investigate and analyse an accident, and to conduct a safety or risk assessment in the transportation and public health sector (Delikhoon *et al.*, 2022)STAMP combined with other approaches was used and reported in 16 articles. FRAM was found in 22 studies and also integrated with other methodologies. FRAM was mainly applied in the aviation domain. Each of these models (STAMP, HFACS, FRAM and AcciMap) have sometimes has been applied in other areas quite different from the original domain appointed for their use. The general aim of all these applications was towards improvement of safety procedures, better management and effective assessment in a variety of areas and systems.

## 2.7. Contemporary systemic analysis models

Systemic accident analysis methods are expanding into diverse research areas. Findings in the literature show an increased research interest in systemic models with a higher trend on application of the contemporary models versus traditional models (Delikhoon *et al.*, 2022; Fu *et al.*, 2020; Wienen *et al.*, 2017; Yousefi *et al.*, 2019). For instance, the 24 Model which was introduced by Fu *et al*. (2005). It is a systemic model which takes principles of the previous methods and models developed by Heinrich, Bird and Loftus, Reason, Stewart and Hollnagel. The 24Model uses a framework in which the accident is assessed at two main levels: (i) individual level; and (ii) organisational level. The model goes deeper by breaking down the systemic failures in four stages: (1) immediate cause; (2) indirect cause; (3) radical cause; and (4) root cause. According to Fu *et al.* (2020) this model is suitable when big significant data analysis is performed on a certain type of accident.

Modern society increasingly depends on automation in work activities and procedures. Fast technology development and automation have built deeper structures within the processes in food businesses and higher complexity in the sociotechnical systems. To analyse and to capture the complexity of the highly technological systems more powerful incident causation investigations and analysis models are needed (Luo *et al.*, 2013) System failures could be due to multiple and cascading failures sand new models can be based on a Complex Network Theory. The complex network is presented as a graph with complex topological structure. In the analysis the network could evolve to determine a certain network or graphical representation which captures the factors that might lead to a food safety incident (Luo *et al.*, 2013).

Contemporary systemic analysis approaches are combined with mathematical models (Fu *et al.*, 2020) in a hybrid approach. These models differ from the previous systemic analysis approaches that are primarily qualitative. However, hybrid models can improve the estimation of risk prediction, and the probability of occurrence, which are both important to prevent food safety incidents. Additionally, to this, researchers have proposed hybrid systemic model with Bayesian network, the network is supplemented by big data (Jin *et al.*, 2020; Malik *et al.*, 2021; Unnevehr, 2021). The Bayesian network has been considered as an effective tool to predict monitor and control food safety and food fraud in the food supply chain (see Soon, 2020; Wahyubi *et al.* 2020; Soon and Abdul Wahab, 2022). A similar approach in underdeveloped

countries where historical data, databases, computing technology, infrastructure and resource are limited has not yet been considered. The following section will provide examples of the application and outcomes of systemic accident analysis in food safety incidents and FBD outbreaks. Moreover, principal systemic accident analyses are critically reviewed to understand the rationale of the chosen systemic approach in this research evaluation.

## 2.8. Examples of systemic accident analysis in food safety incidents and FBD outbreaks

Systemic accident analysis of food safety incidents can uncover systemic failure and go beyond simply identifying the visible and surface individual errors committed by the front-line staff. In a wider context, graphically presenting a complete picture of the multiple, interactions and relationships of these factors across the socio-technical levels is of value. Therefore, systemic accident analysis can improve the existing FSMS, the FS-culture and support applying optimum food safety controls. Systemic accident analysis such as STAMP, CAST, or AcciMap can be used as common models to investigate and analyse FBD outbreaks. Other contemporary and systemic hybrid models are described in this review which use a more quantitative approach. Systemic accident analysis models such as AcciMap endeavour to describe the complex interrelationships and interdependencies between the different components in the socio-technical food systems e.g., human factors and organisational aspects) in a multi-levelled hierarchical framework. Identifying the potential interrelations and multiple causal factors can help to determine why accidents occur from a human, technical, or system perspective. Pennington (2003) in his book “When Food Kills: BSE E. coli and Disaster Science” gave some serious warnings about the context of safety in the food industry. He acknowledged the importance of human factors in analysing FBD outbreaks and called for a more systems-based approach to food safety management.

In response to this appeal Couturier and Levenson (2009) applied STAMP as an advanced approach that can support the redesigning and reengineering of the food safety and risk management system in the United States. The authors suggest that STAMP should be useful in the identification and understanding of existing flaws and interactions that contribute to food safety issues in the United States food industry. Nayak and Waterson (2019) applied STAMP to establish a UK food system’s safety control structure model. They conclude that the STAMP model provided a more comprehensive analysis than other more linear models. Helferich

(2011) states that the changes in the dimension of the food supply chain from a national to an international-wide scale has led to the emergence of a new types and more complex food safety incidents and FBD outbreaks. Outbreaks and their geographical spread have become the focus for many investigations. Often an epidemiological approach to detect and trace the outbreak and its source does not consider a systemic analysis approach to understand the reason why the incident happened. Incident investigation analysis has been applied using STAMP and CAST model to assess the Salmonella outbreak in the Peanut Corporation of America in 2008 (Helferich, 2011). The model applied provides more information about the FBD outbreak and helps to determine which controls were ineffective in enforcing the FSMS.

AcciMap is another systemic analysis model that has been used in food safety investigations. It was used to assess the bovine spongiform encephalopathy (BSE) incident through the human and animal food supply chain and characterised the contributing factors of the epidemic in 1986 (Cassano-Piche *et al.*, 2009). Additionally, in 2003, AcciMap techniques were used to conduct a comparative analysis of two public health outbreaks of *Cryptosporidium parvum* originating in Canadian drinking water systems (Woo and Vicente 2003). Vicente and Christoffersen (2006) used the report of Walkerton incident in 2000 about the *E. coli* FBD outbreak as a case study to evaluate the usefulness of AcciMap in explaining the contributing causes. Similarly, Waterson (2009) applied AcciMap to examine the major events and factors contributing to *Clostridium difficile* outbreaks within the UK Maidstone and Tunbridge Wells NHS Trust. AcciMap has also been applied to proactively prevent incidents and to improve FSMSs in the food industry. As an example, the study of Nayak and Waterson (2016) applied AcciMap to uncover the systemic factors associated with two outbreaks of *E. coli* in the UK, one in 1996 and another in 2005 (Nayak and Waterson, 2016). Among other socio-technical system approaches AcciMap has been considered as a more versatile and user-friendly accident/incident causation technique, useful for in-depth analysis and suitable for complex socio-technical systems (Hamim *et al.*, 2020b; Hulme *et al.*, 2021).

### 2.8.1. Evaluation systemic approach: AcciMap, FRAM and STAMP

These approaches have been changing the single, reductionist approach of considering individuals and processes as a single point of failure in FBD outbreaks to developing systemic analysis models looking at the system as a whole, while simultaneously appreciating the role of regulators, legislation, the presence and adoption of a FSMS and the maturity of FS-culture.

Despite the diversity of models and approaches to evaluate and analyse food safety incidents, some models are more widely proposed in the food science literature than others based primarily on their practicality of application.

Linear accident analysis such as the SCM has been proposed as food safety incident model which can enhance FSMS to improve layers of defence for food safety (da Cunha *et al.*, 2022). However, this model, similar with other sequential and epidemiological models fails to represent the non-linear dynamics of a socio-technical food safety management system and how these factors are associated with and influence food safety outcomes. Difficulty to identify some failures because the latent conditions and active errors are distant from the location of the incident is a challenge (Griggs, 2012). As a consequence, some latent conditions and active errors/failures remain unnoticed which eventually create the environment for individuals to commit mistakes or for processes to fail. Additionally, the SCM and the design defence layer cannot be generalised across all food businesses and all potential food safety hazards because the antecedents and situation that is created is specific to a given food safety incident or FBD outbreak.

The value of systemic accident analysis, weaknesses and strengths of these approaches are considered. Systemic analysis models used in assessing food safety incidents and FBD outbreaks are beneficial to learn from previous incidents e.g., what went wrong, or which control(s) were ineffective. This provides valuable insight, because considering the focus of this study in particular, food as a component plays an important role in tourists' holiday experiences. Therefore, food safety hygiene practices within FSMS should ensure safe food handling in hospitality food settings. If they are effectively implemented. If existing limitations and barriers hinder the implementation of food safety controls such as HACCP-based FSMS as a consequence food safety incident can occur (e.g., FBD outbreaks and recalls). FBD outbreaks can reoccur in less developed economies where there are existing limitations to ensuring consistent implementation of FSMS and wider operational practices such a potable water and waste water management. Food safety researchers have argued the importance of the focused human element to achieve food safety outcomes and these factors have been incorporated into the FSMS and consideration of FS-culture (Wiśniewska, 2022). Other authors advocate the use of risk assessment techniques as complementary tools to enhance and manage food safety (Arvanitoyannis and Varzakas, 2009; Lee *et al.*, 2021; Varzakas, 2015) and the risk of a FBD outbreak. However, a more holistic approach has been considered through systemic

accident analysis approaches that could be used to evaluate food safety incidents in a socio-technical system to reveal the causal and contributory root causes leading to FBD outbreaks. The value of systemic accident analysis, weaknesses and strengths of these approaches are considered. Systemic analysis models used in assessing food safety incidents and FBD outbreaks are beneficial to learn from previous incidents e.g., what went wrong, or which control(s) were ineffective. This provides valuable insight, because considering the focus of this study in particular, food as a component plays an important role in tourists' holiday experiences. Therefore, food safety hygiene practices within FSMS should ensure safe food handling in hospitality food settings. If they are effectively implemented. If existing limitations and barriers hinder the implementation of food safety controls such as HACCP-based FSMS as a consequence, food safety incidents can occur (e.g., FBD outbreaks and recalls). FBD outbreaks can reoccur in less developed economies where there are existing limitations to ensuring consistent implementation of FSMS and wider operational practices such a potable water and waste water management. Food safety researchers have argued the importance of the focused human element to achieve food safety outcomes and these factors have been incorporated into the FSMS and consideration of FS-culture (Wiśniewska, 2022). Other authors advocate the use of risk assessment techniques as complementary tools to enhance and manage food safety (Arvanitoyannis and Varzakas, 2009; Lee *et al.*, 2021; Varzakas, 2015) and the risk of a FBD outbreak. However, a more holistic approach has been considered through systemic accident analysis approaches that could be used to evaluate food safety incidents in a socio-technical system to reveal the causal and contributory root causes leading to FBD outbreaks.

The multiple systemic accident analysis approaches that can be applied to investigate and analyse food safety incidents and FBD outbreaks in particular, in different scenarios have been considered. These studies elaborate on the evolution of understanding of how food safety incidents occur in complex socio-technical systems. Table 2.2 critically reviews three of the main systematic approaches. STAMP, HFACS, FRAM and AcciMap which are the most commonly cited approaches for accident investigation and analysis research (Underwood and Waterson, 2013a).

*Table 2.2 AcciMAp, FRAM and STAMP as systemic approaches with the main advantages (Yes), and drawbacks (No) of systemic approaches.*

| Descriptions | AcciMap | STAMP | FRAM |
|---|---|---|---|
| Description of accidents with a single diagram | Yes | No | Yes |
| Description of accidents in hierarchical level | Yes | No | No |
| Proximal sequence of events and influences | Yes | Yes | Yes |
| Simplicity of identifying the causes of accident | Yes | No | Yes |
| Identification of contributing factors close to or far from the accident | Yes | Yes | Yes |
| Provision of recommendations for the control structure | Yes | Yes | Yes |
| Description of events and actions | Yes | Yes | No |
| Description of components of system | No | Yes | Yes |
| Providing enough information about system structure | No | No | No |
| Taxonomy of errors or failures modes | No | Yes | Yes |
| Focus on operators and functions | No | Yes | Yes |
| Considering the environmental conditions (equipment and surroundings) | Yes | Yes | Yes |
| Identifying singular root causes for accidents | No | No | No |
| Definition of system boundaries | Yes | Yes | No |
| include multiple feedback loop | No | Yes | No |
| Providing a context to identify system safety improvements | Yes | Yes | Yes |
| Identification of the control and feedback inadequacies | No | Yes | no |
| Empirical data are not required | Yes | Yes | Yes |
| Minimized level of system information is required for analysis | No | No | No |
| Easier to be implemented | Yes | No | No |
| Providing adequate guidance regarding the methodology | Yes | No | Yes |
| Appropriate for use in a variety of contexts | Yes | Yes | Yes |
| Ability to quantify the accident occurrence and yield probabilities | No | No | No |
| Is not affected by analyst bias | No | No | No |
| Easy to disseminate results to non-experts | Yes | No | No |

Adapted From: (Delikhoon *et al.*, 2022; Ma *et al.*, 2022; Yousefi *et al.*, 2019).

Systemic accident analysis of food safety incidents especially FBD outbreaks, can uncover systemic failure and go beyond simply identifying the visible and surface individual errors committed by the front-line staff. In a wider context, graphically presenting a complete picture of the multiple, interactions and relationships of these factors across the socio-technical levels

is of value. Therefore, systemic accident analysis can improve the existing FSMS, the FS-Culture and support applying optimum food safety-related and more general operational controls. Systemic accident analysis such as STAMP, CAST, or AcciMap can be used as common models to investigate and analyse FBD outbreaks. Systemic accident analysis models such as AcciMap endeavour to describe the complex interrelationships and interdependencies between the different components in the socio-technical food systems e.g., human factors and organisational aspects in a multi-levelled hierarchical framework. Identifying the potential interrelations and multiple causal factors can help to determine why accidents occur from a human, technical, or system perspective.

Regarding the adavantages or disadvantages of the three approaches (Table 2.2), the AcciMap was selected as the most appropriate model to analysis FBD outbreaks in thue hospitality sector in the DR. The selection of this method is based on the AcciMap approach being able to provide a 'big picture' analysis by identifying the sequences of events contributing to FBD outbreaks and uncovering the potential contributory factors and their interactions among, and across, the levels in a complex socio-technical system. This system hierarchy allows analysts to identify and summarise the contributory factors in an incident and follow the hierarchy structure downwards to visualise the events or failures that have emerged from the socio-technical interconnection and interaction at each level (Gao et al., 2016). Further, this enables analysts to understand how information, actions and decisions made at the top of the system affect the outputs at the lower levels and its systemic complexity (Lee *et al.*, 2017; Underwood and Waterson, 2012). An advantage of this approach is that the AcciMap does not require a taxonomy of errors or failures modes to guide the safety analyst to identify all factors without constraints (Hulme *et al.*, 2021). Conversely, the lack of taxonomy can also seen as an disavantage as the analysis will be entirely dependent upon the analyst knowledge, interpretation and judgment. Another advantage is that graphical representation of the incident makes it easier to communicate and unsderstand the factors leading to the incident. The drawback of this technique is based on the reliability and repeatability of the method given its qualitative nature. In this regard, the literature provides detailed guidelines of how to construct an AcciMap to build up the analytical skills and the theoretical knowledge of the analyst which have been followed in this study.

## 2.9. Summary

This chapter describes the regulatory and national food safety system which governs and influences food safety in the hospitality sector in the DR. As a complex socio-technical system, food safety governance, especially with regard to FBD outbreaks is influenced by the interaction of human, government and organisational aspects. Food safety researchers have emphasised the necessity to consider a systems approach to ensure the effective management of food safety. Therefore, more research is required in applying systematic accident analysis models on FBD outbreak incidents in the hospitality context. This is particularly important in hotels and restaurants, where most of the food safety research has solely focused on linear causal aspects such as the behaviour of food handlers. The focus on the hospitality sector is due to these food settings having been reported as one of the most frequent places for FBD outbreaks to occur. However, a holistic approach to look at the sociotechnical system within the hospitality sector and all the actors involved in the different organisational levels and their interaction is required. Studies of this nature will bridge the gap between regulatory governance public health policy, food safety authorities and food business to address the lack of evidence base relating to FBD outbreaks in the DR and the control measures required to protect consumers and the businesses. Findings from this study will be presented in more detail in Chapter 5. After having identified the knowledge gap in the literature in the context of the DR and establishing the research objectives and research questions, the next chapter will also consider the different approaches, philosophical foundations and methodology of the PhD study.

# CHAPTER THREE: RESEARCH METHODOLOGY

## 3. Introduction

Chapter 1 provided the research intentions with an overview of the background, problem statement, research objectives and the main research aim of this thesis. Chapter 2 reviewed the extant academic literature on the concepts of importance to the scope of this research.

This chapter will present the research strategy, and methodology of a mixed-methods approaches which supports both research design, data collection and data analysis. This methodology chapter is structured as follows:

- Section 3.2 sets out the research paradigm and the research strategies that inform the development of the pragmatic stance and the qualitative approach used in this research.
- Section 3.3 details the research design which describes the methods used for data collection and analysis. In addition, it also included a discussion of the weaknesses and strengths of the different phases of the research and how the quality of the research has been assured through the different phases.

The research methodology is a roadmap or practice guideline that needs to be undertaken to answer a research question or problem (Greene, 2006; Reis *et al.*, 2017) According to Kivunja and Kuyini (2017) the research methodology is the basic framing of the scientific research which comprises some obligatory elements such as: research paradigm, strategy, types of methods, data collection procedures and analysis. The study's general methodology and research approach is schematically represented in Figure 3.1 is outlining the methodology's steps and the thesis's general theoretical underpinnings. These are explored further in this chapter.

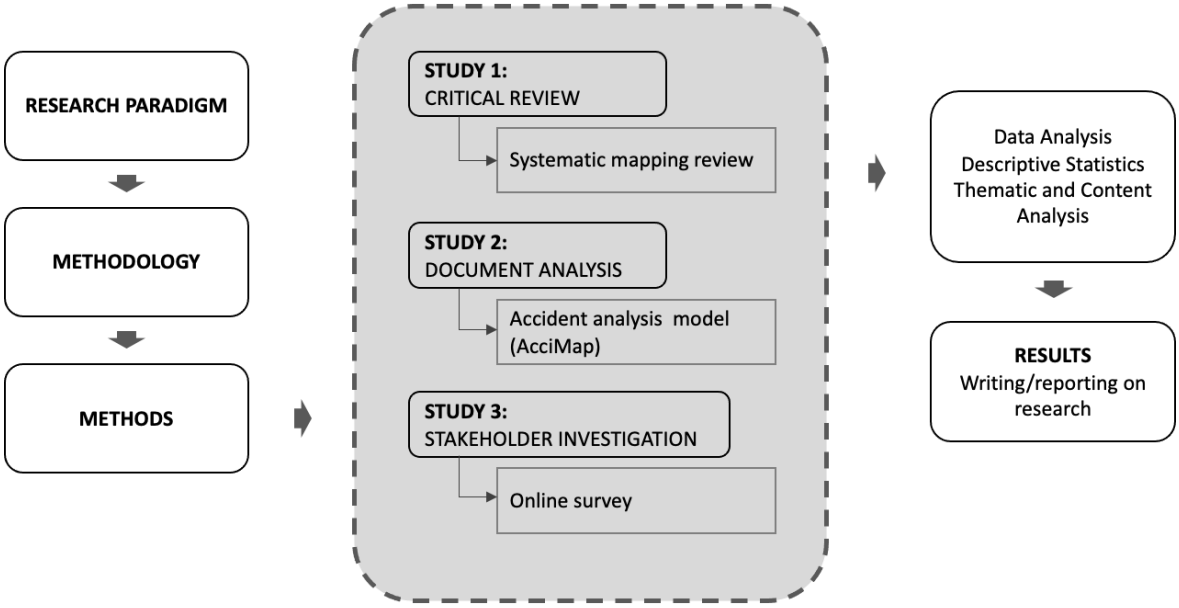



*Figure 3.1 Schematic overview of the research methodology and steps.*

## 3.1. Research paradigm

The research paradigm is defined as the philosophical framework and belief system on which any study is grounded. The philosophical framework is an integral part of the study because the belief system and principles represent the way in which the researcher interprets and perceives the world (Guba and Lincoln, 1994). Through paradigms the researcher examines the methodological aspects of their research project to determine the research methods, how they will be used and how the data will be analysed in an integrated way (Ganiyu *et al.*, 2020). Researchers have several classifications for paradigms which are selectively applied either in social or in natural science research (Kivunja and Kuyini, 2017). In social science there are four main research paradigms: positivism, realism, interpretivism and pragmatism (Saunders *et al.*, 2016) (Table 3.1).

In 1970, the widely known methodological research in social and behavioural approach was quantitative and qualitative. Philosophical assumption, such as positivism, is related to an objective and quantitative approach. Quantitative research is mainly focused on testing a theory/hypothesis and explaining a phenomenon by statistically quantified concepts (Johnson and Onwuegbuzie, 2004). In comparison, constructivism has adopted a more subjective and qualitative approach (Kaur, 2016). Qualitative research seeks to understand a social

phenomenon based on the complex and holistic picture formed with words from reports and descriptions from informants (Lanka *et al.*, 2021). A quantitative approach seems to be limited in providing in-depth understanding of the observed phenomenon, but a qualitative approach can reduce and overcome this limitation (Creswell and Plano Clark, 2007).

Pragmatist researchers in social science rejected the idea that only through a single method can a phenomenon be investigated (Kaushik and Walsh, 2019). In the 1980s, researchers started considering relative advantages and disadvantages of available approaches. Some proposed the type of research studies which combine both paradigm and method research (Tashakkori *et al.*, 2020). Researchers argued about the inappropriateness and incompatibility of combining paradigms, philosophical positions and methods. The fundamental differences between paradigms and research methods from postpositivist and constructivist namely quantitative and qualitative does not make it possible to mix both approaches (Brierley, 2017). However, the disparities between researcher and paradigms have been solved through an inter-subjective position where the researcher embraces with pragmatism (Ghiara, 2020). Pragmatism emerged as a third philosophical concept from researcher dissatisfaction with the common existing philosophies and the urge to answer research questions by considering different realities (Gunasekare, 2015). The significant advantage of pragmatism is that it does not consider positivism and constructivism as incompatible worldviews; conversely, it successfully merges both points of view (Tashakkori and Teddlie, 2003). Johnson and Onwuegbuzie (2004) recognised that pragmatism also builds the necessary bridges between the earlier predominant and often conflicting philosophies and serves as the solid foundation of mixed-methods research. Pragmatism succeeds in capturing the duality between the subjectivity and objectivity of a phenomenon by embracing both points of view that can be later translated into social reality (Parvaiz *et al.*, 2016).

*Table 3.1 Theoretical concepts in scientific research.*

| **Research design** | **Ontology (What is the reality?)** | **Epistemology (How is reality known?)** | **Methods** | **Research Approach** |
|---|---|---|---|---|
| Positivism | Empiricism<br>(There is only single reality or truth) | Objectivism<br>(Reality can be objectively measured) | Quantitative methods: Experimental research<br>Survey research<br>Experiments Sampling<br>Measurement and scaling<br>Statistical analysis<br>Questionnaire<br>Focus group interview | Deductive |
| Constructivism | Interpretivism<br>(There is no single reality; but multiple realities) | Subjectivism<br>(Reality is subjective; it is socially constructed) | Qualitative methods predominate:<br>Qualitative Interviews Observation participants<br>Case study<br>Narrative<br>Visual data analysis | Inductive |
| Pragmatism | Critical Realism<br>(Reality is constantly negotiated)<br>Non-singular reality | Relativism<br>(Reality is relative; best method solved the problem)<br>Combining different perspective to help to interpret the data | Mixed-methods: Qualitative and quantitative analysis<br>Design-based research<br>Action research<br>Interviews, observations, testing and experiments<br>Data mining<br>Expert reviews | Abductive |
| Critical | Realities are socially constructed entities that are under constant internal influences | Transitional/subjective value mediated findings | Ideological approach<br>Open-ended questionnaire<br>Interviews<br>Observations | Deductive |

The researcher can choose among different paradigms according to their applicability to achieve the objective of the research study. The following section will explain the researcher's rationale and positionality for adopting a particular paradigm. Additionally, the overall research strategies and mixed-methods approach adopted as the most suitable method for data collection are explained in more detail. The following section will examine the research paradigms and further to this, a comprehensive discussion of the rationale for selecting a pragmatist paradigm.

## 3.2. Research strategy

A research strategy provides the framework in which a researcher decides how the research will be conducted by putting into practice paradigms and interpretations (Tang, 2010). The topics which are addressed in contemporary social scientific research are increasingly complex and linked to the multiple bodies of knowledge and disciplines (Bender, 2011). The complex and dynamic nature of research studies have encouraged the researcher to explore more epistemological views and do not adhere to a particular epistemological posture (Bentahar and Cameron, 2015). Pragmatism, as a philosophical position, deals with this constant change which occurs due to peoples' experiences and actions (Morgan, 2014). Pragmatism is the philosophical stance that not only merges the multiple research paradigm but also combines data collection approaches in a single project (Lall, 2021). The philosopher John Dewey, one of the notable contributors to the pragmatic theory, stated that pragmatism identifies genuine problems that are part of actual social situations and is oriented towards provision and solving of practical problems in the real world (Kaushik and Walsh, 2019).

Pragmatism creates emphasis on what works and bring solutions. Instead of focusing on the method, pragmatist researchers view the research problem as the most critical concern (Creswell and Creswell, 2018). Tashakkori and Teddlie (2010) reported on the importance of focusing attention on the research problem and subsequently, using multiple methods to derive knowledge about the problem (Creswell and Creswell, 2018). A significant feature of the pragmatism paradigm is that the researcher is guided by their personal value system, and they have the flexibility to choose the direction of research (Robson and McCartan, 2016). The pragmatic approach provides the researcher with the freedom to consider which methods are best suited for answering the research question rather than choosing a single theoretical approach with a narrow scope (Clarke and Visser, 2018). In other words, philosophical

positioning drives the research design and methods used. Bentahar and Cameron (2015) state that the most important aspect is to choose the methods appropriate to the research problem and the research questions. In this regard, a pragmatic approach provides a flexible frame in the research design which connects with the research question and stimulates practical and tangible actions to answer a research question or solve a problem (Kelly and Cordeiro, 2020).

Different realities and perceptions exist in a food context in the hospitality industry. Multiple stakeholders are involved who can influence the governance and operability of the sector in the DR. The stakeholders will consider these activities within the context of their own reality. For this reason, pragmatism would be appropriate as an approach as it emphasises the context and various perspectives in research and reality. Acknowledging the multiple realities that can exist and how the construction of reality through people's experience is not measurable has led to developing a series of methods within this study that are based on qualitative research (Lall, 2021). It is considered that the scientific value of this research is in examining a real-life issue by positioning FBD outbreaks as multiple interactions influenced by multiple social factors, where the root causes in the outbreaks can only be accessed from diverse points of view. The approach adopted for this thesis was firstly the food system itself is complex and an interdisciplinary field of research. Secondly, another important feature of the pragmatism concept is that it is not committed or limited to a particular method but allows the choice of the best method(s) to address the research question or problem posed and produces the desired research outcomes. In this research, a pragmatism approach has been adopted as the most suitable and appropriate approach which can successfully and effectively solve the research questions. Moreover, because phenomena are more dynamic and complex, researchers are less confined in their particular epistemological position (Bentahar and Cameron, 2015). The study will require a holistic and flexible approach to its research techniques in order to avoid being limited by conventional positivist and constructivist approaches. Therefore, it is determined that pragmatism is deemed a solid philosophical stance for this thesis.

### 3.3. Mixed-methods study design

Scholars in scientific research have embraced and used the mixed-methods design in many fields of study aiming to provide a richer, deeper, and greater understanding of a scientific problem (Mik-Meyer, 2020). For instance, Kaur (2016) reviewed mixed-methods applications in public health studies and stated the need of such an approach to understand in a broader

scope the complexity of the social issues involved. The combination of both types of data in mixed-methods design have been applied in field studies that are inherently complex. For instance, health systems (Lall, 2021); leadership studies (Yawson, 2016); agrifood nanotechnology (Yawson and Greiman, 2016); and FS-culture (Zanin, Luning, *et al.*, 2021) which has allowed the researcher to explore complex phenomena in detail. Researchers applying a mixed-methods design confirm the complementary benefit of the approach not only to answer complex research questions, but also to explore different levels of the same phenomenon and provide a greater understanding of the problem (Davidov *et al.*, 2020; Subedi, 2016; Tashakkori and Teddlie, 2003; Zoellner and Harris, 2017). However, Anguerra *et al.* (2018) stated that the rapid growth and use of mixed-methods design has sometimes generated inconsistencies especially when it comes to the terminology and the use of definitions which are some of the common issues in the case of any emerging methodological approach.

The mixed-methods design refers to the explicit combination of both qualitative and quantitative data at some stage of the research (Johnson *et al.*, 2007; Plano Clark and Ivankova, 2016) often where pragmatism is the common epistemological position. However, to other researchers the mixed-methods design defines and puts emphasis on other aspects of the research study such as: the specific methods used, the overarching methodology; philosophical assumption etc. (Creswell and Plano Clark, 2007; Greene, 2006; Plano Clark and Ivankova, 2016; Teddlie and Tashakkori, 2009). A determinant in mixed-methods design is the specific order of collection and type of data during the study, the priority being given to either quantitative or qualitative research, the research purpose and the integration of data (Table 3.2).

*Table 3.2 Types of basic mixed-methods research design.*

| **Design type** | **Timing** | **Priority** | **Weighting/ Notation** |
|---|---|---|---|
| Convergent | Concurrent collection of quantitative and qualitative data | Equal | QUAN+QUAL |
| Embedded | Concurrent and sequential data collection | Equal | QUAN(qual) or QUAL(Quan) |
| Explanatory sequential | Quantitative followed by qualitative data collection | Quantitative | QUAN qual |
| Exploratory sequential | Qualitative followed by quantitative data collection | Qualitative | QUAL quan |

Adapted from: (Lall, 2021; Vivek and Nanthagopan, 2021).

In a mixed-methods design, the quantitative or qualitative approach will drive the theoretical motivation. The decisions, taken about mixed-methods design typologies, are a defining aspect in developing mixed-methods research namely whether to develop parallel, sequential explanatory, or exploratory and embedded design (Creswell and Plano Clark, 2018). Morse (2003) proposes eight combinations of mixed-methods design. In mixed-methods design (see Table 3.2*)* the upper-case letters denote the method priority and dominance in the research, and the lower-case letters denote lower priority. The supplementary or a component function to collect and analyse the data will be represented by a plus sign (+) or/and (→) arrows (Esteves and Pastor, 2003; Vivek and Nanthagopan, 2021). There is a criterion in each mixed-methods design combination that influences the purpose and final research outcome. As a result, researchers need to be aware of the emphasis in the multiple combination design of methods to bring clarity to the research design process (Subedi, 2016). Link (2015) stated that the timeframe in which the data is collected is a primary difference between triangulation design and other mixed-methods research. Moreover, these typologies provide a matrix and clear guidance for the researchers to conceptualise their mixed-methods studies in an easy and feasible approach.

As outlined in Chapter 2 (literature review), there is a paucity of studies that evidence the causation and existence of food safety issues in the hospitality sector in the DR. This makes it difficult for the government and private sector to manage FBD and increase the level of food safety controls and compliance with focussed food safety regulations and FSMS in this sector. The current research has employed a combination of quantitative and qualitative approaches to attain the following aims and objectives:

The aim of this research is to assess the effectiveness, sensitivity, and appropriateness of systems-based approaches to explore and reflect on FBD outbreaks associated with the hospitality sector. The study will inform policy development, especially in developing economies such as the DR.

The specific research objectives are:

- To critically review selected sources and extract the available information related to the FBD outbreaks in the tourism and hospitality sector with particular focus on the DR.
- To apply systems-based methodological approaches to identify the contributory factors that influence food safety management, hygiene practices and operational practices in the hospitality sector. Furthermore, this objective also encompasses a critical assessment of the multiple contributory factors, and to try to reveal their interrelationships and their impact on the FBD outbreaks.
- To use a stakeholder investigation to evaluate expert opinion about factors, such as hygiene, management and food safety practices, and in combination with the findings of the previous phases of the study to propose practical recommendations for prevention and reduction of FBD outbreaks in the hospitality sector of the DR.

This PhD study has used a three-step process applying mixed-methods approach. The first phase marked as (1) in the schematic diagram in Figure 3.2 involved a comprehensive systematic mapping review. This phase of the study identified specific information related to the microbiological, epidemiological, and other important characteristics of foodborne outbreaks. This phase of the research has been published as:

De Oleo, D. D., McIntyre, L., Randall, N., Nayak, R., and Manning, L. (2022). Systematic mapping of food safety outbreaks in the hospitality sector in the Dominican Republic. *British Food Journal*, 1-22. (See Chapter 4).

The second phase of study marked as (2) is a document analysis using a systemic accident analysis approach (AcciMap). The application of AcciMap allows a holistic and coherent explanation of the interrelationships and connections of systemic failures leading to outbreaks. This phase of the research has been published as:

De Oleo, D. D., McIntyre, L., Randall, N., Nayak, R., and Manning, L. (2022). A socio-technical approach to food safety incident analysis using the AcciMap model in the hospitality sector. *Food Control*, *136*, 108849 (See Chapter 5).

The third phase of the study marked as three (3), drew together the findings from study 1 and 2 to develop an investigation of stakeholders' views on the findings that, in turn, can inform recommendations for policy development in the DR. The investigation used a survey approach

to capture stakeholders' and experts' views through an online questionnaire based on the main themes and particular patterns of hygiene and food safety practices which were previously identified in the two aforementioned phases.

The mixed-methods research methodology was chosen for its capacity to provide comprehensiveness, explanation, illustration and to acquire complementary data on the same issue (Stenger *et al.*, 2014). Moreover, Zanin *et al*. (2021) stated that in food safety research mixed-methods is a recommended approach due to the complexity of the phenomenon. However, relatively few researchers have adopted mixed-methods approaches in food safety research (Jogulu and Pansiri, 2011). For instance, studies have adopted quantitative and qualitative methods in combination in food safety and FS-culture maturity (Jespersen et al., 2019; Nyarugwe et al., 2018, 2020; Zanin et al., 2021). To the best of the authors' knowledge, this PhD study is the first research in food safety in hospitality sector in the DR adopting a mixed-methods approach which will involve the use of qualitative and quantitative methods in a single research project. The combination of both approaches enables researchers to explore complex phenomena in detail (Zanin et al., 2021) Hence, a sequential exploratory mixed-methods approach will be adopted to drive both in-depth understanding of the subject matter and generalise findings using three connected studies. The complexity of FBD outbreak accident analysis requires an adopted exploratory mixed-methods in order to provides both in-depth understanding of the subject matter and to generalise the findings. Figure 3.2. Using a mixed-methods methodological design creates an innovative way to evaluate and apply new approaches and methods in emerging and changing scenarios, like those in the area of food safety, while they can strategically compensate for the weakness of a single conventional approach and as a result strengthen any findings and conclusions.

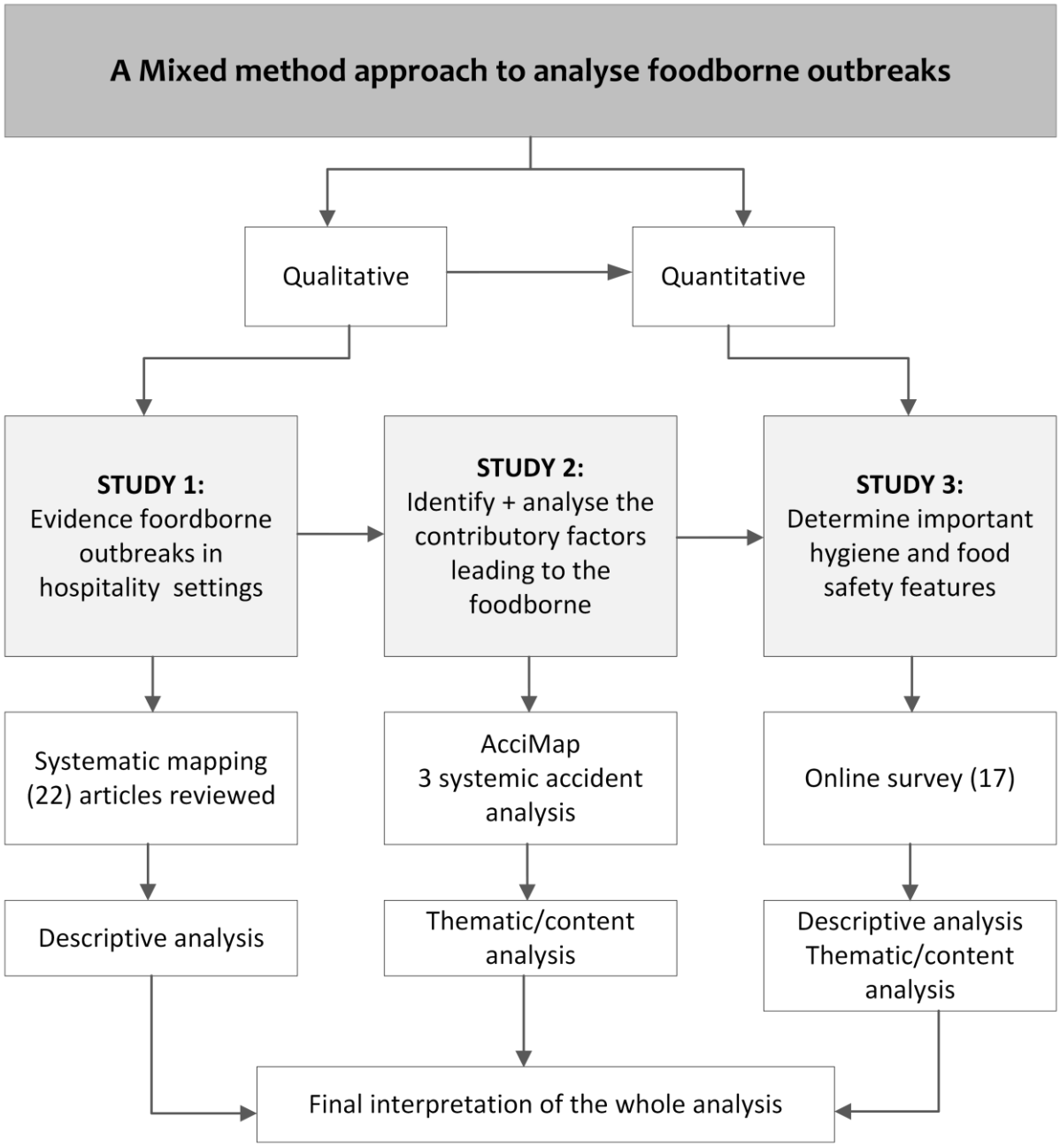



*Figure 3.2 A graphical presentation of the selected theoretical concepts in concepts in mixed-methods analysis.*

Data types from the first and second study will be linked together through iterative analysis to enrich the data, give deeper understanding, and yield a more complete picture and informing the design of the online survey. In this regard, the qualitative methods were given priority over the quantitative research due to the exploratory nature of this topic. Positivism could be considered as the underlying approach in the systematic mapping review because this is the

methodology that objectively makes an attempt to find the truth or exactness of the facts presented in the articles assessed. Theoretically, a positivism paradigm extensively applies a variety of quantitative research methods and similarly the systematic mapping regularly includes quantitative analysis, meta-analysis and presentation of results which require actual numbers, statistics, graphs, etc which are constant, defined and indisputable items that cannot be manipulated. However, if one considers other aspects in the systematic mapping methodology such as an interpretation and/or exploratory reflection of all included studies this could give precedent to a constructivism paradigm which assumed that reality is socially constructed and is a personal perspective based on lived experience.

The systematic mapping methodology, the AcciMap model uses both positivism and constructivism paradigms. In the AcciMap the researcher uses the collected studies and tries objectively to find the real exactness of events from the extracted information. However, the reflexion and thoroughness which need to be applied during the process of analysis requires the use of researcher perceptions about the reality and it is *de facto* interpreted and constructed from the researcher subjective opinion, her/his personal and professional experience. In the stakeholder studies similarly, positivism is present due to the survey assuming that participants in the study would respond objectively to the questions on a given topic is subjective.

Pragmatism as a research paradigm emerged from the duality of subjectivity and objectivity and the researcher in the current study has tried to apply both perspectives. This paradigm solves the ambiguity and the dissatisfaction of researchers that want to consider different realities in a single research project without arguing with the incompatible worldviews that were first considered. Therefore, through pragmatism any conflict was overcome, and this paradigm also serves as the solid foundation of mixed-methods research. The significant importance of this is that in the contemporary social science the topics under investigation increase in complexity and also are linked to multiple bodies of knowledge and disciplines. Therefore, to address such complexity the researcher has considered the use of mixed-methods and different philosophical approaches to study a phenomenon.

Triangulation, by definition, is the procedure to collect from multiple theories, data sources, methods, or investigators information about the same phenomenon. By applying more than one method it is possible to detect convergence in the results from the different methods and thereby increase the validity of the findings (Heale and Forbes, 2013; Hussein, 2009). This

convergence of findings is a triangulation strategy that helps to increase the trustworthiness of a study, its validity, reliability, authenticity, and lack of bias (De Andrade *et al.*, 2017; Merriam and Tisdell, 2015; Morgan, 2022). Studies from de Boeck et al., (2019) and Zanin et al., (2021) applied a mixed-methods approach to assess the prevailing FS-culture in the food business. In these studies, a mixed-methods approach and data triangulation was used to provide a more comprehensive understanding of FS-culture from a different perspective by using both qualitative and quantitative methods. Moreover, triangulation was used to enrich the results and have a better understanding of the FS-culture when the findings within techniques were compared. Combining methods with triangulation helps the researcher validate the results obtained from different strains. The collection of data in the cited research included using questionnaires, checklists, participant observation, microbiological analysis and monitoring of HACCP system. Through the combination of methods and triangulation, they provide confirmation of the results obtained and enhance the credibility and consistency of the study results.

As outlined in the literature review in Chapter 2, there are some issues in the DR in terms of national food safety surveillance, food safety control and in foodservice settings for premises/businesses to properly conduct internal audits, monitoring and verification controls. Budget constrains might prevent the carrying out of microbiological analysis and epidemiological investigation. Based on this, it raises the concern whether similar approaches combining mixed-methods can be generalised and adopted in practice in this context. Therefore, the adoption in this study of mixed-methods approach has provided additional perspectives and alternative approaches to evaluate similar research inquiries. Another reason to use this approach is the lack of previous studies in the field in the country of interest, the DR, and as an initial attempt to inform the direction of this thesis and further research.

The combination of quantitative and qualitative methods will provide a breadth of understanding of topics such as hygiene, food safety practices and management aspects. Inference from these studies also provides insights into which development and educational actions need to be taken to change the prevailing FS-culture. Triangulation in this study was used with the purpose of completeness and achieving a rich amount of data in a field and country where there this phenomenon is barely explored using a combination of systematic mapping review, AcciMap analysis and survey. This form of triangulation provided a deeper understanding of the research question using a variety of methods in the study. In addition, triangulation was

applied to help with the potential bias when data were collected from different time periods, locations, and perspectives.

## 3.4. Qualitative and quantitative methods in the mixed-methods approach:

Three methods were applied in the study. The strengths and limitations of each method were explored in the following section. The application of the methods was as follow:

### 3.4.1. Critical review: Systematic Mapping Review

A systematic mapping review methodology was used in Study 1. The phenomenon of interest in this review was travel related FBD outbreaks. The developed analytical framework has used a component of a PICO (population, intervention, comparator, outcomes). The comparator (C) was omitted from the search because it is irrelevant when qualitative research questions are used. Studies were included even where no comparator was present. A systematic mapping review follows the same strict and transparent methodology process as a systematic review (James *et al.*, 2016). This review attempts to comprehensively identify, collate and critically appraise relevant information to obtain empirical evidence (Gopalakrishnan and Ganeshkumar, 2013). The summary and synthesis of the collected evidence is guided by a rigorous process based on explicit research questions, a defined protocol and a set of pre-specified inclusion criteria to answer a specific research question on a given topic (Granados-Duque and García-Perdomo, 2021). A systematic mapping review is considered to be an effective method to access and gather evidence from possible any existing literature and review it systematically. In addition, a systematic mapping review differs from other types of literature review because its strict scientific design attempts to search, select, and assess studies with a transparent reproducible approach and methods (Moons *et al.*, 2021). A well-defined methodology and following set guidelines reduce the chances of bias and random error in the study review. However, in order to have reliable and more accurate findings in the review as well as to minimise bias, each step of the systematic mapping process was reviewed by other experienced members of the research team.

A systematic mapping exercise in Study 1 was based on specific search strategies, objectives and methods which were detailed in a prior design protocol. The systematic mapping was conducted primarily to provide an overview on the current state of the specific research topic.

According to Petersen (2008), a systematic literature review and systematic mapping have differences in the process, goals, breadth, and depth of the review. Systematic mapping fits the purpose of the current research because it has a broader scope. Consequently, the systematic mapping review was conducted as an overview of the current state of research topic which covers foodborne outbreaks in the hospitality sector in the DR and associated travel related food safety issues. This broader scope in an area of limited research can contribute to expose the gap in contemporary knowledge and shed light on future research directions and opportunities. As a result, the research findings should contribute to a better understanding of FBD outbreaks and associated issues in the DR. At the same time, it should pave the way for solutions to be provided to the national government, academia and the hospitality industry. It should be noted that one of the important limitations of the systematic mapping review is that in attempting to answer the specific research question some information and studies would be deliberately ignored in the search strategies and during the selection process of the studies. In addition, relevant information might become available after this review is completed. The full methodological procedure and results of the systematic review will be discussed in more detail in Chapter 4.

### 3.4.2. Document analysis: AcciMap model

Document analysis is a qualitative research method in which documents are the main data source. Document analysis is a systematic procedure for collecting and analysing printed and electronic documents (Bowen, 2009). Merriam and Tisdell (2015) state that a diverse variety of documents can be used such as text data from verbal, print or electronic media and visual sources. In this process the collected documents are examined and interpreted in order to make inferences and extract the meaning and understanding with the ultimate goal of developing empirical knowledge (Bowen, 2009). Researchers can use a document analysis as a single method of choice for the research or as a complementary approach. According to (Bowen, 2009), document analysis provides context, supplements other types of research data, tracks changes over time and corroborates with other sources. This method was used for collecting and reviewing documents and creating the investigation reports in Study 2. The results of these investigations are presented in Chapter 5. It is not necessary for the document analysis to be stand-alone as, at different stages of analysis it can also include quantitative and qualitative components.

The motivation to use document analysis in this research lies in the advantages of this approach. For example, its flexibility, data sets are accessible, and it is an efficient and cost-effective way to conduct research. Qualitative research in many fields experienced adaptation due to the COVID-19 pandemic disruptions which affected the scientific research community (Kobakhidze *et al.*, 2021). Many researchers have postponed and/or abandoned field work due to bans on travelling, lockdowns and restrictions during the pandemic, and that was the case in this study. The pandemic made it hard to do observations at establishments (e.g. foodservice, restaurants, hotels) during the initial collection of research data due to the closure of facilities or the limitation of how many people could enter their facilities. Therefore, document analysis was used as a flexible and safer approach during a global pandemic but also as a method approach that helped the researcher to gain access to the best source of data for completing this project. Document analysis is an appropriate method to provide background and contextual information of pre-existing documentation of food outbreaks, reports using online sources and electronic databases to collect the data remotely when it is not possible undertake physical field data collection.

The use of online methods, secondary data and moving to more web-based research are some of the alternatives to gain access to data and participants, especially in the midst of the full lockdown restrictions of the pandemic. These necessary COVID-19 mitigation strategies led the researcher to modify their data collection methods. Bratan (2021) reported that many researchers changed or implemented their collection methods using digital tools and some cases opted to make changes in research design or research questions. In the current study, the research design was reconsidered looking to an optimisation of existing data sources and a convenient data collection approach. Therefore, the collection of primary data was redesigned, and the entire research project was adapted due to an unknown time for lockdown and to continue the PhD work despite disruption. Moreover, the methods for document analysis involves affordability and easy access to public records, institutional documents, and investigation reports. The relevance of the documents should always be determined by a critical review by the researcher. However, the use of document analysis as data collection technique is guided by several factors such as Authenticity, Credibility, Representativeness and Meaning (Bowen, 2009; Morgan, 2022). Both Bowen (2009) and Chanda (2021) stated that to avoid bias in the selection it is important to consider the four factors mentioned. However, qualitative research must focus on the comprehensiveness of the selected documents and how fully they cover the desired topic.

Document analysis as a method does have its limitations. One of the main concerns is the low retrievability due to potential lack of disclosure in publicly available material. Thus, it is not always is possible to retrieve all the desired documents especially if the researcher only has access to publicly available documents. Therefore, if the document analysis is used as the sole method in the research there could be insufficient detail, and this will affect the overall findings. In order to overcome some of the inherent limitations in the document analysis such as insufficient detail, low retrievability and selectivity bias a quick scoping review was carried out. The scoping review used the same components of a systematic review but in a timely manner (Hamel *et al.*, 2021). This helps the researcher to collect documents that are precise, accurate and complete and to minimise errors due to the biases that authors might bring to the research. Document analysis also allows the researcher to collect and assess stable documents Bowen (2009). This means that the collected document can be re-assessed and reviewed multiple times while remain unchanged by external influences. In the food safety context, some quantitative approaches do not ensure this unchangeable feature of the collected data is suitably addressed. Therefore, the findings are only snapshots and do not fully report the real situation. Analysis was carried out using an AcciMap accident analysis method, described in detail in Chapter 5. This phase allowed for the application of this systematic analysis approach in a novel context.

### 3.4.3. Stakeholders' investigation: online survey

Stakeholder's evaluation was employed to retrieve data from the regulatory and industry specialists and focused on collating and analysing the experts' opinions, views, and knowledge. Stakeholders is referred to any group or person, internal or external to the company, who influences or is influenced by the execution of an organization's goals (Lima De Oliveira *et al.*, 2023). Stakeholders with significant work experience and expertise on hygiene and food safety aspects were considered relevant to this stage of the research and their perceptions on which food safety practices are of importance to the hospitality sector in the DR. The informants and stakeholders were identified from the hospitality sector as those who have a direct involvement in or can have influence on food safety and operational practices and policy in both the public and the private context. Names and contacts of participants were identified mostly through personal networks, acquaintances and on the internet.

One of the primaries means of gathering quantitative data is through surveys. Therefore, the quantitative phase in this research involved using an online survey tool to gain insight into the stakeholder's perceptions of the hospitality sector. The online survey was adopted due to its effective potential to collect qualitative and quantitative data (Evans and Mathur, 2005). Principles such as appropriateness, feasibility, neutrality, completeness, and cultural and ethically sensitive, completeness, and neutrality (Regmi *et al.*, 2016) were considered in the design and development of the online survey in this research in order to ensure it was methodological sound. Moreover, the usefulness of online surveys is that they enable the researcher to easily design and distribute surveys to the target population, especially with the ongoing limitations of COVID-19. The survey tool allowed access to large and geographically distributed populations, to produce and compilate findings in synchronous time. Additionally, the online survey is cost and time effective.

The online survey provided advantages such as the ability for panellists to participate remotely from the DR. Additionally, the stakeholder evaluation was specifically intended to locate the study in the DR. The online survey contained three sections. The first section consisted of demographic information, the following section was informed by the findings of the first two stages of the research. Participants were asked to rate their level of agreement with a range of statements using a five-point Likert scale and a binary response of YES or NO to questions related to food safety management and practices that should be included in a guide of practices. Prior to launch, the survey was piloted with a member of the research team to evaluate the content and clarity of questionnaire. The questionnaire was translated into Spanish for the participants. The online survey questionnaire design is described in detail in the stakeholder investigation in Chapter 6.

### 3.5. Sampling plan

Participants for the collection of primary data in Study 3 were selected based on a purposive sampling approach. Purposive sampling was employed to gain information from participants with the relevant expertise in a particular field in the topic of interest (Martínez-Mesa *et al.*, 2016). This approach enables the researcher to select independently and strategically select the participants that will provide the sources of empirically rich data for the purpose of this study (Creswell and Creswell, 2018; Robson and McCartan, 2016). The sample was drawn from government officials, the private sector, consultants, and academics involved in the hospitality

sector and all with food safety expertise. The researcher relied on her professional network to identify potential participants across the stakeholders. Each identified potential participant (38) who met the required criteria, who were willing to participate and confirmed their interest were contacted by email and phone.

### 3.6. Data Analysis

In this research various data-collection approaches were adopted; the collected data and analysis was accordingly driven by both quantitative and qualitative methods. Quantitative analysis was carried out using descriptive statistics, mean and percentage. Qualitative data analysis was conducted using Nvivo 14 to manage and organise the data and generates the code and nodes during content analysis. Coding is the primary process that permits recognizing the patterns involved in the sample and verifying their frequency and occurrence (Creswell, 2018). Furthermore, the data gathered were analysed using content analysis for main ideas and patterns identifications captured in the data. A thematic approach is widely used in qualitative research to analyse identify and synthesise the pattern and meaning of the data (Braun and Clarke, 2006; Thomas and Harden, 2008).

Thematic analysis in qualitative research is recognised as a useful analytical method to summarise and capture the specific meaning from reading between lines the details within the set of data obtained (Nowell *et al.*, 2017). An analytical method helps researchers to examine a participant's perspective and determine similarities, differences and key features of the data (Sutton and Austin, 2015). The thematic framework can be outlined in six generic steps. This allows analysis of large qualitative data in a systematic manner into organised and manageable chunks by: (1) data familiarisation; (2) generating initial codes; (3) searching themes; (4) reviewing themes; (5) interpreting the codes and themes; and (6) reporting the case in detail (Nowell *et al.*, 2017). These steps provide more clarity to the analytics process and the multiple phases have provided involved researchers with a framework with detailed, practical explanations and the guideline steps to follow in thematic analysis. It also helps to assist novice and professional researchers (Braun and Clarke, 2006; Byrne, 2022; Nowell *et al.*, 2017; Roberts *et al.*, 2019).The methodical manner which yields meaningful information in thematic analysis can be conducted through an inductive or thematic approach.

The inductive approach means that the analysis and coding process is performed for the information generated from the raw data without a predetermined frame based on predefined preconceptions (Nowell *et al.*, 2017). Conversely, the deductive approach follows a framework in which the data is categorised into themes based on the specific research questions or the analytical interest of the researcher (Maguire and Delahunt, 2017). A combination or hybrid approach is widely used in qualitative research and is considered by the researcher as the best approach able to answer the research question (McNeil, 2019; Roberts et al., 2019). Combined deductive and inductive reasoning was chosen as a suitable in this research due to its qualitative explorative nature and the multiple methods adopted the deductive and inductive principles of both approaches. Gale (2013) stated that a combined approach is appropriate in studies focused on exploring a subject, as in Chapter 2, to find specific trends and which factors need to be tested until following studies provided answers. It is helpful to have the framework to identify from unexpected themes from participant's responses based on their experiences.

Analysis in this research involved an iterative process and each stage of data collection informed the conceptualization and application of the subsequent stage. Table 3.3 summarises the steps involved in analysing the data. In general, the process involved data extraction, synthesis, coding, mapping, clustering and analysis of the data gathered. Descriptive analysis was used to analyse the data associated with the questions that arose from the findings from the systematic mapping review (Chapter 4). The findings from this stage of the research provide an overview of the microbiological food hazards, contamination source, implicated food, and common settings associated with FBD outbreaks. This led to considering which microbiological pathogens, aetiological agents, poor hygiene, and food safety practices were identified as issues in hospitality settings and this informed consideration of the agent of interest in the AcciMap analysis.

To expand and understand in more depth the potential causes, the study in (Chapter 5) applied the AcciMap approach. The systemic accident analysis model (AcciMap model). This systemic analysis process involved an extensive analysis to first compile all the information on specific outbreaks from published and unpublished literature from diverse sources. Because this analysis requires abundant information, a Norovirus outbreak in the hospitality sector in the DR was used for the analysis due to the available research, documents and information. After familiarisation with the data and the different causal and contributory factors that serve to categorise the systemic factors, the findings from the AcciMap model identified key actions and

activities that influence food safety outcomes. These also emerged in the literature review (Chapter 2) and in the findings from the systematic mapping (Chapter 4).

*Table 3.3 Summary of the steps in the overall data analysis process*

| Task | Method | Explanation |
|---|---|---|
| **Data reduction** | Time-series analysis | Patterning of data over time |
| | Coding | Classifying and categorising groups of words |
| | Memorising<br>Post it | Theorising and write-up ideas about codes and their relationships |
| **Data Display** | Matrix | Representing data in tables |
| | Maps and Charts | Diagrams and visual representation of data |
| | Causal networks | Set of boxes or nodes linked between them |
| **Conclusion Drawing/Verification** | Observing patterns, themes and trends | Noting recurrent themes, ideas thoughts |
| | Clustering | Grouping similar characteristics |
| | Comparison | Highlighting similarities and making inferences between the data set |
| | Relating Variables | Visualising the relationship between variables |
| | Making conceptual/ theoretical coherence | Moving from data to construct or theories, thought analysis categorisation |

Adapted from: (Lin and Roberts, 2018; Tang, 2010).

The recurrence of key aspects related to hygiene, food safety practices, and management indicates that there are challenges in the socio-technical systems in the hospitality sector. These factors informed further questions in the survey. In the final study, in Chapter 6, the key factors identified previously became the focus of the descriptive and thematic analysis. It was important to consider the opinions and the perspective from experts and professionals related to hospitality and food safety in the areas selected for consideration in this study. A stakeholders' engagement phase through the online survey was used to sense check the key factors identified and evaluate in the DR context which factors experts feel are important in order to identify some key actions that could be taken, or some key controls adopted and how effective they think they are to any FBD outbreak. At the time of the completion of the survey

COVID-19 was still a major public health issue so it was also important to consider if specific key factor identified from the previous studies were considered in the same way before the COVID-19 pandemic or have been strengthened during and afterwards. In addition, the survey sought to determine if these key factors might inform and improve FSMS, FS-culture and food safety practices and their impact on wider public health in the hospitality sector to prevent similar failures in the future.

The particular advantage of these approaches in this study is that it enables the use of existing and available data from real research, documents, and reports to provide context to investigate the research question in depth where scarcity of published scientific data is an issue. In a country where food safety research epidemiological investigation, to control and reduce the likelihood of food safety hazards, has not been prioritised then the approaches like those used in this research can be an alternative to provide information on this matter. The mixed-methods approach allows researchers to gather rich and abundant data that in this study gave a solid foundation in helping with the interpretation of human behaviours and situations, in a sector with paucity of information and consequently allowed the researcher to make recommendations based on the particular reality of the country. Additionally, the adopted approach follows a systematic design which produces reliability and validity in the results thus providing transparency and the opportunity to take the approach forward to be generalised and then used as a tool to investigate food safety issues and especially FDB outbreaks in the future in the DR.

Another advantage is that the methods applied are accessible and a low-cost approach using secondary data, databases and a desk-based approach which does not involve major economic investment. Primary data was generated in the use of an online survey as the research data collection method. In general, one of the disadvantages of the methods used is that almost all the approaches use internet-based data. If the data availability and retrieval is not sufficient or the data is of low quality, then this will influence the final findings. Another potential disadvantage is undertaking large studies and extensive data collection through different techniques also represented a challenge for the researcher and team. Additionally, the methods used rely on the analyst's expertise to systematically search, collect, manage and analyse the data gathered in this research.

## 3.7. Ethical considerations

The study, prior to data collection, received approval from the Harper Adams University Ethics Committee. Potential participants in the online survey were fully informed about the important issues of risks, benefits, privacy and confidentiality of the right to withdraw, the provision of feedback and data management protection information. The systematic mapping and AcciMap model were not related to any ethical consideration since no human subjects were involved to provide information and the material was freely accessible in the public domain Appendix C details the ethics approval documentation.

## 3.8. Summary

This chapter gives a detailed description of the methodology, research design and used in the research. The study adopted the pragmatic paradigm and justified the reasons. An exploratory sequential mixed-methods approach was adopted using quantitative and qualitative research methods to analyse from a holistic perspective FBD outbreaks in the hospitality sector in the DR. The methods and data collection were designed to answer the research questions and explore the advantages and disadvantages of each method selected. The use of three phases of the research for data gathering from both strands was justified; therefore, this study built its analysis plan and data processing practice with regards to the analytical techniques that are applied to qualitative and quantitative data. These are discussed in the following sections and a detailed description of the data collection and analysis techniques used in each study is provided in Chapters 4, 5 and 6.

# CHAPTER FOUR: A systematic map of food safety hazards outbreaks affecting the hospitality sector in the Dominican Republic.

This paper is published. Minor modifications have been made for presentation in this thesis. The complete citation is: Diaz, D., Oleo, D., McIntyre, L., Randall, N., Nayak, R. and Manning, L. (2022), "Systematic mapping of food safety outbreaks in the hospitality sector in the Dominican Republic", British Food Journal, 1–22.
DOI: https://doi.org/10.1108/BFJ-10-2021-1146

## Abstract

The hospitality sector underpins the economy of the Dominican Republic (DR) by attracting millions of visitors per year and is a common setting in which customers might suffer from foodborne illness if food safety and hygienic practices are not adequately met. Whilst food safety outbreaks remain a global public health and economic concern, the information available regarding such events in developing countries is still limited. This study used a systematic mapping approach to collate evidence on food safety outbreaks in the hospitality sector in the DR and their link to food safety and hygienic practices. Publications (n= 2,793) from databases (e.g. Web of Science, PubMed) were identified, and systematically selected for relevance. A full-text assessment based on the inclusion criteria led to the identification of a refined list of studies and relevant academic publications (n=22) which were included in this review. The analysis suggests a low rate of reported or investigated food safety outbreaks in the DR. Therefore, a knowledge gap on food safety outbreaks, the related food safety hazards and how they are mitigated by stakeholders and local health authorities in the DR exists. Further research is required to understand the potential efficacy of risk-based surveillance systems and reporting structures. Improving government and other stakeholder capacity to report, investigate and understand food safety outbreaks and the practices involved will reduce risk to tourists when on holiday and also safeguard tourism as a critical element of the DR's economy. This is one of the first studies to focus specifically on food safety outbreaks in the DR.

# 4. Introduction

The hospitality sector is important because underpins and diversifies the Dominican Republic's (DR) economy by attracting millions of visitors per year (WTTC, 2018). However, the hospitality and tourism industry and its competitiveness are highly vulnerable to political instability, terrorism, natural disaster epidemics and foodborne disease and health threats (Arbulú *et al.*, 2021; Indar *et al.*, 2020; Ma *et al.*, 2020; Rosselló *et al.*, 2020). Foodborne diseases (FBD) in a tourism dependant country such as the DR represent a threat. The most recent example is the novel coronavirus (COVID-19) and the impact on the tourism and hospitality industry across the world with travel restrictions, border closures, quarantine requirements that have challenged the resilience of the tourism and hospitality sectors aside from the health crises, fear and mortality rate impact on the global population (Aharon *et al.*, 2021; Kaushal and Srivastava, 2021; Rahman *et al.*, 2021; Song and Kim, 2021) Changes in people's behaviours and lifestyle were made; moreover, the hospitality sector, public health policymakers and tourism stakeholders will need to introduce new way to operate (post-pandemic) focusing on preparedness by improving risk management, biosecurity procedures, and health, hygiene and sanitation procedures to improve travellers' confidence (Aharon *et al.*, 2021; Rahman *et al.*, 2021).

## 4.1. Food safety reviews in the Caribbean

Relatively little is known of the incidence and risk of foodborne diseases in the tourism and hospitality sector in Caribbean countries. A detail record of any occurrences of FBDOs is needed in order to implement the appropriate food safety control measures at the time and in the future (Pires *et al.,* 2012). Food safety risk analysis is a useful tool, via risk assessment, for the identification at the local level of food hazards and risks and taking into account the specifics of the operating food chain (de Bock *et al.,* 2021). The literature review by Pires *et al.* (2012), which considered bacterial pathogens between 1993 and 2010, used the data from the Regional Information System on FBDOs of each country within Latin America and the Caribbean. In general, the study concluded that food items such as meat, dairy products, seafood, eggs, vegetables and water were the most important sources of bacterial FBDOs during the investigation timeframe. Findings from this study showed 24 outbreaks in the DR, but it does not specify the source of contamination (i.e. food or water). Guerra *et al.* (2016) reviewed food safety and foodborne zoonoses in the Caribbean Region from 1995 to 2015.

Species of *Campylobacter, Salmonella* and *Shigell*a were the main pathogens in these incidents, and although these data do not include the DR specifically, the findings increase the concern regarding FBDOs in the Caribbean region. Moreover, a 12-year review conducted by Hull-Jackson and Adesiyun (2019) aimed to determine the etiological agents, food and locations of FBDOs in Barbados. Findings reported during this period that *Salmonella* was the common pathogen identified and eggs and poultry were the primarily contamination source. Hotels and tourist resorts were the common location associated with these outbreaks. Apart from these review articles, there is limited information about FBDOs and public health and the hospitality sector in the DR. Even more scarce is the publicly available literature and information about travel-associated FBDOs and only some anecdotal evidence could be found on online blogs and travel websites. On these online blogs some visitors shared their symptoms and the general experience related to foodborne illnesses during their stay in all-inclusive hotels in the DR (Christopher, 2013; Elliot, 2016; Meikle, 2009; TripAdvisor, 2018). Such personal episodes include subjective opinions but can still be used as a first step in a scientific epidemiological investigation, if combined with more robust evidence. Timely reported personal episodes could be individual, single cases but also could be important early-warning notifications for associated FBDOs. The most important task for the further epidemiological investigation is to identify the causative agents, sources of contamination, the main food involved and the unsafe practices that led to the outbreak. A formal recording process is also an essential part of any surveillance system to preserve people's health and prevent further spread of disease (Ntshoe *et al.,* 2021; do Prado *et al.,* 2021).

In this study, we applied the method of systematic mapping which requires a predefined review protocol in order to guide the literature search. This systematic mapping review will be the first one critically appraising food hazards and travel associated risk in the DR. Therefore, we aim to explore and systematically examine the literature and describe the evidence on foodborne disease associated with travel/tourism in the DR to inform policy, as well as identify research gaps for future studies in the country.

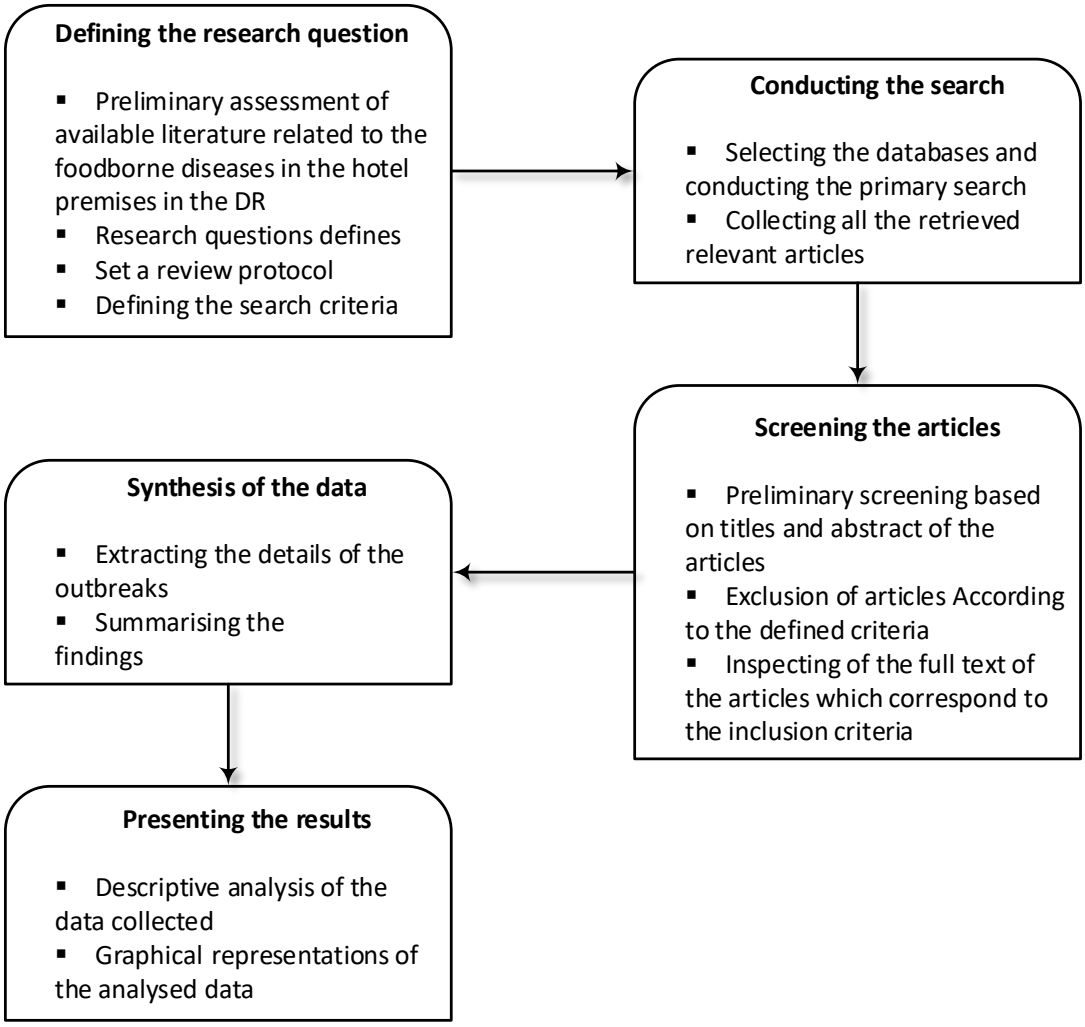
## 4.2. Materials and methods

### 4.2.1. Study design

Systematic mapping provides a broad overview of a specific research area, systematically organising existing data within the literature (dos Santos Garcia *et al.,* 2019; Nguyen and Li, 2021). This method uses an a priori methodology and reduces the likelihood of bias and increases the transparency of the approach (James *et al.,* 2016). Due to the limited information about FBDOs in the Caribbean and the DR, the authors found a need for a more methodical approach to map FBDOs in these countries. Hence, a systematic mapping exercise was carried out. This method was proposed for identifying data, categorising the data, analysing, summarising and reporting the findings of the subject of interest (Adhi Tama and Lim, 2021; Dalponte Ayastuy *et al.,* 2021). There have been previous reviews on food-related illnesses in the Caribbean, which have included food safety-related aspects, bacterial foodborne zoonoses and documentation of FBDOs (Guerra *et al*., 2016; HullJackson and Adesiyun, 2019). However, the study by Hull-Jackson and Adesiyun (2019) comprised of countries that are full member states of the Caribbean Community organisation (Caricom) of which the DR is not a member. Neither of the previous known reviews used a systematic approach for search and inclusion of studies.

The systematic methodology process and protocol was performed according to the guidelines provided by the Collaboration for Environmental Evidence (CEE) Guidelines for Systematic Reviews Collaboration for Environmental Evidence, 2013; James et al., 2016). Supervisory Team members guiding this review have expertise in knowledge synthesis, risk assessment, and systematic review methodology and supported the research. Adapted from (Garcia *et al*., 2019).

Figure 4.1 illustrates the systematic mapping process followed in every stage of the review.




Adapted from (Garcia *et al*., 2019).

*Figure 4.1 Methodological framework and stages covered in the systematic protocol and mapping review.*

### 4.2.2. Research question and review protocol

This review began by defining the research questions according to the scope and objective of the research, and an a-priori protocol was prepared prior to commencing the work. The protocol described the criteria which should be applied at each consecutive steps of the systematic mapping. This approach intended to reduce the potential for bias during the preliminary search and to ensure collection of the relevant articles as objectively as possible. A copy of the original review protocol is registered in Open Science Framework (https://osf.io/wq3df). Any changes from protocol are included in the methodology here.

The primary question addressed was: What food safety related outbreaks have affected the hospitality sector in the DR? In order to have a comprehensive search term food safety related was used attempting to retrieve all suspected threats to the food safety in the hospitality sector. An analytical framework was developed using the PICO (population, intervention, comparator, outcomes) key elements (Arton *et al.*, 2020). It should be noted that whilst outbreaks are described as food safety related in the research question the search string included 'disease' and 'outbreak' but not the word 'foodborne' specifically rather food*.

This question has the following components:
**Population** (s): Food safety-related outbreaks
**Occurrence** (s): The number, distribution and type of food safety outbreaks in the DR
Secondary questions of this systematic map and the following components:

- What food safety practices have influenced food safety outbreaks in the DR?

**Population** (s) Areas in the food service/hospitality sector/individuals or groups of people in the DR that have been impacted by outbreaks
**Intervention** (s) different food safety practices
**Comparator** (s) any
**Outcome(s)** outbreaks

### 4.2.3. Data collection

#### *4.2.3.1. Search strategy*

A search of articles was performed from the 26th of February to 3rd of April 2020. No restrictions were defined for the date, year of the study or type of publication. Keyword, Boolean expressions and Truncation (*) symbol were applied to broaden the search across all included bibliographic database (Table 4.1). Grey literature searches were also conducted from 27th October to 2nd November 2020, using a combination of key elements from the same search algorithms as the published literature. These searches had no date restrictions.

*Table 4.1 Search terms used in the searching process in the selected online databases.*

| Database | Search string |
|---|---|
| **Web of Science**<br>**EBSCOhost**<br>**Wiley online library**<br>**PubMed** | (food*) AND TOPIC: (disease* OR outbreak* OR contamination OR intoxication OR poison* OR pathogen* "gastrointestinal disorder" OR infection* OR allergy OR hygiene OR sanitation OR Campylobacter* OR Cryptosporidi* OR Cyclospor*OR "Escherichia coli" OR "E. coli " OR "Hemolytic Uremic Syndrome" OR Giardia* OR Listeri* OR Salmonell* OR Shigell* OR Toxoplasm*OR Vibrio OR cholera* OR Yersini* OR Norovirus OR Hepatitis OR Staphylococcus OR "waterborne" OR diarr* OR vomiting OR "Ciguatoxins" OR epidemic OR epidemiology or pandemic) AND TOPIC: (Caribbean Or Dominican Republic) |
| **Academic searches** | |
| **Bibliography databases** | Google Advance Search, Google Scholar and Pubmed |
| **Specific websites** | Public Health Department Dominican Republic, US Centers for Disease Control and Prevention (CDC), World Health Organisation (WHO), Pan American Health Organisation (PAHO/WHO), Food and Agriculture Organisation of the United Nations (FAO). |
| **Grey literature databases** | Dissertations and theses from ProQuest, EThOS, Institutional Repository from a Technological Institute of Santo Domingo (INTEC) |

### 4.2.4. Inclusion Criteria

#### *4.2.4.1. Articles screening*

Inclusion and exclusion criteria were used to identify relevant food safety related outbreaks occurring in the DR hospitality sector in this review. Articles were screened according to the following criteria: (1) studies conducted to examine food safety outbreaks occurring in the DR hospitality involving travellers; (2) Studies focused on the risks, diagnosis, management or consequences of infection, poisoning, the virulence of foodborne illness in the DR; (3) Studies in English and Spanish and any other language with relevant information was considered for inclusion. Literature from governmental and other organisations were also included. All relevant published and unpublished studies were screened using the predefined inclusion and exclusion

criteria to ensure specific information relating to the research question is included in the studies. Where the relevance of articles was unclear at the title and abstract assessment stage, the articles were included and assessed during the full-text review. Articles were assessed for inclusion by one reviewer where there were any queries regarding inclusion at any stage and the second reviewer then also screened the article and its inclusion/exclusion was resolved through discussion. If an article describing a given outbreak provided formal evidence of laboratory confirmation in both human cases and foodstuffs, that outbreak was classed as definitely foodborne (food or water) rather than another vehicle or mode of transmission. Outbreaks reported in multiple publications were only recorded once. Reasons for exclusion at the full text level together with details of articles that cannot be located or accessed were recorded.

### 4.2.5. Data extraction

Citations identified via the search were exported into the web-based citation management software RefWorks version 2.0 to extract and collect. Further, all data on the occurrence of foodborne disease were retained and exported to Microsoft Excel version 16.37 for coding and analysis. The following information was extracted from each study: study location, author, year, risk factor(s), type of publication (e.g. conference, journal), major study findings, outbreak, with variables: year of outbreak, food incriminated, food category, the main reason, number of cases, number of laboratory-confirmed cases, number of hospitalisations, deaths and location of cases, incidence, prevalence, food safety practices, and socio-demographic characteristics of targeted participants (Table 4.2.). Results were summarised visually and with descriptive statistics to display the number of studies and publication/reported year and etiologic agents of concern that were identified, and these are analysed in the next section of the chapter.

*Table 4.2. Summarised characteristics and data extracted from the final studies included in the full paper review.*

| Year | First author/year (ref) | Title | Type | Contributing Factors | Year Outbreak | Disease | Source Implicated | Food Setting | Etiologic Agents | # Of Cases/ People/Where | Symptoms | Socio-Demographic Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1992** | Lange *et al.*, | Travel and Ciguatera Fish Poisoning. | Article | Risk to travellers to endemic regions | 1987 - 1990 | Ciguatera | Suspected fish included grouper, red snapper, and amberjack. | Hotel restaurant | Ciguatera toxin | 1 | Paraesthesia of the extremities or around the mouth, weakness, pruritus and diarrhoea | Not reported |
| **1992** | Roca *et al.*, | Toxoplasmosis and hepatitis. | Article | Eaten raw or partly cooked foods | Not reported | Toxoplasmosis | Eaten raw or partly cooked foods. | Not reported | *Toxoplasma gondii* | 1 | Acute hepatitis; a high fever, general weakness, aching joints and jaundice. | 23-year-old male |
| **1997** | Sanner *et al.,* | Ciguatera fish poisoning following travel to the tropics. | Article | Food and Potable water | Not reported | Ciguatera fish poisoning | Meal of grouper | Not reported | Ciguatera toxin | 16 people | Vomiting and watery diarrhoea | Not reported |
| **1999** | Blume *et al.,* | Ciguatera poisoning. Growing differential diagnostic significance in the age of foreign tourism. | Article | Ciguatera fish poisoning | 1999 | Ciguatera intoxication | Peak bass and lemon sauce. | Dinning | Ciguatera toxin | 4 people | Paraesthesia, nervousness, inverse temperature perception, muscle cramps, headache and dizziness | 22 and 31 years |
| **2000** | Green *et al.,* | Two Simultaneous Cases of *Cyclospora cayetanensis enteritis* Returning from the Dominican Republic | Article | Not reported | 1998 | Gastroenteritis | Not reported | Not reported | *Cyclospora cayetanensis* | 2 people | Diarrhoea | 72-74 year |
| **2001** | Perez *et al.,* | Treatment of Ciguatera Poisoning with Gabapentin. | Article | Food and Potable water | Not reported | Ciguatera fish poisoning | Dusky grouper | Punta Cana | Ciguatera toxin | 2 people | Nausea, vomiting, abdominal cramps, and watery diarrhoea | 32- 37 years old |

| Year | First author/year (ref) | Title | Type | Contributing Factors | Year Outbreak | Disease | Source Implicated | Food Setting | Etiologic Agents | # Of Cases/ People/Where | Symptoms | Socio-Demographic Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2004** | Jiménez *et al.*, | Waterborne outbreak among Spanish tourists in a holiday resort in the Dominican Republic. | Article | Sewage system to the water supply system | 2002 | Amebic dysentery (amebiasis) | Consumption of unsafe foods or drinking untreated fresh water. | Resort | *Entamoeba hystolitica* cysts | 76 | Acute diarrhoea | The mean age was 31.6 +3.5 years. 61.8% of cases were male |
| **2007** | Gupta *et al.,* | Emergence of Shiga toxin 1 genes within *Shigella dysenteriae* type 4 isolates from travellers returning from the Island of Hispanola | Article | Endemic in the island of Hispañola. | 2004-2005 | Shigellosis | Not reported | All-inclusive resort in Punta Cana | Stx1-producing *S. dysenteriae* 4 | 2 cases / 6 people | abdominal cramping, and non-bloody diarrhoea | 17-year-old male resident of Florida / 3-year-old boy |
| **2007** | Szakacs and McCarthy, | An all-inclusive vacation. | Article | Food and Potable water | Not reported | Typhoid fever | Food or water contaminated with faeces. | Resort in Punta Cana | *Salmonella enteritica* serovar Typhi | Not reported | Abdominal cramping, nonbloody diarrhoea and fever | 70-year-old |
| **2008** | Develoux *et al.,* | A case of ciguatera fish poisoning in a French traveller | Article | Ciguatera poisoning/ The species of ingested fish could not be specified | 2008 | Ciguatera | The species of ingested fish could not be specified. | A hotel-club of Puerto-Plata | Ciguatera toxin | 2 | Abdominal cramps and diarrhoea | Not reported |
| **2009** | Doménech-Sánchez *et al*., | Gastroenteritis Outbreaks in 2 Tourist Resorts, Dominican Republic | Article | Sewage water | 2005 | Gastroenteritis | Water | Not reported | Norovirus | 773 | Diarrhoea, vomiting, headache and fatigue | Not reported |
| **2010** | Doménech-Sánchez *et al*., | Unmanageable norovirus outbreak in a single resort located in the Dominican Republic | Article | Food and Potable water | 2007 | Acute gastroenteritis | Contaminated food or water as the source of the infection. | Not reported | Norovirus | 800 | Not reported | Not reported |

| Year | First author/year (ref) | Title | Type | Contributing Factors | Year Outbreak | Disease | Source Implicated | Food Setting | Etiologic Agents | # Of Cases/ People/Where | Symptoms | Socio-Demographic Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2011** | Johnson *et al.,* | *Salmonella* infections associated with international travel: a Foodborne Diseases Active Surveillance Network (FoodNet) study. | Article | Travel-associated | 2004-2008 | Salmonellosis | Not identified | Not reported | *Salmonella enterica* serotype | 66 | abdominal cramps, and bloody diarrhoea | 3-year-old boy |
| **2011** | Jiménez *et al.,* | Multinational cholera outbreak after wedding in the Dominican Republic. | Article | Poor food handling practices | 2011 | Cholera | Shrimp and prawns were served on ice or ice sculptures. | Wedding banquet | *Vibrio cholerae* O1 | 42 case-patients | Watery diarrhoea, nausea, vomiting, cramps | Median age of case-patients was 42.5 years (range 16–84 years); 33 (79%) were male |
| **2011** | Newton *et al.,* | Cholera in United States Associated with Epidemic in Hispaniola. | Article | Consumption of contaminated food or water | Not reported | Cholera | Not reported | Not reported | *Vibrio cholerae* O1 | 23 associated cases, 9 to Dominicans | Not reported | Not reported |
| **2011** | Martinez *et al.,* | Un caso de ciguatera en viajera a la República Dominicana | Article | Ciguatera fish poisoning | Not reported | Ciguatera intoxication | Chillo hervido (*Lutjanus vivanus*). | Lodge in Santo Domingo | Ciguatera toxin | 1 people | Nausea, vomiting, chills, and diarrhoea | 44 years old woman |
| **2012** | Kendall *et al.,* | Travel-associated enteric infections diagnosed after return to the United States, Foodborne Diseases Active Surveillance Network (FoodNet), 2004-2009. | Article | Enteric infection | 2004-2009 | Enteric infection | Not reported | Not reported | *Campylobacter* (42%), nontyphoidal *Salmonella* (32%), and *Shigella* (13% | 201 Travellers | Not reported | Not reported |

| Year | First author/year (ref) | Title | Type | Contributing Factors | Year Outbreak | Disease | Source Implicated | Food Setting | Etiologic Agents | # Of Cases/ People/Where | Symptoms | Socio-Demographic Characteristics |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2015** | Fillion and Mileno, | Cholera in travellers: shifting tides in epidemiology, management, and prevention | Article | Cholera | 2010 | Cholera | Not reported | Not reported | Vibrio cholerae O1 | 9 travellers | Not reported | Not reported |
| **2015** | Loharikar *et al.,* | Cholera in the United States, 2001-2011: a reflection of patterns of global epidemiology and travel. | Article | Cholera | 2011 | Cholera | Not reported | Not reported | *Vibrio cholerae* O1 | 40 | Not reported | Not reported |
| **2015** | Gray *et al.,* | Prevalence of Stx-producing *Shigella* species isolated from French Travellers Returning from the Caribbean: An Emerging Pathogen with International Implications | Article | Environmental factors have contributed to the emergence of these species in that region. | Records between 1994 and 2008 | Shigellosis | Not reported | Not reported | stx-positive. This included nine strains of *S. flexneri* 2a, one *S. dysenteriae* 4, and one *S. flexneri* Y. and *S. flexneri* 2a | Not reported | Not reported | Not reported |
| **2016** | Ministerio de Salud Pública, | Brote de gastroenteritis, Complejo hotelero Live Style Resort Puerto Plata | Repor t | Contaminated water and ice | 2016 | Acute gastroenteriti s | Contaminated water and ice. | Live Style Resort | Norovirus | 301 | Not reported | Not reported |
| **2016** | Thompson *et al.,* | Ciguatera fish poisoning after Caribbean travel. | Article | Ciguatera fish poisoning | Not reported | Ciguatera intoxication | Dog snapper | Not reported | Ciguatera toxin | 2 people | Nausea, vomiting and diarrhoea. Severe generalized pruritus | 68 years old |

## 4.3. Results

### 4.3.1. Data analysis

The search strategies identified a total of 2,793 articles. Further searches included seven studies identified in grey literature and two additional studies were identified through reference checking. Six hundred and seventy-eight duplicated studies were removed, and 2,122 studies remained. Screening of 2,088 studies was performed using titles and abstracts against the inclusion and exclusion criteria. Full-text screening was performed on thirty-four articles, and twenty-two relevant published and unpublished studies in English and Spanish were eligible for inclusion in this review. The information obtained from the data was summarised and reported in Figure 4.2 using the guidance from Preferred Reporting Items for Systematic Reviews and Meta-Analyses or PRISMA approach (PRISMA, 2015). Figure 4.2 using the guidance from Preferred Reporting Items for Systematic Reviews and Meta-Analyses or PRISMA approach (PRISMA, 2015).

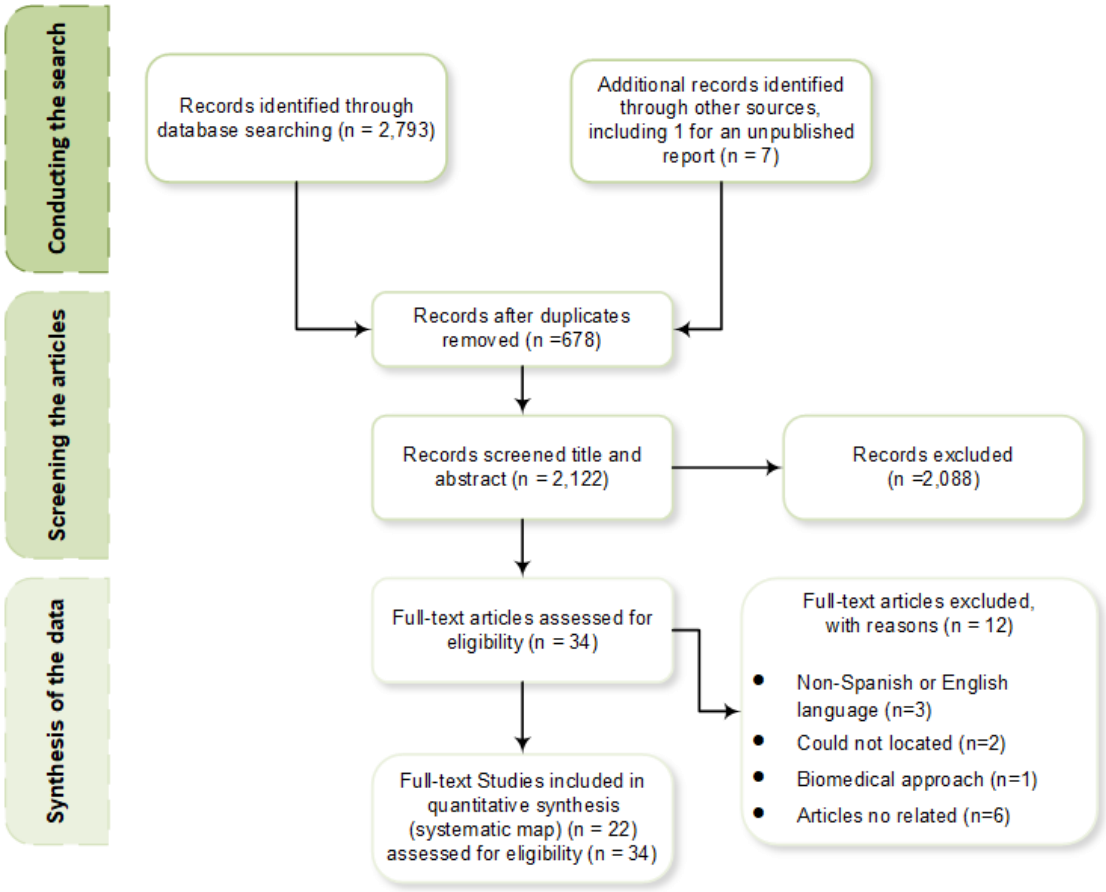



*Figure 4.2 Systematic mapping process (n is the number of studies).*

### 4.3.2. Scientific literature of foodborne travel-associated diseases in the DR

This study used systematic mapping to gather existing information and evidence from academic and grey sources on food safety outbreaks in the DR. The systematic map spanned articles published from 1992 to 2017 (Figure 4.3) with four articles in 2011, three in 2015, and either one or two articles in other years.

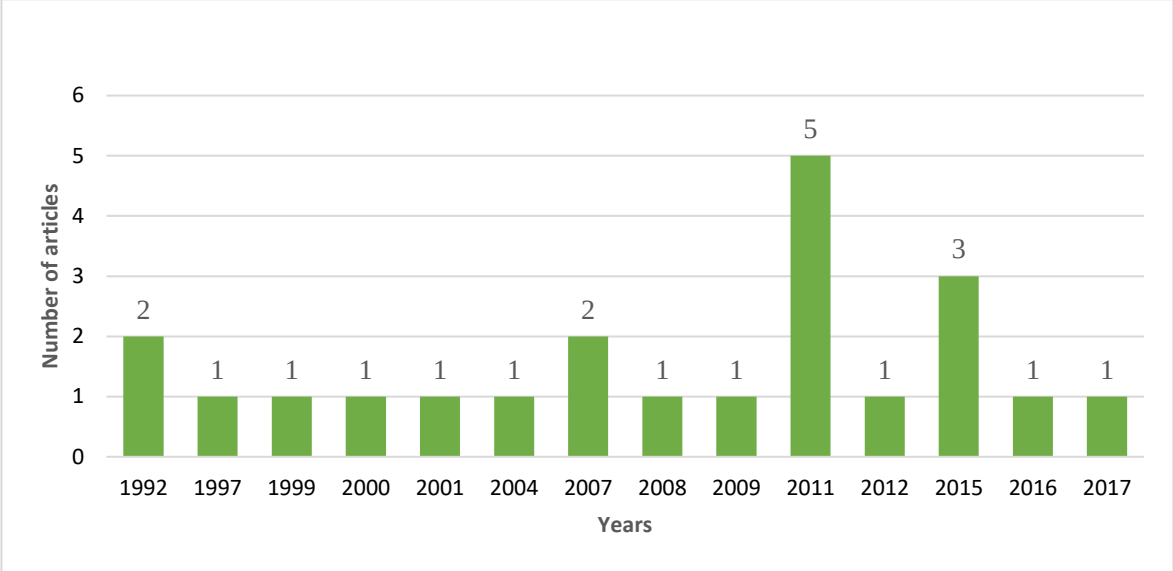



*Figure 4.3 The distribution of eligible articles included in the systematic map (1992 – 2017).*

This research finds a low rate of reported or investigated outbreaks in the academic literature; with 22 publications with pertinent information identified in a time frame of approximately 24 years; and the most recent paper with timely data being published in 2016.

### 4.3.3. Microbiological risk identified from the systematic review

In all screened studies, the aetiologic agent associated with the outbreak was determined (Figure 4.4). The foodborne hazards identified encompass microbiological, marine microalgae hazards, parasites and virus agents. Nine (40%) of the microbiological hazards in the studies reviewed are enteric pathogens, namely *Salmonella enterica* serotypes Enteritidis, Typhimurium, Newport and Javiana, non-typhoidal *Salmonella* spp., *Campylobacter, V. cholerae* serogroup O1 and *Shigella* serogroups, e.g. Shiga toxin (Stx)-producing *S. dysenteriae* type 4.

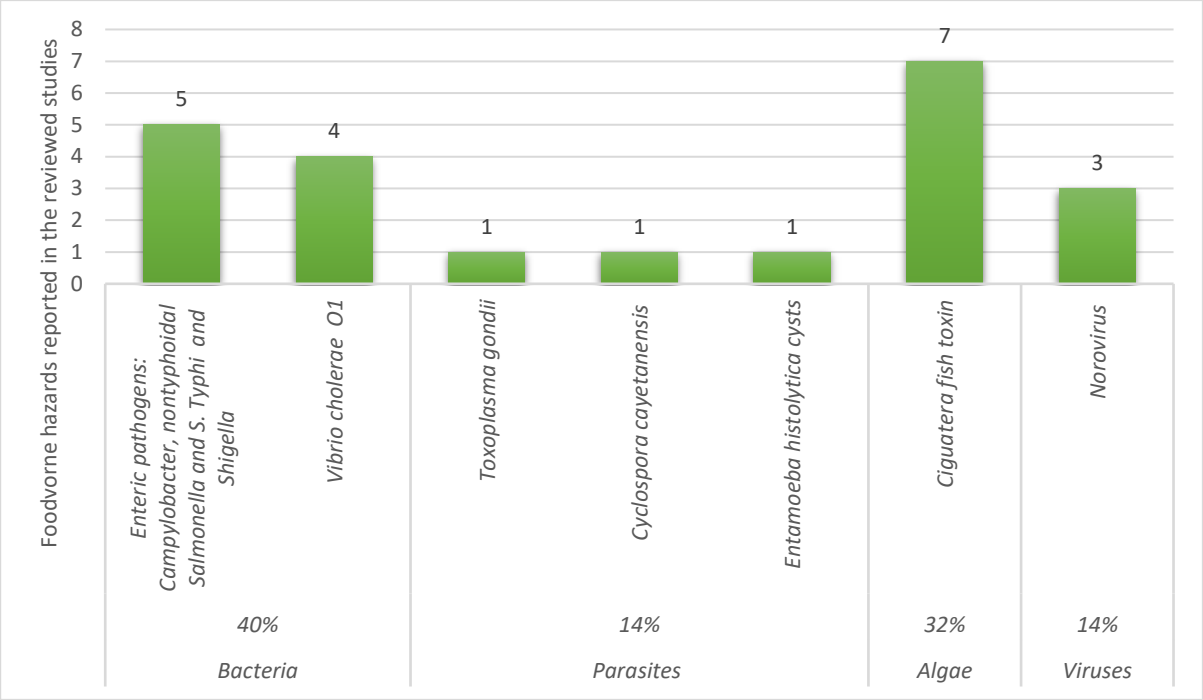



*Figure 4.4 Etiologic agents associated with food and waterborne outbreaks in holiday settings in the DR.*

The parasites *Toxoplasma gondii*, *Cyclospora cayetanensis* and *Entamoeba histoyitica* (14%) were identified. Norovirus was identified in three of the studies reviewed (14%), and 32% of studies were linked to ciguatoxins. In this review, five publications reported ciguatera fish poisoning (CFP) outbreaks in hotel settings after seafood and fish consumption. From the microbiological outbreaks explored in the sources, where determined, the implicated food was raw or partially cooked food and seafood such as grouper, red snapper, amberjack, shrimp and prawns.

The systematic mapping used seven articles that reported foodborne outbreaks in food premises such as an all-inclusive hotel restaurant (Develoux *et al.*, 2008; Gupta *et al.*, 2007; Jimenez *et al.*, 2004; Lange *et al.*, 1992; Martínez *et al.*, 2011; Ministerio de Salud Pública, 2016; Szakacs and McCarthy, 2007), dining, wedding banquet (Blume *et al.*, 1999; Jiménez *et al.*, 2011), and a guest house (Perez *et al.*, 2001). However, eight articles did not report the food premises. The FBDOs were categorised into three types: (1) the consumption of unsafe food and water (72%); (2) travel diarrhoea (18%); and (3) poor handling in food premises (Figure 4.5).

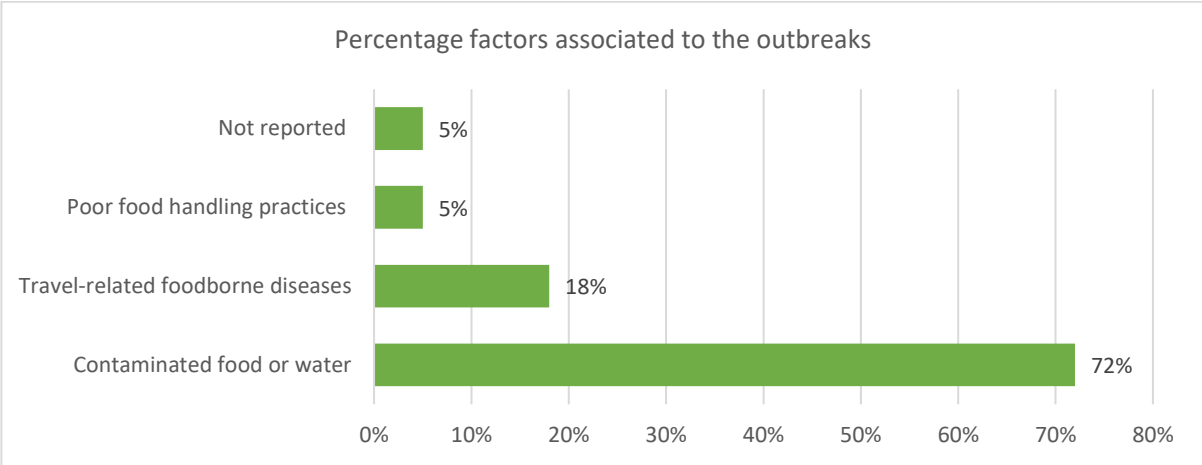



*Figure 4.5 The common contributory risk factors of FBD in the papers reviewed as the associated cause of the outbreaks.*

The results defined the lack of hygiene or care in food handling as the most prevalent factor responsible for the contamination of the food in approximately 83.3% of the articles; the weak sanitisation of the equipment and utensils accounted for 58.3%; and inadequate storage of food was the most prevalent factor in 41.6% of the analysed outbreaks. The FBDOs were categorised into three types: (1) the consumption of unsafe food and water (72%); (2) travel diarrhoea (18%); (3) poor handling in food premises (5%), and (4) not reported (5%). The results defined the lack of hygiene or care in food handling as the most prevalent factor responsible for the contamination of the food in approximately 83.3% of the articles; the weak sanitisation of the equipment and utensils accounted for 58.3%; and inadequate storage of food was the most prevalent factor in 41.6% of the analysed outbreaks.

In the literature sources reviewed it was found that three studies reported on the same outbreak affecting travellers returning to the US, Spain, Canada, Germany and France from the DR. This was where a multinational cholera outbreak occurred after a wedding in the DR where the first case was reported in Haiti in November 2010. By January 2011, a total of 1,115 suspected cases and 280 laboratory-confirmed cases were reported by the DR Ministry of Health involving travellers from US, Spain, Mexico and Venezuela, and locals who attended this large wedding reception at a luxury tourist resort. Two other studies reporting the same outbreak considered the US National Surveillance Database and laboratory analysis cases associated with travelling to countries with endemic cholera (Fillion and Mileno, 2015; Newton *et al.*, 2011) Two out of the three aforementioned articles (Jiménez *et al.*, 2011; Newton *et al.*, 2011) state that the

epidemiology investigation was undertaken in conjunction with the DR health authorities of and only one of the studies (Jiménez *et al.*, 2011) identified locals as being involved in the outbreak.

The summarised data of systematic mapping based on eleven articles showed a broad range of people affected (from three to 74-years-old). The most commonly reported symptoms were acute diarrhoea, abdominal cramps, vomiting, nausea and fever were the most commonly, while seven articles did not provide any information about the symptoms. None of the sources reported how many locals, staff, workers were affected. During the collection of data, the systematic mapping revealed that few articles provided information about the implemented control measures in the hotel premises.

## 4.4. Discussion

The current systematic mapping provides the first comprehensive and systematic examination of published articles (n= 22) related to food safety outbreaks in hospitality settings in the DR. It retrieved twenty-two articles reporting food safety issues covering a period from 1992 to 2016. It has been pointed out that non-industrialised countries have few academic contributions to evaluate, which diminish understanding and estimation of the occurrence of food safety incidents (Lee, 2017). The paucity of scientifically based research and investigation has a significant impact on government, non-governmental, private sectors, and educational organisations to record and investigated foodborne diseases (Lakhan *et al.*, 2013). In line with previous studies on the Caribbean (Guerra et al., 2016; Hull-Jackson and Adesiyun, 2019; Lakhan et al., 2013). This research finds a low rate of reported or investigated outbreaks. It is worth mentioning that the systematic mapping detected a greater number of reports in 2011 and 2015. These reports were related to several large outbreaks which affected tourists from different countries and raised international concern. (Jiménez et al., 2011; Loharikar et al., 2015; (Fillion and Mileno, 2015; Newton *et al.*, 2011).

The current study used systematic mapping to provide details such as attribution sources, foodstuff implicated and the improper food handling practices that lead to the reported outbreaks. The systematic mapping was trying to fill the gap between the theoretical basis of foodborne diseases and risk analysis and management in the hospitality sector. A systematic review also tries to gather information and give recommendations of the study subject. As an example, the review by (Magalhães *et al.*, 2019) tried to establish the link between the

published reports of FBD and food chain traceability. The study also provided information that can be used by public policies and regulation of food traceability systems (Magalhães *et al.*, 2019). The literature review conducted by (Ortega and Tschirley, 2017) which deals with less developed economies such as Asia and Sub-Saharan Africa concluded that the lack of information on food safety issues affects agri-food systems. As a result, the tourism industry is also affected especially when it relies on local food production to satisfy visitor food demand. Aforementioned reviews focused on developed and less developed economies and stressed about the persistent deficiency of information towards foodborne diseases and poor notification systems.

To gather information a systematic mapping used approaches established by systematic review but applied a more structured approach to the available data and tried to visualise the findings in a comprehensive way, so they can be used by researchers, policy makers and governmental agencies. (Lebelo *et al.*, 2022) stated that prediction of foodborne disease and food contamination could not be underestimated or neglected because of the impact that foodborne disease outbreaks can have on the public health and economy. The systematic mapping and the analysis which is part of its methodology reveals the area of high priority in foodborne outbreaks (Gissing *et al.*, 2017).

The systematic mapping provides summarised information about the etiological agents which affected travellers in the hotel premises. The pathogens that contributed significantly to the reported foodborne outbreaks were mainly bacteria (*Campylobacter spp., Salmonella spp., Shigella)* and algae (CFP), and some viruses, primarily norovirus. Similar results about the nature of etiological agent reported some studies of acute gastroenteritis (AGE) and norovirus in Barbados as the leading foodborne pathogens causing AGE-related illness (Ingram *et al.*, 2013). The likely contributory factors to the infection which systematic mapping identified were the consumption of unsafe food and water. The primary studies support the findings of this systematic mapping by providing specific etiological agent related to the cases under investigation (Gray *et al.*, 2015; Gupta *et al.*, 2007; Do Prado *et al.*, 2021; Zhi *et al.*, 2021).

In comparison with aforementioned research, the current study used a more structured methodology which provided explicit and reproducible systematic mapping. As a result, the food safety hazards which have affected a particular population in the hospitality sector were identified and visualised. Similarly, Torres et al. (2021) found that systematic mapping has

been useful in identification of neglected areas during food safety hazards surveys. Other authors also support the idea that surveillance and epidemiological studies and even the active laboratory surveillance in the hotel premises have limitations and leave gaps in the information about foodborne diseases, sources and etiological agents which is necessary for proper surveillance (Hull-Jackson and Adesiyun, 2019c; Mohammadi *et al.*, 2022; Ntshoe *et al.*, 2021; Torres *et al.*, 2021). In particular, by providing scientific evidence the systematic mapping could facilitate governmental decisions and policy makers and their recommendations towards food safety and risk analysis in tourism sectors in the DR and in other regions in order to prevent threats for public health. Moreover, to assess the compliance towards food safety regulations and voluntary certifications in this sector to improve food hygiene and safety practices in this sector. Applying the results of systematic mapping could also reduce the FBD burden, the economic and health implications at national and regional levels (Indar *et al.*, 2020). The improved integration between health authorities and hotel businesses should enhance the effectiveness of notification and surveillance systems by inclusion of data of several streams e.g., hotels, local premises, regional and international food supply chain, etc.

## 4.5. Conclusion

The consistent identification and reporting of cases and food safety outbreaks allows governments to make informed risk-based local decisions about the potential for public harm and the actions needed to mitigate problems should they arise. This study has examined, via a systematic mapping exercise, the context and the publicly available evidence of microbiologically related food safety outbreaks affecting the hospitality sector, and the food safety practices which may have been of negative influence in the DR. Systematic mapping is a useful tool to examine existing literature sources to identify the common microbiological agents and sources of food contamination within the scope of a given investigation (time frame, location, types of incidents, location of incidents, etc.).

Systematic mapping relies on primary research and the lack of sufficient information can decrease its power and effectiveness to draw conclusions. A challenge with systematic mapping is the level of confidentiality associated with FBDOs affecting staff and workers in hospitality, as well as how managers or policymakers control the availability of such information for public scrutiny. Future research should focus on risk assessment, management, and communication of foodborne outbreaks. The contribution of this study is to demonstrate the

value of systematic mapping of both public and private evidence sources (e.g. government information not publicly available) and how this could firstly reveal the areas and practices that need improvements in order to prevent FBDOs. Secondly, the appropriate management systems and control measures that should be applied at the local and national level to minimise the risk of FBDOs associated with the hospitality sector can be identified. A further contribution is to suggest in future research combining systematic mapping as the first stage of the research with supporting methodologies such as AcciMap analysis. To develop the findings of systematic mapping further to gain evidence of where practices or contributing socio-technical factors have contributed to FBDOs and what actions can be taken to prevent further problems in the future.

### 4.6. Summary

This first experimental chapter provided significant findings on food safety hazards, poor safety practices present in hospitality settings in the DR and evidence on specific microbiological hazards. Systematic mapping review has been described as an effective method to provide a robust evidence-base in a research discipline in a timely way. In addition, reviews of this kind can identify the knowledge gap beyond existing primary studies that can be translated to a specific research question. Based on this, the systematic mapping review was chosen as the first study in this research. This approach accomplished objective one of this study by providing the publicly available evidence of FBD affecting travellers and highlighted the knowledge gap regarding food safety research in the hospitality sector in the DR. Moreover, this phase also identified common pathogens associated with FBD.

Findings from the systematic mapping review informed the second phase in this research which aimed to analyse FBD outbreaks from a socio-technical perspective by applying an AcciMap model. From all the microbiological hazards identified, the subsequent study will focus on norovirus in hospitality settings. Applying the AcciMap model requires extensive and abundant information to perform the analysis so this requirement meant that for studies with a scarcity of background information they could not be analysed. The systematic mapping review found that among the higher level of incidences from pathogen bacteria (41%) and algae (32%). The information available for these identified bacteria and algae was not sufficient to apply the AcciMap.

Conversely, information on norovirus outbreaks, such as official reports, was available, and extensive epidemiological investigations and scientific research were found. Moreover, another reason to considered appropriate the AcciMap analysis on norovirus (NoV) outbreaks is that NoV is a pathogen of importance in the hospitality sector where it has been described as a challenging pathogen. However, these efforts to control and manage NoV outbreaks seem to remain ineffective (Doménech-Sánchez *et al.*, 2020; Inns *et al.*, 2017; Migliorati *et al.*, 2008). Considering the advantages of the system approach and accident analysis model such as AcciMap will provide deeper understanding of the errors or chain of events that led to the norovirus incident. The AcciMap methodology, process and analysis of 3 NoV outbreaks are detailed in the following chapter.

# CHAPTER FIVE: A socio-technical approach to food safety incident analysis using the AcciMap model in the hospitality sector

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## Abstract

A theory-based systems approach, such as AcciMap accident analysis, has been widely used over the years in multiple safety critical sectors such as the nuclear, petrochemical, aviation and railway industries to provide a detailed understanding of complex systems and the chain of events contributing to accidents resulting from system failure. However, despite its advantages, the use of a systems approach in the food safety context has to date been limited. The purpose of this study was to investigate three established norovirus incidents using the AcciMap accident analysis approach to determine its efficacy at informing the design of food safety policies following a norovirus outbreak to prevent reoccurrence. This approach was found to be of value in analysing norovirus outbreaks. The findings of the AcciMap analysis reveal the norovirus outbreaks were not the outcome of a single causal incident, but a chain of events and interactions that occurred across the entire system. The analysis identified the contributory factors that led to each incident across the hierarchical levels within a socio-technical system. The majority of the contributory factors mapped in the framework were related to the actions and decisions made at the government and physical/individual levels, which influenced the public health outcomes of the outbreak. The value of using the AcciMap approach is that it does not constrain the analysis to individual components or particular types of incidents, allowing for a more holistic and interconnected risk assessment.

# 5. Introduction

Viral gastroenteritis has a substantial impact on public health. Norovirus (NoV) is one of the most common causes of viral acute gastroenteritis (AGE) outbreaks worldwide (Chhabra *et al.*, 2021; Greening *et al.*, 2012; Parrón *et al.*, 2020; Qin *et al.*, 2016). NoV has been described as a challenging pathogen due to attributes such as multiple transmission routes, environmental persistence, and low infectious dosage, which hinders efforts to detect early transmission, and control/prevent infection before it turns into a large outbreak (Barclay *et al.*, 2014; DiCaprio *et al.*, 2013; Esposito and Principi, 2020). Viral gastroenteritis has a substantial impact on public health producing intestinal symptoms including watery diarrhoea, vomiting, or both (Tesson *et al.*, 2019). It has been estimated that 18% of all sporadic and epidemic AGE cases are associated with NoV (Inns *et al.*, 2017), which can easily spread in closed and semi-enclosed settings such as restaurants, hospitals, schools, healthcare facilities, tourist resorts and cruise ships (Alsved et al., 2020; Kreidieh et al., 2017; Leshem et al., 2016; Ong, 2013). Large NoV outbreaks have occurred via the environment, through contact with contaminated objects, hands or surfaces, and by the consumption of contaminated food or water (Rajiuddin, Hansen, & Schultz, 2020). For instance, sewage-contaminated water supplies containing NoV were implicated in large outbreaks in Sweden (Larsson *et al.*, 2014). Contaminated raw food products, specifically leafy vegetables, fruits, and seafood have also been implicated in globally reported NoV outbreaks (Bozkurt *et al.*, 2021; Dewey-Mattia *et al.*, 2018; Elbashir *et al.*, 2018).

Environmental, direct person-to-person transmission and surface cross-contamination are frequent in hospitality settings such as cruise ships (Towers *et al.*, 2018; Wikswo *et al.*, 2011), and restaurant settings (Morgan *et al.*, 2019) This sector which is especially affected by this public health issue has been implementing and developing safety control measures such as hand hygiene and cleaning and disinfection agent in enclosed settings to reduce the occurrence of infections and outbreaks (Maccannell *et al.*, 2017). However, these efforts to control and manage NoV outbreaks seem to remain ineffective (Doménech-Sánchez *et al.*, 2011; Inns *et al.*, 2017). Researchers have focused attention on evaluating the specific issues behind the mishandling of food and unhygienic procedures that lead to public health incidents within hospitality settings. However, given the complexity and nuances of the food safety/ public health literature, there is a need for the development of a wide conceptual framework that

combines the available knowledge, new analytical techniques, and a multidisciplinary integration of approaches with experts and practitioners from different theoretical disciplines (Zanin *et al.*, 2017).

The hospitality sector is an example of a complex system that encompasses the integration of hotel suppliers, ministry of public health officers, private businesses, local enterprises, managers and staff interacting with process, conditions and the effect of human factors (Dhir *et al.*, 2020). This group participating individually, or collectively, across the socio-technical food system can influence the outcomes and safety performance of any given organisation. Indeed, the degree of stakeholder participation is a determinant of the ability to deliver on food safety/public health outcomes (Nayak and Waterson, 2016).

### 5.1. The AcciMap approach in foodborne incidents

Incident analysis approaches have been developed and used in different contexts and scenarios including public health, rail, aviation, mining, maritime and nuclear power plants (Hulme *et al.*, 2019; Salmon *et al.*, 2020b). Each approach proposes a specific theory to provide insights into the errors or chain of events causing the accident (Grabbe *et al.*, 2020; Stefanova *et al.*, 2015; Waterson *et al.*, 2017; Yousefi *et al.*, 2019). Systemic models are based on systems theory and endeavour to describe the complex interrelationships and interdependencies between the different components in the systems (Yousefi *et al.*, 2019). For instance, the analysis of high-profile accidents (e.g. Chernobyl) has employed systemic techniques to depict the contributory factors which triggered the accident, rather than focusing on a single element approach regarding human error or a conventional cause-effect approach, which is unable to depict the variety of causes [contributory factors] involved in an accident or their interplay (Salmon et al., 2020b; Thoroman et al., 2020).

An AcciMap is a systemic framework approach to consider foodborne disease incidents representing the actors (e.g., individuals and organisation) in the system allocated in six hierarchical levels. In the theoretical framework proposed by (Rasmussen, 1997) it is assumed and expected that each systemic level works together in the management of safety to control hazards by the mechanisms available on each level e.g., laws, regulations, and protocols (Goode *et al.*, 2017). Rasmussen's approach considered other external factors that stress the systems such as the fast pace of technologic development, competitiviness, market conditions,

public and safety awareness, political climate, economic pressure, globalisation which constrain the dynamic of the system in production and safety management (Lee *et al.*, 2017; Salmon *et al.*, 2012). Furthermore, in the theoretical framework proposed by Ramussen it is assumed and expected that each systemic level works together in safety management to control hazards by the available mechanics on each level (e.g., laws, regulations and protocols). Likewise, the AcciMap model aligns with risk framework management principles and has in common that human behaviours, safety and accidents interact in a system and are the result of the active performance and its interaction across all the actors involved in the socio-technical system (Goode *et al.*, 2017).

This system hierarchy allows analysts to identify and summarise the contributory factors in an incident and follow the hierarchy structure downwards to visualise the events or failures that have emerged from the socio-technical interconnection and interaction at each level (Gao *et al.,* 2016). Further, this enables analysts to understand how information, actions and decisions made at the top of the system affect the outputs at the lower levels and its systemic complexity (Lee *et al.*, 2017; Underwood and Waterson, 2013b). The analysis of simultaneous interactions of multiple risk-contributing factors is of greater value in incident analysis than considering single factors in isolation (Stefanova *et al.*, 2015). Moreover, the socio-technical system is comprised of a set of interrelated or interdependent elements, and these can be analysed to reveal the contributory factors that could have been prevented and/or controlled to improve the safety output (safe food) in a complex system (Hamim et al., 2020).

There is limited literature on food safety incident analysis by a non-linear, systemic approach such as AcciMap. This chapter will look at NoV incidents through a socio-technical perspective to identify contributory factors and events involved in NoV outbreaks in hospitality settings that have been published in the literature. The purpose of this study is to investigate three established norovirus incidents using the AcciMap accident analysis approach and to determine its efficacy at informing the design of food safety policies following a NoV outbreak to prevent reoccurrence.

## 5.2. Material and methods

### 5.2.1. AcciMap Framework and methodology

The study involved an analysis of three norovirus outbreaks using the AcciMap method using a framework which is comprised of six basic systemic levels as shown in Table 5.1.

*Table 5.1 Main systematic levels of AcciMap framework.*

| Level | Measures and control at the system level |
|---|---|
| Government | Laws and legislations developed to control public health concerns the hazardous procedures. |
| Regulatory | Legislation is converted into industry rules and regulations for a given health concern. Regulatory bodies can be further divided into sub-levels: (a) National and (b) Local regulators |
| Company | The rules and regulations are integrated into the company rules and policies |
| Management level | Staff activities and roles are specified and overseen with a reference to the company level rules and policies |
| Staff | The work force that follows the rules set about by the company and implemented by their managers |
| Equipment and surroundings | The company's rules and policies apply based on the government level regulations (Branford et al., 2009). |

### 5.2.2. Study selection

In the current study, before the actual AcciMap analysis, two preliminary steps were implemented following the procedure by (Waterson, 2009). During the first step data was collected, and information and details related to each of the incidents using articles and official reports. A thorough review was undertaken to select the foodborne outbreak with the following inclusion criteria (1) NoV outbreaks; (2) different locations (national/international), (3) hospitality setting (e.g. all-inclusive hotels and resorts); (4) vehicles and modes of infection transmission (waterborne infection), and (5) sufficient publicly available information (e.g. published papers, reports). The reason to select NoV outbreaks was to provide safety measures to prevent future

outbreaks and current study focused on outbreaks related to two particular genogroups (GI and GII). These genogroups have been commonly associated with foodborne outbreaks in hotel premises affecting staff, guest and locals (Arvelo et al., 2012; Lee et al., 2015; Lu et al., 2020; Nguyen et al., 2017; Ong, 2013; Rico et al., 2020).

The second step established a time frame which provided a precise overview of the events and decisions made by the actors involved during each outbreak. After these two preliminary steps, the AcciMap analysis was done independently for the three NoV outbreaks. For each outbreak, the AcciMap analysis followed a similar approach using the guidance of previous work (Branford et al., 2009; Hamim *et al.,* 2020; Nayak and Waterson, 2016), and the consecutive steps of the procedure are shown in *Figure 5.1.*

### 5.2.3. AcciMap construction

The AcciMap framework was drawn manually on a blank sheet and the contributory factors identified were placed at the bottom of the diagram in the sheet. A critical step in the AcciMap construction was to organise the gathered information (contributory factors) and allocate each factor in the corresponding level of the AcciMap (Branford *et al.*, 2009). At that stage, before analysis of the contributory factors and interconnections, the draft AcciMaps were reviewed by the second author, a socio-technical analyst with specific AcciMap expertise. Aside from the minor modifications related to the wording of the contributory factors in order to ensure accuracy of the AcciMap and provide clarity to the readers no further changes were made (Branford, 2007).

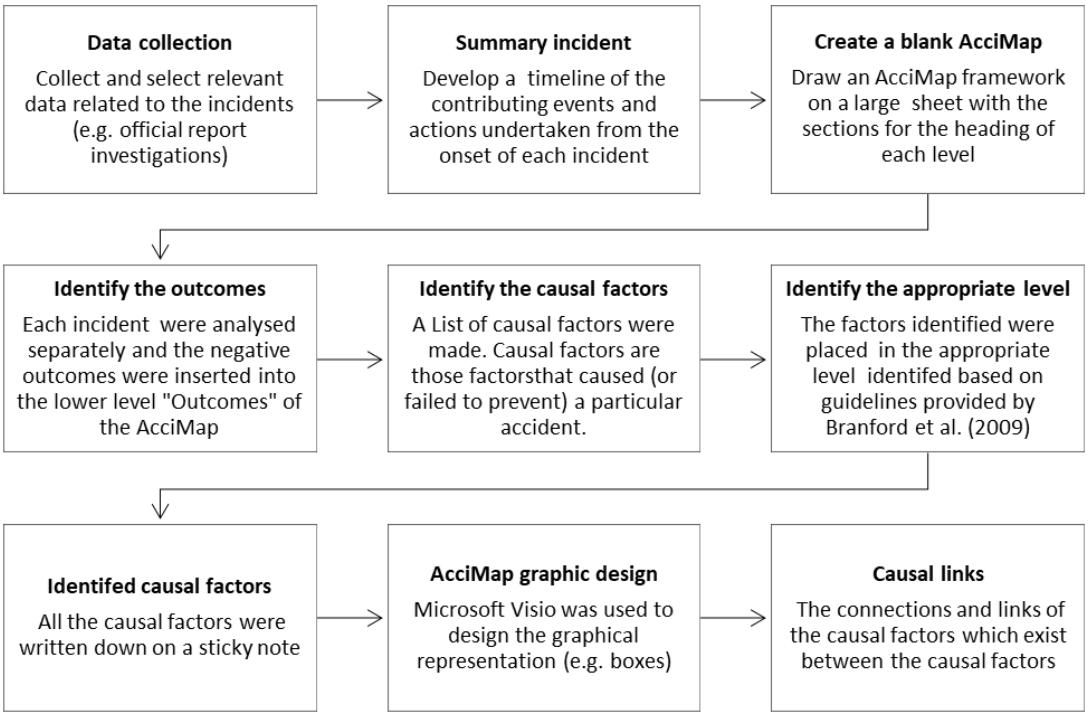


*Figure 5.1 Flowchart illustrating the steps used to construct the AcciMap.*

The final step involved using Microsoft Visio (version 1808), to develop each AcciMap. Contributory factors were displayed in boxes and grouped at a particular level. The connections and links were displayed as arrows, which represent the interconnections between factors. A colour code was used for each level to highlight the interactions and range of each causal factor across the system.

## 5.3. Results

The AcciMap approach analysed the multiple contributory factors of the three NoV outbreaks where similar elements such as aetiological outbreak agent, holiday setting, and transmission mode were considered to identify particular patterns of events that could compromise public health in hospitality settings. These patterns are identified in the results and discussion sections.

The standardised AcciMap frameworks developed are shown in Figure 5.2Figure , and each level in the framework has been depicted by separate colour code to first visualise the different contributing factors at each level and to highlight the impact of these factors across the

AcciMap. Following the connection across the levels will illustrate how the different elements are connected. The background to the three incidents is now considered in turn.

### 5.3.1. Contributing factors in an NoV outbreak in Bermuda (1998)

Brown et al. (2001) is the primary source for this case study. The Bermuda Department of Health was notified on 10th February 1998 that 14 foreign guests staying in a large resort hotel were affected by gastroenteritis. However, the onset of the outbreak began on 7th February with 401 suspected cases. In the following days additional cases were reported and a least 488 people were affected among tourist guests, hotel staff, locals after visiting the hotel and emergency premises. Table 5.2 details the subsequent events and actions taken after the onset of the outbreak.

*Table 5.2 Timeline of a NoV outbreak affecting 448 people in a hotel in Bermuda in 1998.*

| Date | Events |
|---|---|
| 7 February | Outbreak onset of 401 suspected cases. |
| 10 February | Bermuda Department of Health (BDOH) was notified of gastrointestinal illness among 14 foreign guests. |
| 14 February | It was reported that many of the bathrooms were out of service. Flooded areas and an odour of faeces near a restaurant were detectable. |
| | Valentine's day functions held at the hotel. |
| 15 February | Peak in number of cases with similar symptoms. |
| 16 and 19 February | Widespread faecal contamination within the hotel's distribution system and from the terrace tank. |
| 21 February | The hotel was closed. |
| 23 February | The BDOH invited a team from the Caribbean Epidemiology Centre (CAREC) to assist with an investigation. |

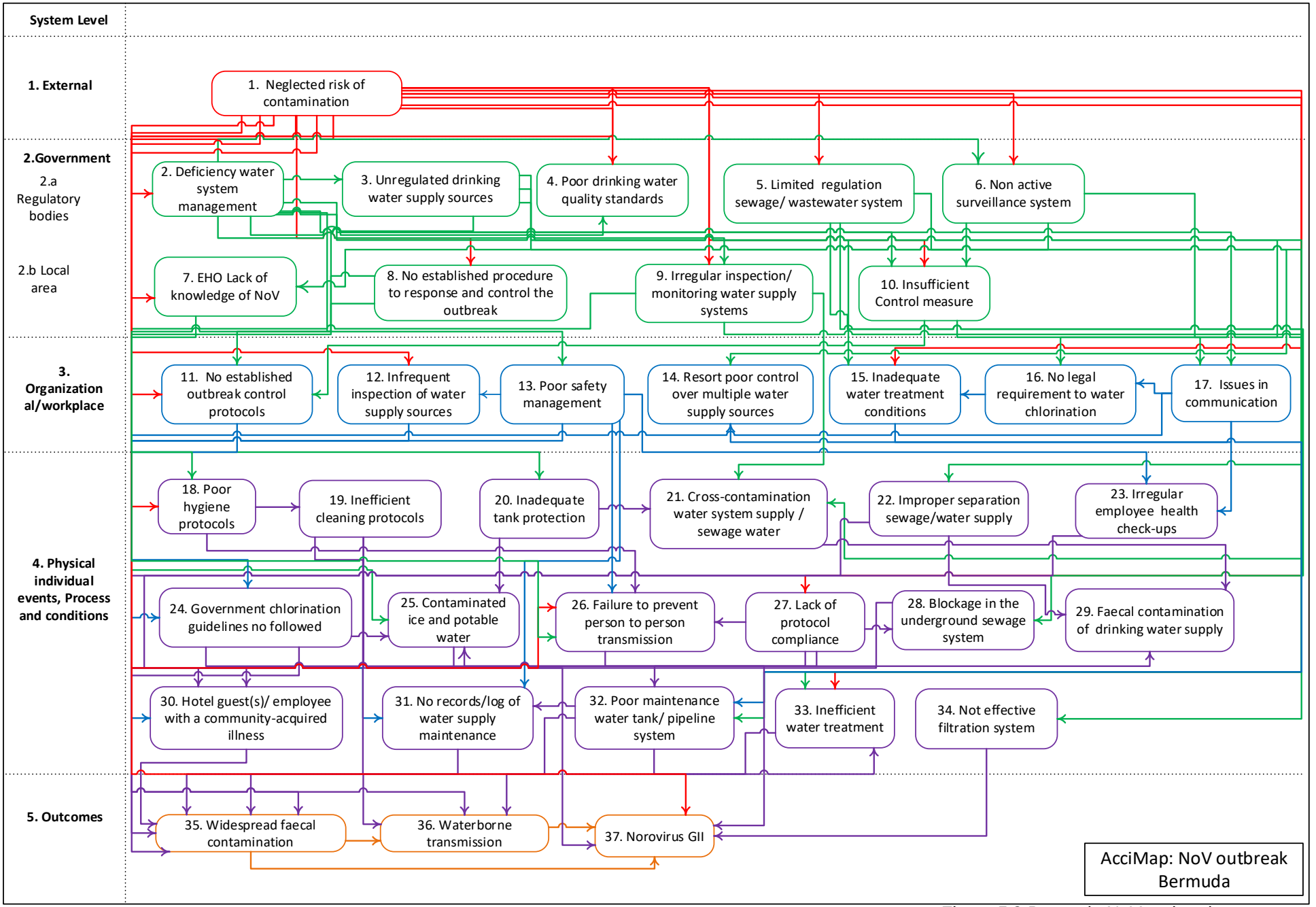


*Figure 5.2 Bermuda NoV outbreak*

Causal factors identified in the AcciMap at the top level indicated a low-risk assessment towards hazards in the hotel premises, moreover; the diagram shows the direct link of the contributory factor among factors across the levels. The approach highlights the ambiguity of water quality standards from the government and its regulatory body. Furthermore, failures were common to both drinking and wastewater systems by infrequent inspections and controls over the water supply sources and its treatments. Similarly, (Woo and Vicente, 2003) found that government ambiguity in monitoring and adopting compliance programmes compromised the ability of the health authorities to guarantee the quality and safety of the drinking water supply. At a lower-level, non-compliance with the hygiene and safety protocol was ignored and this, the poor maintenance of the water tank, and underestimation of government advice regarding chlorination guidelines to water supply, were contributing factors to the widespread faecal contamination that occurred. Moreover, irregular employee health check-ups were significant factors leading to the outbreak. In line with other research (Nayak and Waterson, 2016; Woo and Vicente, 2003), using the AcciMap approach was a useful method to determine the contributory factors at different socio-technical levels to understand in a wider scope of analysis how decisions made at the government level also influenced the decisions and performance at lower levels of the system.

### 5.3.2. Contributing factors in an NoV outbreak in the Dominican Republic (2007)

This section summarises the NoV outbreak in the Dominican Republic in July 2007, affecting 800 people over a two-week period (Doménech-Sánchez *et al.*, 2011). Table 5.3 provides a timeline of the contributing events and actions undertaken from the onset of the incident. A total of 41 factors were identified and the sequence of events between all the levels in the system leading to the outbreak were identified (Figure 5.3). By analysing the contributory factors from the high level 1 and the vertical integration across the multi-layer system down to the lower level 5, the numbers of actions contributing to the outbreak are evident.

*Table 5.3 Timeline for NoV outbreak affecting 800 people in a single resort in the Dominican Republic resort in 2007.*

| Date | Events |
|---|---|
| 27 July | Onset of the outbreak. |
| August | Ongoing outbreak reported. |
| | On the first day of the outbreak, seven people were affected by diarrhoea and explosive vomiting in public areas. |
| | In the following days, sanitary and safety measures were taken to remove high-risk food from the menu, treatment of recreational and potable water, cleaning and disinfection of hotel premises. |
| 3 and 6 August | New cases with a similar clinical picture continuously arose by 100 cases per day after two new guest arrivals. |
| 7 August | The number of cases dropped after new entrants into the resort were cancelled |
| | Swab surface samples were collected from objects and common areas in the hotel. |
| | Airplanes were used to transport some tourists to and from the Dominican Republic on different dates when a severe gastroenteritis case was diagnosed. |
| 12 August | The last case was reported. |

The ongoing outbreak was reported on 29 August with seven people affected the first day. Several episodes of vomiting and diarrhoea was registered in public premises of the hotels; therefore, a presumably viral gastroenteritis outbreak was notified. As a consequence, general safety and hygiene measures, such as chlorination of recreational and portable water, were implemented and maintained as was the disinfectant level during the ongoing outbreak. Frequent cleaning and sanitation were reinforced in the hotel settings and common areas such as bar, kitchen, toilets, and hard surfaces. Hygiene practices e.g. hand washing, was mandatory prior to entry to the restaurant areas. Furthermore, use of the self-service and buffet areas were banned and high-risk food (e.g., salads and seafood) were removed from the menu. Despite the measures adopted the disease continued to spread in the hotel by person-to-

person transmission through front desk employees who were in direct contact with guests and housekeeping staff affected with diarrhoea.

Between 3rd and 6th August 2007, cases exponentially increased with similar clinical symptoms. Moreover, in the following days the hotel registered an influx of holiday visitors and two days after the arrivals new cases appeared, reaching a peak of 100 cases per day. Investigation of the outbreak has suggested environmental contamination and person-to-person transmission passing it from one guest group to another. On 7 August the hotel cancelled new entries into the hotel as a contingency plan to stop the spread or infection of new guests. Consequently, the number of cases significantly decreased and by August 12th the last case was reported. Epidemiological investigation was performed by the Caribbean Epidemiology Centre in Trinidad and Tobago to detect the aetiological agent associated with the outbreak. Food and water samples were analysed for bacterial pathogens and negative results were obtain from both samples. Moreover, environmental, water, surface and stool specimen samples were collected and tested for norovirus. Swabbing surface samples were collected from taps, toilet flushers, door handles, keys and remote controls as the common frequently touched surface in a hotel premises. Water samples from swimming pools, pipes, sewage treatment plant, tanks and water mangles surrounding the resort were also collected.

Norovirus was detected by a multiplex real-time reverse transcription–polymerase chain reaction (RT–PCR) in two of the fourteen samples taken from surfaces. Moreover, norovirus particles were present in the waste and water mangle samples. Stool samples confirmed gene-group II norovirus. The outbreak epidemiologic investigation suggested that one of the contamination sources was an airplane used to transport some tourists from the Dominican Republic on different dates. One severe gastroenteritis case was diagnosed in a returning flight. Therefore, passenger infection is the likely source of how the virus was introduced into the hotel and later disseminated through the air as a result of explosive vomiting, or through fomites contaminated with diarrhoeic material. Also, contact with contaminated environmental surfaces could also have been other pathways, such as person-to-person transmission.

This second outbreak (Figure 5.3Figure ) shows that events from the external level played a role in the Dominican Republic outbreak. Poor health and safety regulations (refer to second level) were significant factors in the outbreak's occurrence and magnitude. Moreover, contributing factors were related to the governmental managerial aspects and budget limitations. The current study found the government shortcomings such as a reduced and

limited budget is a potential risk to safety management operations. Other studies for example, (Nayak and Waterson, 2016) and (Vicente and Christoffersen, 2006) analysed two different outbreaks using the AcciMap framework and found that both government and managerial aspects (budget cutbacks) played a contributory role.

The complex interaction of factors at all levels of the sociotechnical systems analysed were also found to be of importance by (Hamim et al., 2020) and (Woo and Vicente, 2003), who support the versatility of the AcciMap approach to comprehensively analyse and understand a complex system, regardless of the context in which it is applied (Gao, Tian, *et al.*, 2016; Hulme *et al.*, 2021). Furthermore, this study supports the utility and validity of the approach due to its capacity to reveal the contributory factors in an incident and provide through the analysis of a given set of evidence (Branford, 2007; Salmon *et al.*, 2012; Waterson *et al.*, 2017).

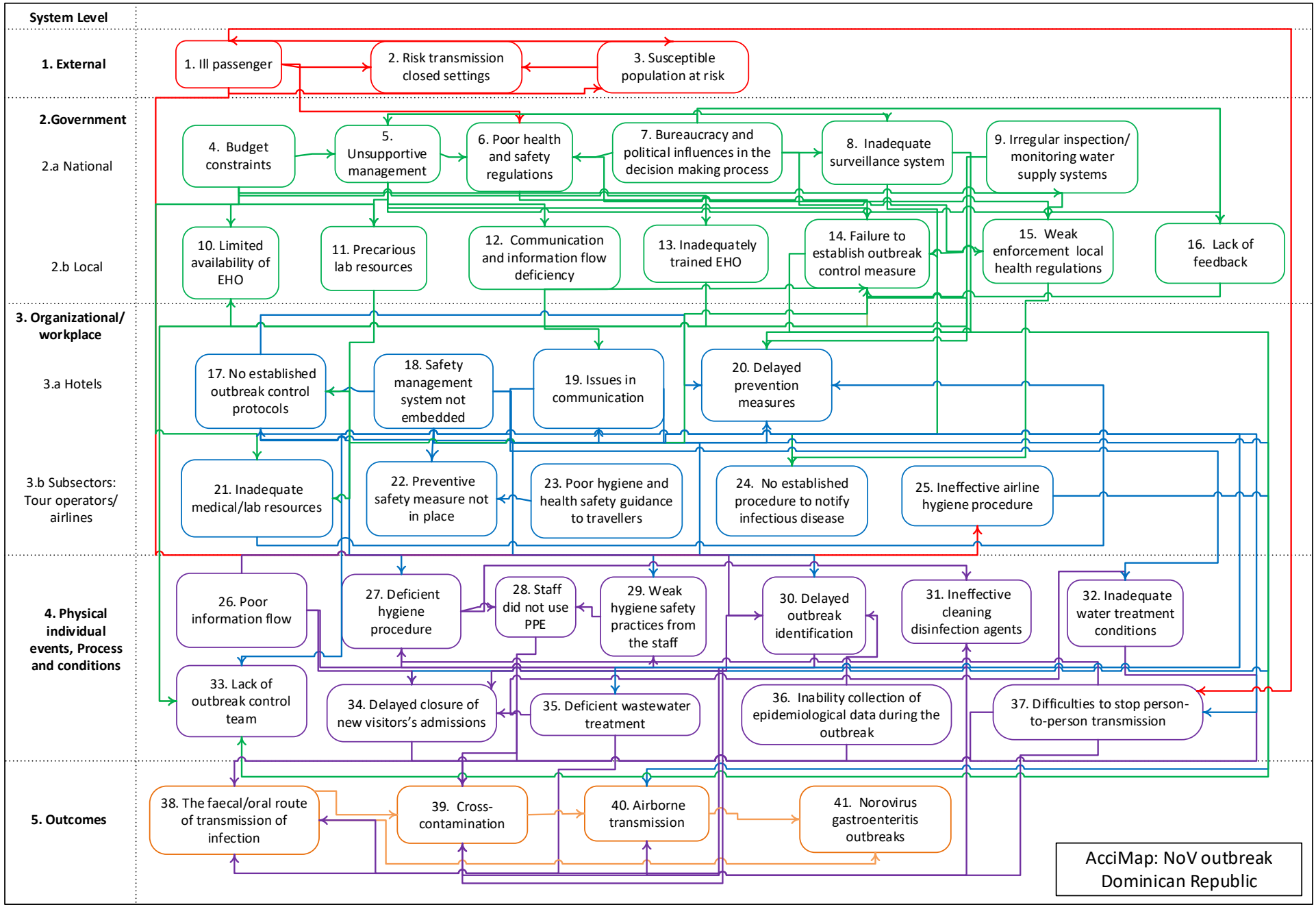


*Figure 5.3 Dominican Republic NoV outbreak.*

Communication issues between the different organisational levels led to the failure to take the necessary measures to prevent the occurrence of events leading to the outbreak. In line with other research (Nayak and Waterson, 2016), this study identified lack of communication, poor safety behaviours and lack of knowledge regarding infectious disease. (Dansai *et al.*, 2021) states that effective communication between the decision maker, managers and front-line staff is a key factor to improve the performance of food safety. Additionally, education and training are a valuable tool to ensure an effective food safety system management is in place to mitigate foodborne illness incidents in hotels (Gruenfeldova *et al.*, 2019; Lee and Seo, 2020). Moreover, when organisations do not ensure sufficient awareness of appropriate training and assessment, employees tend to neglect food safety in the work environment, leading to weak control of food safety hazards and foodborne illness incidents to occur. Thus, to reduce the repeated foodborne illness issues and incidents, regular, focused training should be provided (Kuo *et al.*, 2020).

### 5.3.3. Contributing factors in an NoV outbreak in New Zealand (2012)

In the study carried out by Jack et al. (2013), 53 cases of AGE in a southern ski resort in New Zealand were reported in August 2012. On the 27th August, Public Health South was notified that eleven diners became ill between 24 and 48 h after dinner on the 24th August. The timeline is provided in Table 5.4.

In the proximate days similar symptoms were reported from a group of diners and visitors after consuming tap water at the same restaurant from the same water supply. The resort is the water supplier of the neighbouring residences boarding the resort. In the outbreak investigation previous sporadic gastroenteritis cases affecting 4 hotel's staff were reported. On September 6 a general inspection of the hotel kitchen was conducted and as the outbreak evolved cleaning and sanitisation were strengthened of the hotel surfaces and communal places. Outcomes from this inspection showed that the manager during the outbreak did not follow the sickness policy which establish 48 hours of absence. However, staff were admitted within just 24 hours.

*Table 5.4 Timeline for NoV outbreak affecting 53 people in a busy tourist location in New Zealand in 2012.*

| Date | Events |
|---|---|
| 18 August | Sporadic acute gastroenteritis cases reported from locals/hotel staff. |
| 24 August | Hotel guests and local patrons become ill after dining/drinking tap water at the hotel. |
| 27 August | The public health office was notified of 11 diners ill with gastroenteritis. |
| | Local authorities inspected the water system supply. |
| 29 August | Leftover food samples were collected. |
| 6 September | Inspection of the hotel kitchen was conducted, and strict cleaning procedures were implemented. |
| | Chlorination levels were tested from the kitchen tap and other water supplies. |
| 13-14 September | Environmental water samples were taken from the neighboring resort (local river surface, surface water stream). |

The AcciMap analysis from this outbreak identified 39 contributory factors across the entire system (Figure 5.4) depicting all possible factors of influence in the waterborne outbreak. It is evident that systemic failure in the organisational management of water and wastewater systems occurred.

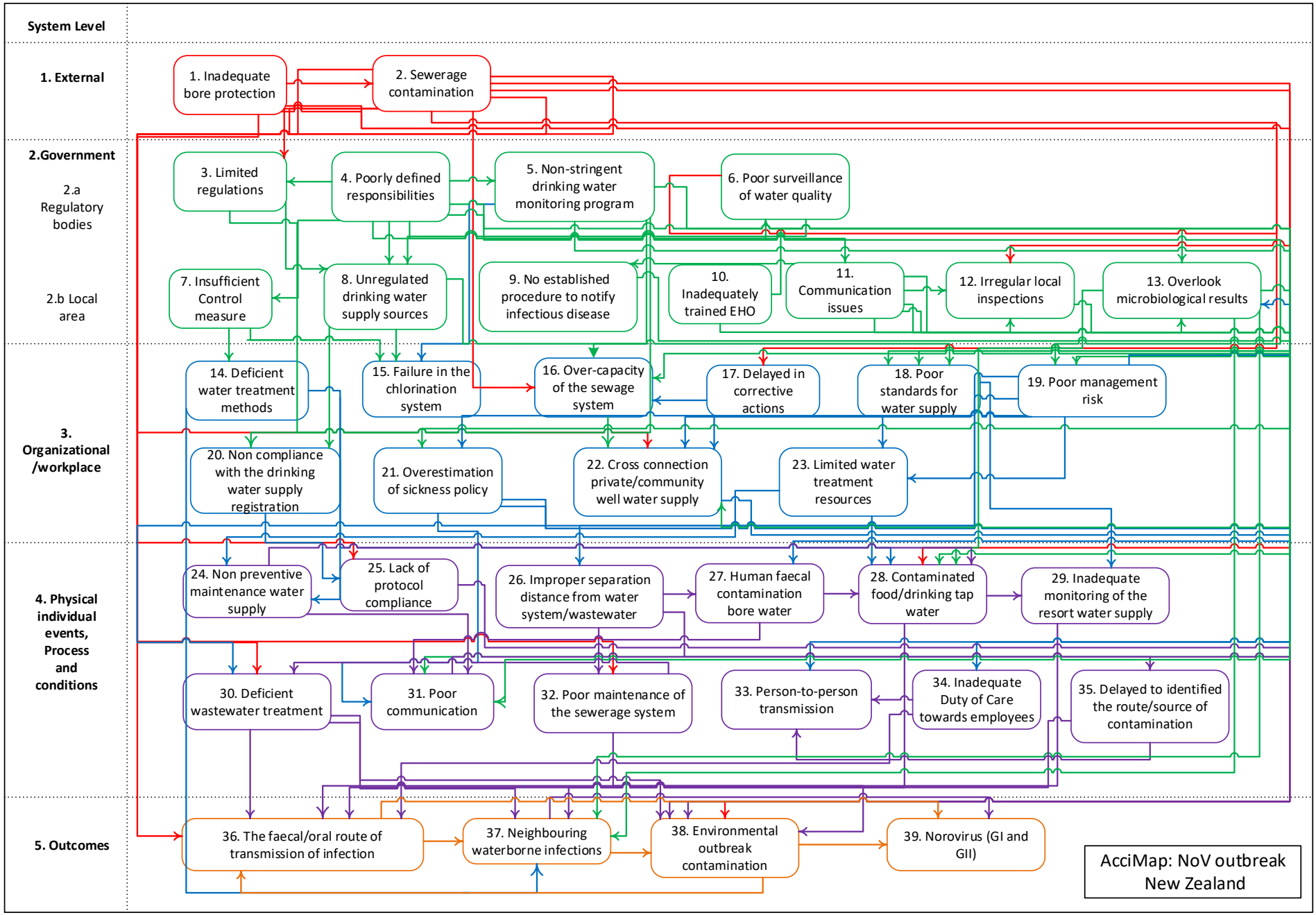


*Figure 5.4 New Zealand NoV outbreak.*

Environmental investigation to the water supplies system were undertaken and a chlorination test done. In addition, the inspection was extended to the sewage disposal field site in the resort and from surrounding areas. A microbiological investigation was carried out from August 29th to 12th September to collect food samples, leftovers and feacal samples to conduct bacteriological tests such as those for *Bacillus cereus, Clostridium perfringens, Salmonella spp*, and *Campylobacter s*pp. Further water samples were collected on 6th and 7th September from different locations within the hotel (e.g., hotel kitchen tap; hotel bore) as well as neighbouring resort drinking water taps. On 13th and 14th September water samples from the local river surface water, and surface water upstream and downstream of sewage disposal were collected for total coliforms*, E. coli*, NoV GI and GII. All samples were submitted to the Environmental Science and Research Ltd (ESR).

Results from the chlorination level (Free Available Chlorination) tests indicated inadequate chlorination of the bore water supply, which is also in near proximity to the sewage disposal unit of the hotel and from a private house septic tank. As a result, from further inspection low chlorination level was detected due to an ineffective chlorine pump in injecting chlorine against the flow of water. Inspection also revealed that neighbouring septic disposal surface water run-off was potentially seeping into the ground water from which the bore drew water. From water samples taken from the neighbouring resort outside drinking taps on 13th September positives result for both *E. coli* and NoV GI and GII. Similarly, water samples from the local river surface and downstream of the resort sewage collected on 13th and 14th September respectively were both NoV GI and GII positive. *E. coli*. Drinking tap water from the resort tested positive to NoV GI and negative to *E. coli.* NoV variants were also detected in three faecal samples (NoV GI.7) and one of the eight samples collected contained both GI and GII, the GII was identified as the GII.4 Sydney 2012 variant. Similar variant was also identified in the environmental water sample (surface water downstream of disposal field).

The AcciMap depicts systemic deficiencies from the local regulator (refer to second level) which were related to local public health governance and the unregulated procedures toward water supply management and the lack of proactiveness to comply with corrective actions from previous public health inspections. Other factors prevailing were the irregularity of inspection from the environmental health officers (EHOs) and the communication issues which led to the inadequate safety practices being adopted by local regulators such as overlooking past

microbiologically related events. In addition, poor risk management led to a failure to safeguard proper treatment of the water drinking supply and wastewater system.

## 5.4. Discussion

The AcciMap has previously been employed to analyse several foodborne outbreaks. However, to our knowledge, this study is the first to use AcciMap incident analysis in hospitality settings to investigate the contributory factors in three NoV outbreaks. Studies integrating human factor error analysis in food safety management systems are limited (Walsh and Leva, 2019). Food systemic analysis, such AcciMap, considers the interactions of human and organisational factors in a system. An advantage of this AcciMap is that it provides a broad view of the external/internal organisational contributory factors involved in each outbreak. AcciMap analysis goes further by providing a wider scope of how decisions made by the actors at any level might affect the outcomes of the incidents in the system. Table 5.5 summarises systemic failures of the three outbreaks and their differences and similarities.

*Table 5.5 Summary common contributory factors from the analysis of the three Norovirus outbreaks.*

| System level | Causal factors | | | Common factors |
|---|---|---|---|---|
| | **AcciMap Dominican Republic** | **AcciMap New Zealand** | **AcciMap Bermuda** | |
| **1. Government** | • Inadequate surveillance systems<br>• Unsupportive management<br>• Poor health and safety regulations<br>• Irregular inspections/ monitoring water supply systems | • Poor surveillance of water quality<br>• poorly defined responsibility<br>• Limited regulations<br>• Non-stringent drinking water monitoring program | • Non active surveillance system<br>• Deficient water management<br>• Limited regulations sewage/ wastewater system<br>• Poor drinking water quality standards<br>• Unregulated drinking water supply sources | • Inadequate/poor surveillance system<br>• Limited health and safety regulations |
| **2. Regulatory bodies** | • Limited availability of EHO<br>• Inadequately trained EHO<br>• Communication and information flow deficiency<br>• Weak enforcement local health regulations | • Inadequately trained EHO<br>• Irregular local inspections<br>• Communications issues<br>• Unregulated drinking water supply sources<br>• No established procedure to notify infectious disease | • EHO lack of knowledge<br>• Irregular inspections, monitoring water supply systems<br>• Insufficient control measure<br>• No establish procedure to response and control the outbreak | • Inadequately trained EHO<br>• Irregular inspections<br>• Communications issues |

| | | | | |
|---|---|---|---|---|
| | • Failure to establish outbreak control measure | • Insufficient control measure | | |
| **3. Organisational workplace** | • Safety management system not embedded<br>• No established outbreak control protocols<br>• Issues in communications | • Limited water treatment resources<br>• Failure in the chlorination system<br>• Poor management risk<br>• Deficient water treatment methods<br>• Poor standards for water supply<br>• Overestimation of sickness policy<br>• Non-compliance with the drinking water supply registration | • No legal requirements to water chlorination<br>• Poor safety management<br>• Infrequent inspection of water supply sources<br>• Resort poor control over multiple water sources<br>• No established outbreak control protocols<br>• Inefficient cleaning protocols<br>• Issues in communication | • Poor safety management systems<br>• Infrequent inspection of water supply sources<br>• Overestimation of sickness policy<br>• Issues in communication |
| **4. Physical individual events, Process and conditions** | • Poor information flow<br>• Weak hygiene safety practices from the staff<br>• Staff did no use PPE | • Poor communication<br>• Lack of protocol compliance<br>• Person-to person transmission | • Failure to prevent person to person transmission<br>• Lack of protocol<br>• Inefficient water treatment | • Deficient hygiene procedure<br>• Lack of protocol compliance |

| | | | |
|---|---|---|---|
| | • Inadequate water treatment conditions<br>• Deficient hygiene procedure<br>• Ineffective cleaning disinfections agents<br>• Lack of outbreak control team<br>• Delayed outbreak identification<br>• Difficulties to stop person-to-person transmission<br>• Delayed closure of new visitor's admissions<br>• Deficient wastewater treatment | • Deficient wastewater treatment<br>• Delayed to identify the route/ source of contamination<br>• Inadequate duty care towards employees<br>• Non preventive maintenance water<br>• Inadequate monitoring of the resort water supply<br>• Poor maintenance of the sewerage system | • Poor maintenance water tank/ pipeline system<br>• No records/ log of water supply maintenance<br>• Government chlorination guidelines no followed<br>• Not effective filtration system |
| **5. Outcomes** | 1. Widespread/faecal contamination<br>2. Waterborne transmission<br>3. Cross-contamination<br>4. Hotel closure | | |

The study identified socio-cultural factors and linked them to other factors across the socio-technical levels. Thus, it shows the complexity and inter-relationship of the contributory factors between levels (Waterson *et al.*, 2017). AcciMap analysis differs from other incident analysis models such as cause-effect, epidemiological, sequential models as it supersedes binary or linear analysis and considers the hierarchical interaction and feedback loops that can occur. Further, this moves the discourse away from culpability and direct cause analysis to bringing together all possible contributing factors of influence in the system hierarchy (Nayak and Manning, 2021). Common failures among outbreaks identified were weak management, lack of authority, irregular monitoring activities and enforcement, communication issues and poor safety behaviours/knowledge towards food safety all factors leading to the occurrence of the incident. These factors are all aspects that would be addressed by a food safety management system aligned with ISO 22000. Moreover, stakeholders' practices in each level of the socio-technical system show that the prevailing weak FS-culture has affected the performance of the embedded food safety management system and contributed to NoV outbreaks (Nyarugwe *et al.*, 2020). The AcciMap approach identified unique failures in each outbreak that were also related to technical operational management. FS-culture within an organisation is influenced by the external business environment; furthermore, this is shaped by the food safety governance structures at all levels of a socio-technical system (Manning, 2017; Nyarugwe *et al.*, 2020). FS-culture Assessment has become increasingly relevant (see ISO 22000:2018) to identify the likelihood of an outbreak by assessing the attitudes and actions of managers/staff and to identify areas for improvement (Griffith *et al.*, 2010a). In this regard, the AcciMap approach can benefit the process of hazard risk analysis and be used in combination with FS-culture assessment to provide more in-depth analysis of the systemic failures affecting the socio-technical system. Moreover, using AcciMap provides the ability to compile specific recommendations for each responsible stakeholder in the system to specifically implement preventive measures to improve the food safety management system at each level and across all levels (Branford *et al.*, 2009).

## 5.5. Conclusion

The AcciMap analysis carried out in this research demonstrates how a systems approach can comprehensively elucidate the factors and decisions made which may contribute to a NoV outbreak. The findings indicate that further food safety governance strategies need to be implemented at government, regulatory and management levels to shape the knowledge,

attitudes and practices of all actors involved in a more practical and comprehensive way. The strength of this approach was its versatility to depict the systemic failures from the three outbreaks from the economically developed and less developed countries analysed in this study. Findings from this paper can inform and improve public health management and practices in hospitality settings; therefore, it has practical implications for organisations to prevent similar failures in the future by taking appropriate precautionary and reactive measures.

In this context, AcciMap analysis could be used as a first stage within a research study to then inform other data collection methods such as semi-structured interviews and/or direct observation or analytical testing to improve the focus of a particular study. Further studies should focus on quantifying the interaction amongst contributory factors and determine the dominant contributory factors in the system or across multiple foodborne disease outbreaks. For instance, a hybrid systemic causation system should be applied in order to overcome the deficiencies of a single method and use the power of combined approaches. This research could then inform decision support tools that could be used at the lower levels of the system to better improve public health outcomes especially for NoV outbreaks in the hospitality sector. AcciMap accident analysis does have some limitations such as the high level of theoretical knowledge required to ensure its successful operation. This approach needs to be performed by analysts with expertise in using accident causation analysis, and its application in the field other than by academia seems too theoretical perhaps and time-consuming. Furthermore, the analysis activity and AcciMap design require the collection of significant volumes of data. Contributory factor identification and classification can lead to analysis errors and failure at each of the different levels if the factors identified are not appropriately analysed. Finally, analysts often use different terminology and classify failures differently, reducing the reliability of results between analysts so effective quality control processes are essential.

### 5.6. Summary

The iterative process at each data collection in (Chapter 4) and AcciMap (Chapter 5) informed the subsequent methodological stage, the conceptualisation and application of an online survey. The AcciMap analysis in this chapter included the analysis of three different NoV outbreaks. The findings accomplished the second objective of this PhD study through a robust analysis uncovering systemic failure, operational and food safety issues that are not that obvious when seen in isolation. Also, the approach was of value in identifying specific factors

contributing to the NoV outbreaks and the role of the level of the system in a broader scope in reducing FBD. Moreover, the systematic mapping findings are supported by the AcciMap models, which identified similar areas of high priority in preventing, identifying and minimising the impact of FBD outbreaks. For example, food safety issues are related to the lack of hygiene or care in food handling, improper health and safety regulations, lack of communication, poor safety behaviours, managerial aspect. Therefore, in the iterative and reflection process of the critique of the findings from the previous methodological phases key themes were identified that emerged repeatedly. These themes, related to unsafe food safety practices and systemic failures in the hospitality sector, were used to design the survey questions for the stakeholder investigation.

Both approaches, the systematic mapping review and the AcciMap, can improve the hospitality sector's risk analysis and food safety management systems. However, the AcciMap outlined at which level of the socio-technical system and in what context the control measures or interventions need to be improved. Based on this, the areas of consideration of hygiene, food safety and operational practices and their effective management were grouped into socio-technical levels being government level (Policy focus); technical and operational management, workplace (Place focus); and people with the physical individual events, processes and conditions (People focus). In the stakeholder investigation the online survey was designed using the three key themes to provide deeper understanding of these areas from stakeholder perspective. Following this, study 3 undertakes a quantitative survey questionnaire as a data collection method. The survey design and results are presented in the next chapter.

# CHAPTER SIX: An evaluation of expert opinion on good hygiene and food safety practices in hotel premises in the DR using an online survey.

## Abstract

The theoretical and practical knowledge of experts in the food hospitality sector is crucial to the improvement and development of food safety performance. As part of this mixed-methods research approach an online self-administrated survey. During the COVID-19 internet-based data collection methods raised interest from researcher. Online survey questionnaire has been considered as an appropriate approach due to the travel constrains to undertake other approach such as face-to-face interview. This study aims to identify the expert views on hygiene and food practices that could help to identify which aspects should be taken into consideration to prevent foodborne disease outbreaks on hotel premises. Seventeen experts in the Dominican Republic were selected due to their working experience and knowledge in food safety, risk assessment, microbiology, and food regulations. The link to the self-administrated online questionnaire, which had three sections evaluating hygiene, food safety and management practices in hotel premises in the DR, was sent via email and an instant messaging software. The findings aligned with the results of the previous studies in this research which highlighted the importance of protocols in good hygiene, personal practices, protocol to temperature control, hygiene design in kitchen and food operation in hotel premises. Experts emphasised that wastewater management and training were the central aspect to focus on towards preventing foodborne outbreaks in the hotel premises in the DR.

# 6. Introduction

Food safety is one of the main factors increasing global health concerns (Ji and Ko, 2021). The continued foodborne outbreaks and malpractices require special consideration because it significantly impacts the provision of safe food (Fontannaz-Aujoulat *et al.*, 2019). Restaurants and hotels are establishments with food safety risks if proper food safety procedures are not followed. Hotels and restaurants are an important sector of the economy that can influence the health and well-being of the local population, consumers and guests (Onjwa-Onyango, 2016). Food safety operations' impact on consumer health highlights the significance of incorporating food safety principles and protocols in the food service sector and preventing it from becoming the source and route of foodborne diseases (Bajaj, 2021). Quality, hygiene and food safety in the food service sector in the DR is one of the issues not only in the hotel industry but in the whole food supply chain (Ashley *et al.*, 2005). Therefore, all stakeholders in the food industry need to ensure food safety is achieved as the most crucial aspect of their operations. National food regulations have been developed through the sanitary ordinances, decree-laws, regulations, resolutions of the Ministry of Public Health taking international standards by the Codex Alimentarius as a reference (Decreto No. 528-01, 2001).

Food safety incidents and outbreaks occur due to improper food handling, cooking, cooling, incorrect heat treatment, lack of training, monitoring, cross-contamination, inadequate equipment, and poor hygiene and sanitation, which causes foodborne illnesses (Evans and Redmond, 2018; Uçar *et al.*, 2016). Similarly, (Läikkö-Roto and Nevas, 2014; Rebouças *et al.*, 2017) asserted that unhygienic handling is a critical cause of food contamination. In the early stages of this study, a systematic mapping review of travel-related outbreaks in the hospitality settings in the DR found that the most prevalent factors responsible for the contamination of food was the weak sanitisation of the equipment and utensils, inadequate storage of food, and lack of hygiene or care in food handling leading to foodborne illness outbreaks (Díaz de Oleo *et al.*, 2022). The sanitary food regulations on food hygiene standards which affect food companies, including restaurants, is required as part of a self-control system that can guarantee food safety by identifying and evaluating the critical control of food hazards (Decreto No. 528-01, 2001). All these aspects are linked to the continuous improvement of the business's food safety management system and food safety culture (Manning, 2018; Mutua, 2021).

The stakeholders' opinions regarding the food safety practices that are relevant in the hospitality sector in the DR is the third phase of this study; which encompass the primary research data collection. In food safety area surveys have been broadly used as data collection technique to help with the implementation of food control system (Kafetzopoulos and Gotzamani, 2014). Moreover, to understand and assess food safety culture (De Boeck *et al.*, 2015; Taylor *et al.*, 2015; Ungku Fatimah *et al.*, 2014; Wiśniewska and Zamojska, 2015). In these studies, the first empirical and methodological approach are quantitative using primarily questionnaires as their main data collection tool. In food safety studies Zanin et al (2021) reported the 94% of the studies assessing food safety culture mostly adopt quantitative and Likert-scale questionnaires as the main tool of data collection. A similar approach will be adopted in this study considering the effectiveness of questionnaire to make comparison and correlations.

### 6.1. Method overview

An online survey is a research strategy that collects meaningful information of a target population in a mixed-methods approach through the internet (Creswell and Hirose, 2019; Tenuche, 2018). Online surveys are among the promising and highly convenient tools for online research (Buchanan and Hvizdak, 2009). Survey methods have evolved to fit the newest developments in communication technology; moreover, during the COVID-19 pandemic online survey this tool was extensive used for its ability to collect data in view of the restrictions (Akintunde *et al.*, 2021; Singh and Sagar, 2021).

Due to COVID-19 circumstances, in this study online surveys were chosen as the research strategy method over traditional face-to-face interviews. However, the advantages and limitations of the online survey questionnaire were also considered such as collecting data from participants challenged to reach this research stag. As an advantage this approach allows collecting a wide range of data in a single instrument and the ease of quantifying the data collected. Also, it offers faster data collection and a relatively low-cost way of researching this population(Gao, House, *et al.*, 2016). Additionally, a valuable feature of the online survey is that provide a sense of anonymity. The online platform generated a unique code for each respondent, which kept responses anonymous, and the online platform generated a unique code for each respondent. This might facilitate eliciting confidential, objective and reliable expert responses and reduce possible bias from dominance or affiliation, peer pressures or

other factors that could influence experts' opinions. This approach's common limitations are uncertainty over data validity, nonresponse, error problems and sampling (Ponto, 2015; Tenuche, 2018). Other limitations are related to bias because respondents do not understand the questions, take enough time to provide accurate data or biased views on their opinion or practices (Da Cunha *et al.*, 2014a; Rowley, 2014).

The mentioned limitations can be minimised through a robust questionnaire design with proper pre-testing and pilot testing (Dillman and Smyth, 2014; Mertens, 2009). In this regard, the online survey in this research carefully revised and piloted (i) the development of the initial questionnaire; (ii) the selection of the expert panel; (iii) the questionnaire distribution; and (iv) the collection and analysis of the final results. The aim is to identify which food safety control measures and practices are relevant to the food safety issues in the DR hospitality industry.

## 6.2. Materials and methods

The online self- administrated questionnaire was designed and hosted on 'Online Survey UK'. Jisc online survey platform is a tool created for education, academic research and organisation. 'Online Survey UK' was chosen because it is Harper Adams University's preferred option due to the university holding an organisation license. In addition, the platform is governed by UK law, is GDPR compliant and meets the ISO/IEC 270001 information security standard (Online survey). The list of questions in the questionnaire included topics such as hygiene, safety practices and management, and the list was based on the information obtained from the literature analysis and preliminary findings (Chapters 4 and 5). The Harper Adams University Ethics Committee provided ethical approval for this study. The online access to the questionnaire was open for one calendar month, and reminders were sent every two weeks if the survey had not been sent back.

### 6.2.1. Sampling and data collection

The selection of participants in this study followed the criteria of experts' definition found in the literature. According to (de Villiers *et al.*, 2005), an expert is an individual with relevant knowledge and experience in a specific field. In this study, the experts/stakeholders are individuals in the government, academia or private sector with the knowledge, experience and direct interest in or having influence over workforce development in the hospitality sector in the

DR. A non-probabilistic sampling technique is considered an appropriate sampling approach (Soon *et al.*, 2012). Identifying the most qualified experts for the current research started with personal and acquaintance contact, a survey through professional networks and LinkedIn. A preliminary list of participants contained 38 possible candidates for inclusion in the stakeholder investigation. This list was organised according to candidate names, expertise areas, job positions, and employer. The selection criteria for expert recruitment were inspired by previous studies (Lilja *et al.*, 2011; Reguant and Torrado, 2016) and adapted to this research. Panellists in the study should meet the following criteria: (i) expertise in hygiene, food safety and related areas; (ii) closeness to the hospitality sector; (iii) work experience in food safety and related subject in the DR; and (iv) willingness to participate in the study. All 38 selected professionals were approached and invited to participate in a stakeholder investigation based on an online survey. The experts were contacted either directly through email or via internet-mediated communication platforms such as WhatsApp and LinkedIn. A detailed explanation of the study objectives, instructions for completion and a consent form were sent to the participants. In addition, personal communication was offered in case additional clarification of the survey, or any other query related to the question was required. After receiving the expert's voluntary participation confirmation, a link to the online questionnaire was officially provided via email and WhatsApp.

### 6.2.2. Online survey questionnaire design

In this study, the survey began with a short introductory information indicating the study importance. A statement detailing the rights of the participant's taking and encourage to take part in the study, the guidelines to complete the survey and contact details of the researcher should the need arise to make contact. The survey questionnaire was design with the key theme's questionnaire on the food safety issues in the hospitality setting in the DR was developed explicitly based on the findings of the systematic mapping review and AcciMap analysis in the current study. Members of the research team reviewed the list with the area of consideration extracted from the analysis and synthesis of previous research findings. Any discrepancies and wording were discussed and finalised into a final consensual questionnaire. The food safety actions, activities, and practices were narrowed and refined to a set of areas of consideration and were included in the questionnaire. It reduces the overall time span for the participant to complete the questionnaire.

The survey was organised into three sections covering the following themes: Inspection programmes, Disease Surveillance & Reporting, Water supply, Water waste Management, Staff health and hygiene, Staff training, Cleaning and disinfection procedures in common areas, Sanitation facilities, Surveillance and case/incident management, Food preparation kitchen and restaurant. The first section registered demographic information: location, expertise, years of work experience, and institutional affiliation (five multiple-selection questions). The second section evaluates general hygiene practices before, during and after the COVID-19 pandemic (nine items) in hotel premises in the DR. The questions related to control measures related to COVID-19 were considered to gather evidence from professionals close to the hotel premises and confirm if the measures were or were not always implemented on these premises.

This study used five-point Likert-type scale indicating the likelihood of implementation from 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented, 4= very likely to be implemented, and 5= always implemented. The last section involved a professional appraisal of good hygienic practices in the hospitality business (29 items). In another set of items, the experts have to select a (Yes or No) on good hygiene practice should be in place in hotel premises. The third section included a rank of items to distinguish which should be prioritised and which are appropriate to prevent foodborne illness from occurring on hotel premises. The respondents were given a chance to suggest modifications to the current objectives/topics within each domain for evaluation through open-ended questions.

### 6.2.3. Testing the online survey questionnaire

After the researcher and supervisory team agreed on the questionnaire's content, the survey was designed and translated from English into the participants' mother tongue Spanish. The questionnaire was pre-tested by a research team member via a pilot survey with seven participants. The pilot survey was performed to spot difficulties and find any errors in the text, to test the online interface, to check the questionnaire design in general, its content, and wording and to clarify the terms that might differ or change their meaning and stance during the translation from English to Spanish. The obtained feedback was used to modify online settings in the platform, to allow or restrict actions, to divide longer sections into more comprehensible ones, to make the questionnaire more aesthetical, and to facilitate participants' response rate.

### 6.2.4. Data analysis

The data analysis started with the examination of the completion of responses. Responses were organised to highlight commonality and divergence in perspective among the participants. The study used the mean score to analyse the importance of the experts' responses for evaluation of a given question or statement. Content analysis was used to analyse the data and how experts responded to the questions. The demographic information was subject to descriptive analysis (frequencies and percentages), and the survey data were presented in tables.

## 6.3. Results and analysis

### 6.3.1. Stakeholder general description

This section summarises the main findings in the stakeholder investigation using an online survey. Of the thirty-eight experts who were invited, twenty-five replied to the invitation, but only seventeen completed the questionnaire. Participants had professional qualifications in more than one area ranging from food safety, general food science, hospitality management, epidemiological surveillance, consultancy on ISO 9001, 1400 and 22000, and microbiology (Table 6.1).

Some of the participants have some experience also in policy implementation and hospitality. The median years of professional experience ranged between five and eleven. Most participants are in the DR, except one currently living in Mexico. However, their work in the hospitality sector in the DR.

*Table 6.1 Demographic characteristics of respondents participating in panel.*

| Respondent | Professional qualifications | | | | | | Work experience (years) | Country |
|---|---|---|---|---|---|---|---|---|
| | FS | FS-c | RA | PPI | HP | OT | | |
| **1** | x | x | x | x | - | x | 6 - 10 | Dominican Republic |
| **2** | x | - | - | - | - | - | + 11 | Dominican Republic |
| **3** | - | - | - | - | x | - | + 11 | Dominican Republic |
| **4** | x | x | x | - | - | - | 2 - 5 | Dominican Republic |
| **5** | x | - | x | - | - | x | + 11 | Dominican Republic |
| **6** | - | - | - | - | x | - | 0 - 1 | Dominican Republic |
| **7** | x | x | - | - | - | - | 6 - 10 | Dominican Republic |
| **8** | x | - | x | x | x | - | 2 - 5 | Dominican Republic |
| **9** | x | x | x | x | - | x | + 11 | Dominican Republic |
| **10** | - | - | x | - | - | - | 6 - 10 | Dominican Republic |
| **11** | - | - | x | - | - | - | 6 - 10 | Mexico |
| **12** | x | x | x | - | - | - | 2 - 5 | Dominican Republic |
| **13** | x | x | x | - | - | - | 2 - 5 | Dominican Republic |
| **14** | x | x | - | - | - | - | 6 - 10 | Dominican Republic |
| **15** | x | - | - | - | - | - | 2 - 5 | Dominican Republic |
| **16** | - | - | - | - | - | x | + 11 | Dominican Republic |
| **17** | x | - | - | - | x | - | 2 - 5 | Dominican Republic |

FS: Food Safety; FS-c: Food Safety Culture Food Science; RA: Risk Assessment; PPI: Planning and policy implementation; HP: Hospitality; OT: Other.

The panels were composed of professionals from regulatory institutions (35%), followed by the hospitality/food service sector (23%), and from private consultants' businesses (18%). Fewer experts (12%) were affiliated with educational institutions, and 6% were related to international organisations and consultancy/professors in tourism and gastronomy. None of the respondents was affiliated with hotel chains (international) or research institutions.

The results from the second and third sections of the questionnaire are collated in Table 6.2 to Table 6.10 As not all respondents answered every question the total number of respondents is recorded.

### 6.3.2. General Good Hygiene Practices in the DR hotel premise before and during COVID-19 pandemic.

*Table 6.2 A list of topics provided to the participants as a matter of choice for inclusion in the precautionary measures against spreading the SARS-CoV-2.*

| | A) Indicate which of the following elements of cleaning and disinfection procedures in common areas are/were usually implemented in a hospitality environment prior to any COVID-19-related protocols having been introduced. | 1 | 2 | 3 | 4 | 5 | Total | Average |
|---|---|---|---|---|---|---|---|---|
| A.1 | Daily cleaning of common areas | 0 | 0 | 1 | 2 | 14 | 17 | 4.76 |
| A.2 | Disinfection routinely of food contact areas | 0 | 0 | 2 | 2 | 13 | 17 | 4.65 |
| A.3 | Disinfection routinely of bathrooms, toilets and high hand-contact areas | 0 | 0 | 1 | 7 | 9 | 17 | 4.47 |
| A.4 | Disinfection of surfaces and contact areas such as telephones, and handrails | 0 | 3 | 3 | 9 | 2 | 17 | 3.59 |
| A.5 | Disinfection of floors, or walls | 0 | 1 | 4 | 3 | 9 | 17 | 4.18 |
| A.6 | Monitoring the effectiveness of the cleaning and sanitation procedures (audits, inspections) | 0 | 0 | 2 | 10 | 5 | 17 | 4.18 |
| A.7 | Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning | 1 | 1 | 2 | 10 | 2 | 16 | 3.69 |
| A.8 | Regular cleaning and maintenance of water systems especially water storage | 0 | 0 | 4 | 8 | 5 | 17 | 4.06 |
| A.9 | Strengthening of the procedure for decontamination during an outbreak, e.g. cleaning and disinfection of rooms associated with sick people | 0 | 1 | 4 | 7 | 4 | 16 | 3.88 |

Notes: 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented, 4= very likely to be implemented, and 5= always implemented.

From the nine hygiene activities listed in the questionnaire to determine if these are/were usually implemented in a hospitality environment prior to the COVID-19 pandemic ( Table 6.2). Experts indicated that before COVID-19, some activities were identified as nearly always being implemented:

- A.1 Daily cleaning of common areas [4.76]
- A.2 Disinfection routinely of food contact areas [4.65]
- A.3 Disinfection routinely of bathrooms, toilets and high hand contact [4.47]

Usually implemented:

- A.5 Disinfection of floors, or walls [4.18]
- A.6 Monitoring the effectiveness of cleaning and sanitation procedures [4.18]
- A.8 Regular cleaning and maintenance of water systems especially water storage [4.06]

And then less focus:

- A.9 Strengthening of the procedure for decontamination during an outbreak [3.88];
- A.7 Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning [3.67]
- A.4 Disinfection of surfaces and contact areas such as telephones and handrails [ 3.59]

The following table (Table 6.3) presents the hygiene activities listed in the questionnaire to determine if these are/were usually implemented in a hospitality environment during the COVID-19 pandemic. Table 6.3 show responses to good hygienic practice in food preparation areas, usually implemented in a hospitality environment.

Table 6.3 A list of topics provided to the participants as a matter of choice for inclusion in the precautionary measures against spreading the SARS-CoV-2.

| B) Indicate which of the following elements of cleaning and disinfection procedures in common areas are/were usually implemented in a hospitality environment prior to any COVID-19 pandemic. | 1 | 2 | 3 | 4 | 5 | Total | Average |
|---|---|---|---|---|---|---|---|
| B.1 Daily cleaning of common areas | 0 | 0 | 0 | 3 | 14 | 17 | 4.82 |
| B.2 Disinfection routinely of food contact areas | 0 | 0 | 0 | 6 | 11 | 17 | 4.65 |
| B.3 Disinfection routinely of bathrooms, toilets, and high hand-contact areas | 0 | 0 | 1 | 7 | 9 | 17 | 4.47 |
| B.4 Disinfection of surfaces and contact areas such as telephones, and handrails | 0 | 1 | 2 | 9 | 5 | 17 | 4.06 |
| B.5 Disinfection of floors, or walls | 0 | 1 | 2 | 9 | 5 | 17 | 4.06 |
| B.6 Monitoring the effectiveness of the cleaning and sanitation procedures (audits, inspections) | 0 | 0 | 1 | 11 | 4 | 16 | 4.19 |
| B.7 Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning | 1 | 0 | 5 | 7 | 3 | 16 | 3.69 |
| B.8 Regular cleaning and maintenance of water systems especially water storage | 0 | 1 | 2 | 7 | 6 | 16 | 4.13 |
| B.9 Strengthening of the procedure for decontamination during an outbreak, e.g. cleaning and disinfection of rooms associated with sick people. | 0 | 2 | 1 | 7 | 6 | 16 | 4.06 |

Notes: 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented, 4= very likely to be implemented, and 5= always implemented.

Experts indicated that during COVID-19 (Table 6.3), some activities were identified as nearly always being implemented:

- B.1 Daily cleaning of common areas [4.82]
- B.2 Disinfection routinely of food contact areas [4.65]
- B.3 Disinfection routinely of bathrooms, toilets and high hand contact areas [4.47]

Usually implemented:

- B.4 Disinfection of surfaces and contact areas such as telephones, and handrails
- B.5 Disinfection of floors, or walls
- B.6 Monitoring the effectiveness of the cleaning and sanitation procedures (audits,
- inspections)
- B.8 Regular cleaning and maintenance of water systems especially water storage
- B.9 Strengthening of the procedure for decontamination during an outbreak, e.g. cleaning and disinfection of rooms associated with sick people

And then less focus:

- B.7 Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning

By contrasting the results with the expert's opinion before and during COVID-19 there is not a significant different in the changes of practices during the pandemic.

Nearly always being implemented: were Daily cleaning of common areas [4.82 previously 4.76]; Disinfection routinely of food contact areas [4.65 remained the same]; Disinfection routinely of bathrooms, toilets and high hand contact [4.47 remained the same]; Monitoring the effectiveness of cleaning and sanitation procedures [4.19 previously 4.18].

Usually implemented: Regular cleaning and maintenance of water systems especially water storage [4.13 previously 4.06]; disinfection of floors, or walls [4.06 fell from 4.18]; disinfection of surfaces and contact areas such as telephones and handrails [ 4.06 previously 3.59]; strengthening of the procedure for decontamination during an outbreak [4.06 previously 3.88]; And then less focus: regular cleaning and maintenance for air filters, ventilation systems or duct cleaning [3.69 previously 3.67].

Table 6.3 A list of topics provided to the participants as a matter of choice on good hygienic practice in food preparation areas, kitchens, restaurants in hospitality settings.

| C) | Indicate which of the following aspects of good hygienic practice in food preparation areas, kitchens and restaurants are usually implemented in a hospitality environment. | 1 | 2 | 3 | 4 | 5 | Total | Average |
|---|---|---|---|---|---|---|---|---|
| C.1 | Adoption of appropriate time/temperature controls | 0 | 0 | 1 | 4 | 12 | 17 | 4.65 |
| C.2 | Cleaning and sanitising training for staff | 0 | 0 | 1 | 11 | 5 | 17 | 4.24 |
| C.3 | Consideration for handwashing stations (Handwashing sinks and automatic handwashing facilities) | 0 | 2 | 3 | 8 | 4 | 17 | 3.82 |
| C.4 | Designing areas to ensure the appropriate layout | 0 | 2 | 3 | 9 | 2 | 16 | 3.69 |
| C.5 | Goods inwards food inspection procedures | 0 | 1 | 2 | 5 | 8 | 16 | 4.25 |
| C.6 | Implementation of written standard operating procedures | 0 | 1 | 3 | 5 | 8 | 17 | 4.18 |
| C.7 | Preventive measures for cross-contamination | 0 | 1 | 2 | 5 | 8 | 16 | 4.25 |
| C.8 | Safe food-handling practice | 0 | 0 | 1 | 10 | 6 | 17 | 4.29 |

Notes: 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented, 4= very likely to be implemented, and 5= always implemented.

In kitchen areas in the hospitality setting (Table 6.3) practices identified as nearly always being implemented were

- C.1 Adoption of appropriate time/temperature controls [4.65]

Usually implemented:

- C.2.Cleaning and sanitising training for staff [4.24]
- C.5 Goods inwards food inspection procedures [4.25]
- C. 6 Implementation of written standard operating procedures [4.18]
- C. 7 Preventive measures for cross-contamination [4.25]

And then there was suggested to be less focus:

- C.3 Consideration for handwashing stations (Handwashing sinks and automatic handwashing facilities) [3.82]
- C.4 Designing areas to ensure the appropriate layout [3.69]

In the evaluation of the hygiene practices in kitchen facilities, the respondents indicated that adopting appropriate time/temperature controls from the set of items is the only one practice that was always implemented. It was suggested there was lesser adoption of: Consideration for handwashing stations (Handwashing sinks and automatic handwashing facilities) [3.82]; Designing areas to ensure the appropriate layout [3.69]. However, by looking at the individual responses from participants, experts from the regulatory institutions considered important: C.3 Consideration for handwashing stations (Handwashing sinks and automatic handwashing facilities) [3.82]; and C.4 Designing areas to ensure the appropriate layout [3.69]. Also, those mentioned above and the C.6 Implementation of written standard operating procedures [4.18] are likely to be implemented as stated by education, regulatory and hospitality experts.

### 6.3.3. Professional appraisal of good hygiene, food safety and management practices

The second section sought experts' opinions on important hygiene, food safety and management practices that should be included in a good hygienic practice guide and must be in the hospitality business. The following tables will cover the following sections: staff and hygiene, staff training, and water supply, and waste management.

Table 6.4 Items of good hygienic practice guide in a Staff and hygiene section.

| D) | Indicate which of the following elements should be included in a good hygienic practice guide for procedures that need to be in place in hospitality business. | Yes | No | Total |
|---|---|---|---|---|
| D.1 | Good hygiene personal practices protocol | 17 | 0 | 17 |
| D.2 | Protocols for cleaning/disinfection of tools, equipment | 12 | 5 | 17 |
| D.3 | Clearance for health return-to-work policies protocol | 16 | 1 | 17 |
| D.4 | Adequate layout for hygiene facilities e.g. wash basins, lavatories changing facilities | 11 | 6 | 17 |
| D.5 | Sanitiser and equipment purchasing protocol | 8 | 9 | 17 |
| D.6 | Personal Protective Clothing (PPE) protocol | 16 | 1 | 17 |

Results in Table 6.4 indicate that most of the experts agreed and considered as important D.1 good hygienic practices protocol; D.3 clearance for health return-to-work policies protocol; and D.6 Personal Protective Clothing (PPE) protocol without a significant difference between these responses. However, for other items also considered as important by some there was also still a large number of participants who considered the practice as unimportant within a good practice guide. These include: D.2 Protocols for cleaning/disinfection tools and equipment; and D. 4 Adequate layout for hygiene facilities, e.g. wash basins, lavatories changing facilities. The data was reviewed to determine if is the same group of experts were voting in the negative but there was no conclusive trend.

There was little agreement that the practice guide should include D.5 Sanitiser and equipment purchasing protocol.

Table 6.5 Items of good hygienic practice guide in a Staff training section.

| E) | Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. | Yes | No | Total |
|---|---|---|---|---|
| E.1 | Cleaning and disinfection procedures | 17 | 0 | 17 |
| E.2 | Induction training guide | 16 | 1 | 17 |
| E.3 | Guidance for employee refresher training | 13 | 4 | 17 |
| E.4 | Guidance on training in basic handwashing and promotion of proper hand hygiene | 16 | 1 | 17 |
| E.5 | Guidance on developing employee food safety training | 14 | 3 | 17 |
| E.6 | Guidance for provision of a staff handbook addressing principles of food safety and hygiene | 12 | 5 | 17 |
| E.7 | Guidance for signage/posters about expected behaviours and descriptions | 11 | 6 | 17 |

Results from Table 6.5 show that several items in the staff and training section were considered important to include in a good hygienic practice guide. However, there are items considered as having more importance according to expert responses. They strongly agree on the importance of E.1 cleaning and disinfection procedures, E.3 induction training guide, E.4 guidance on training in basic handwashing and promoting proper hand hygiene. Items that still important to be included in a guide of practice but with less positive responses are E.5 guidance on developing employee food safety training, E.3 guidance for refresher training; E.6 guidance for provision of a staff handbook addressing principles of food safety and hygiene; E.7 Guidance for signage/posters about expected behaviours and descriptions in a practice handbook. Comparing these responses for items experts considered least important were the use of posters addressing principles of food safety and hygiene and expected behaviours.

Table 6.6 Items of good hygienic practice guide in Water supply section.

| F) | Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. | Yes | No | Total |
|---|---|---|---|---|
| F.1 | Guidance on ensuring an adequate supply of hot and/or cold potable water | 15 | 2 | 17 |
| F.2 | Policies for adherence to water national regulations | 16 | 1 | 17 |
| F.3 | Guidance on appropriate facilities for water storage | 17 | 0 | 17 |
| F.4 | Policies for regular inspections of water quality and records | 16 | 1 | 17 |
| F.5 | Policies for regular sanitation of water storage systems | 16 | 1 | 17 |

Overall, most experts considered the water supply section as the most important section to be included in a practice guide (Table 6.6). Results show consensus from the participants in each of the items listed. Interestingly experts consider this section as even more important to include in a good hygienic practice guide than some elements of hygienic practice, and staff training.

Table 6.7 Items of good hygienic practice guide in Waste management section.

| G) | Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. | Yes | No | Total |
|---|---|---|---|---|
| G.1 | Guidance for providing adequate drainage and waste disposal systems and facilities | 16 | 1 | 17 |
| G.2 | Guidance on ensuring system protection is in place for wastewater especially cross-connections, backflow, and disinfection protocols | 17 | 0 | 17 |
| G.3 | Policies and monitoring processes for wastewater and sewage treatment | 16 | 1 | 17 |
| G.4 | Guidance for adequate and appropriate maintenance and cleaning of wastewater systems. | 14 | 3 | 17 |
| G.5 | Policies for the monitoring of the effectiveness of maintenance and sanitation procedures for wastewater systems | 15 | 2 | 17 |

The waste management section also received general agreement from most of the participants for the items listed (Table 6.7). Similarly, to the results of the water system sections, very low numbers voted for practices not to be included in a good hygienic practice guide. Three out of seventeen participant considered not important for inclusion G.4 Guidance for adequate and appropriate maintenance and cleaning of wastewater systems. and two respondents considered G. 5 Policies for monitoring the effectiveness of maintenance and sanitation procedures for wastewater systems, as important for inclusion.

The last section of the questionnaire regarded control measures associated with the management and food safety practices, and participants ranked the most important in order based on their judgment. The summary of all the controls to guarantee the food safety practices in the hospitality sector associated with management and disease surveillance is shown in Table 6.8 and Table 6.9.

Table 6.8 The most important control measures in the hospitality sector associated with management of food safety practices.

| A) | The following list summarises some of the controls associated with management of food safety practices in the hospitality sector. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Total number of responses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| H.1 | Adopting cleaning and disinfection procedures in common areas | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 10 |
| H.2 | Implementing disease surveillance and reporting procedures for staff and guests | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 12 |
| H.3 | Implementing inspection and audit programmes | 2 | 2 | 4 | 2 | 0 | 1 | 2 | 0 | 1 | 14 |
| H.4 | Implementing sanitation protocols and associated procedures for kitchens and restaurants | 7 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 3 | 13 |
| H.5 | Implementing staff health and hygiene procedures | 5 | 1 | 1 | 0 | 0 | 0 | 0 | 2 | 3 | 12 |
| H.6 | Implementing staff training procedures | 3 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 10 |
| H.7 | Implementing water supply controls and water quality assessment procedures | 1 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 1 | 8 |
| H.8 | Implementing wastewater management procedures | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 7 |
| H.9 | Work instructions for food preparation for kitchen and restaurants | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 7 |

Notes: 1 to 9, in order of importance with 1 being the least important and 9 being the most important.

Table 6.9 The most important control measures in the hospitality sector associated with disease surveillance and reporting.

| | A) The following list summarises some of the controls associated with disease surveillance and reporting in the hospitality sector. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Total number of responses |
|---|---|---|---|---|---|---|---|---|---|
| I.1 | Developing an outbreak prevention and management policy | 9 | 2 | 2 | 2 | 0 | 0 | 2 | 17 |
| I.2 | Establishing a surveillance and case / incident management policy | 6 | 4 | 1 | 1 | 1 | 1 | 3 | 17 |
| I.3 | Implementing inspection programmes for disease surveillance and reporting | 6 | 5 | 2 | 1 | 1 | 1 | 1 | 17 |
| I.4 | Monitoring of water safety/quality programmes and their effectiveness | 2 | 6 | 0 | 1 | 2 | 6 | 0 | 17 |
| I.5 | Monitoring for relevant and suitable training of staff | 3 | 3 | 2 | 3 | 2 | 1 | 3 | 17 |
| I.6 | Periodic audit/inspections of hospitality settings to ensure compliance with disease surveillance and reporting policies and legislative requirements | 5 | 4 | 2 | 2 | 1 | 2 | 1 | 17 |
| I.7 | Review of processes to report a foodborne illness outbreak | 3 | 2 | 3 | 2 | 2 | 1 | 4 | 17 |

Notes: 1 to 7, with 1 being the least important and 7 being the most important.

Experts were asked to range from 1 to 9 and from 1 to 7. The one is the least important, and 9 and 7 are the most important. Observing how experts respond, both question items were ranked between 6 and 1, the lowest position to be ranked. However, the higher position was barely ranked. In Table 6.4.9, we can highlight that in the expert's opinion the most important items were H.5, implementing staff health and hygiene procedures, followed by H.3, implementing disease surveillance and reporting procedures for staff and guests and H.9 work instructions for food preparation for kitchen and restaurants. In Table 6.9 the most important items were I.4 monitoring of water safety/quality programmes and their effectiveness, then I.7 review of processes to report a foodborne illness outbreak and I.5 monitoring for relevant and suitable training of staff.

The section did not receive a reply from all the participants in the questionnaire, as can be seen in Table Table 6.8. The low-rate responses may be because they have not understood the question or how to properly order the items by their importance. It is possible that a low engagement and rush to finish the questionnaire. However, the questions in Table 6.10 received a complete response. However, it indicates that the main issues with the question completion were based on the fact that the experts did not understand the question and instructions to complete these two questions.

Open comments of any suggestions experts considered important to be included in good hygiene and practice for the hospitality sector to prevent foodborne disease outbreaks are summarised in Table 6.10. Because the comments were written in Spanish, the native language of the experts, each of the comments provided by the panellist was translated by the researcher into English to gain more understanding of what experts considered important and thought should be included in a procedure to prevent FBD.

Table 6.10 List of comments provided by the panellist.

| Respondents | Comments |
|---|---|
| 1 | The knowledge an employee must have to be a food handler. |
| 2 | The contact numbers of the local and national authorities for relevant notification, case management and follow-up. |
| 3 | The temperatures of the buffets. |
| 4 | Handwashing control, identify colour tables to avoid cross contamination |
| 5 | Solid waste disposal and food storage |
| 6 | No |
| 7 | Microbiological tests |
| 8 | N/A |
| 9 | An informative questionnaire from the client with information on infectious diseases suffered the last few months |
| 10 | No |
| 11 | The importance of the manuals is the integration of the operatives' personnel to the specific management system to live a safety culture from senior management to the operative personnel. And the important is also the correct storage of cold and frozen foods. |
| 12 | Training in food microbiology, performing swabs in the hands of employees who have direct functions in food handling to verify or validate correct hand washing or that the hygiene supplies used are of quality or reliable |
| 13 | Yes, monitoring of medical tests, performing ATP swabs on staff |
| 14 | Food temperature control. e.g. cold chain |
| 15 | Food contamination prevention practices, customer information pamphlet |
| 16 | I understand have been covered most regarding the importance order |
| 17 | As observed, I understand that the information is very complete |

Three out of seventeen respondents (6, 8 and 10) did not make any comments about any other good hygiene practices they considered important. Two comments (respondents 16 and 17) were general and did not offer an opinion to suggest another aspect that should be included in

a code of practice on hotel premises, rather they considered that all the important aspects were covered in the questionnaire. The vast of the comments made by the experts are related to good hygiene and practices, it is observed that comments are very focused on microbiological aspects, running regular tests for employees close to the food handling, and monitoring medical tests. It was also mentioned to monitor and validate the handwashing procedure. This is followed by food temperature control, and two experts mentioned cold chains and adequate temperatures for frozen foods. Another important comment made by the experts is related to knowledge of the food handlers and training. Other comments were related to management aspects, risk communication to diseases notification, providing information to consumers and prevention strategies involving the authorities and hotel managers. One expert considered that solid waste disposal should also be addressed in a procedure on the hotel's premises. Another comment cover in general that food safety principles and this expert considered it important to be integrated into an organisation. The next section has presented a discussion summarising the main findings and the conclusion.

## 6.4. Discussion

The stakeholder's investigation sense checked the findings obtained in the previous studies in this research and identifies which hygiene and food safety practices are considered relevant to reducing FBD incidents in hotel premises based on the experts' perspectives in the DR. The self-administrate survey approach to attain experts' opinion and perspective to provide scientific and social-based evidence from experts with considerable experience, knowledge, closeness with the topic, time availability and willingness to participate was of value and these were the main inclusion criteria to select the participants. This study succeeded in selecting adequate participants which was vital to the study outcomes. According to Reguant and Torrado (2016) expert selection is a critical step because the experts are the ultimate source of information and a factor that will influence the success of the entire method. Similarly, (Auad *et al.*, 2018; Ceniccola *et al.*, 2014) considered expert selection important to achieving a reliable validation of risk assessment instruments in their studies.

Analysing the responses suggests that food hygiene and safety practices did not change on hotel premises, and the same practices that were implemented before COVID-19 were not improved. It was an important finding due to during the pandemic, it was expected that hotels, restaurants, and food services settings would improve and strengthen their food hygiene and safety practices. Olaimat *et al.* (2020) stated that hygiene and safety practices changed significantly during and after the pandemic. However, this did not happen in the hotel's premises in the DR. Conversely, hygiene procedures such as the disinfection of surfaces and contact areas which might be expected to be more routinely enforced during the lockdown in the hotel's facilities, remained the same in the DR. This could be explained that for the experts' point of views all the hygiene practices have always been properly implemented and there is no need to improve it. But, the results from the AcciMap model show that in the DR, a contributory factor was related to poor behaviours in adopting hygiene practices, e.g. cleaning and disinfection or using PPE, it could be inferred that the hygiene practices in the hotel premises in the DR were not improved after COVID-19 due to a reluctance to adopt them.

When the experts have the opportunity to freely provide more suggestions toward improving food safety practices in hotels premise, they included food temperature control as an imperative good hygienic practice in food preparation areas. Experts also suggested of importance the

consistency in the cold chains and food storage of frozen products. Similar to previous findings, this study outlines that appropriate time and temperature, and food storage are aspect of importance as identified in the reviewed outbreaks. In general, basic hygiene practices such as the ones established in the Five Keys to Safer Food are still needed to be emphasised in hotel premises in the country. It means that a pre-requisite programme for good hygienic practice should be in place. (Ukwueze, 2019) found that appropriate consumer protection is required to ensure food safety along the entire food supply chain. Failure to achieve this will have a negative economic and public health impact. It is required actions from the government, hotels owner and managers to increase hygiene and safety practices to reduce food safety incidents.

Findings drawn from the experts' opinions shed light and explain further some of the food safety issues in the hospitality sector in the DR. For instance, aspects such as the kitchen hygiene design and handwashing facilities have low responses in the questionnaire as requiring adoption. However, these are critical aspects of good hygiene practices. Findings in the systematic mapping review of the outbreaks reported contamination of unsafe water and food linked to transmission of diseases such as *Salmonella, E. coli,* and *V. cholerae*. This can also be related to deficiencies in the food operation layout and handwashing. Design deficiencies also facilitate cross-contamination and provide an unsafe environment where a food pathogen can quickly spread. In addition, the lesser consideration of the layout aspects of food preparation areas fosters poor food handling practices from staff and employees. In this element of the study, the hygiene design of kitchen and food areas was repeatedly considered not essential to be included in a hygienic code of practice by experts in regulatory bodies and the education sector. Therefore, educators could transmit this opinion to their students, and regulators cannot advise on this matter, leading to poor knowledge and behaviour towards food safety. Two other aspects essential to build a positive food safety culture are related to the artefacts and a staff handbook addressing principles of food safety and hygiene, but they were not extremely popular among the experts. Some experts do not see the value of artefacts in food operations as a reminder to staff about basic hygiene practices. Also, the consideration of the value of posters to emphasise good hygiene practices could be related to the level of literacy of the employees; therefore, experts might consider it not practical. This is worthy of further research. Aligned with the findings in this study, Da Cunha *et al.* (2022) concludes that inadequate facilities and education being seen as administrative control failures may have demotivated appropriate food safety behaviour. Overall, proper hygiene safety practices and management in hotel settings could have a better order of priority for the health authorities,

hotel owners and managers. Furthermore, in recent findings by Pan *et al.* (2021) hygiene controls were seen as the most important predictor of future hotel selection behaviours by tourists.

Guidance and protocols such as staff and training, water supply and wastewater were considered of great importance among the experts. However, according to the importance of ranking water supply management excels. These findings confirm what was found in both the systematic mapping review and AcciMap that water supply and wastewater management, if not effectively managed, could lead to FBD outbreaks in which unsafe water and poor sanitisation are the sources of multiple outbreaks. Therefore, it is essential to emphasise the importance of food hygiene and appropriate management practices in the drinking water system and wastewater management and go beyond simply monitoring the sewage management consistently on the hotel premises. The NoV outbreak in the DR (Doménech-Sánchez *et al.*, 2011) showed the presence of NoV in the waste and water samples.

For this study, the online survey was a valuable method to gather professional perspectives about food safety-relevant practices that should be in place in hospitality settings. The expert opinion indicated the importance of protocols in good hygiene, personal practices, protocol to temperature control, hygiene design in kitchen and food operation and the management of the water supply, wastewater management and training as the central aspect to focus.

## 6.5. Conclusion

In the current study, a stakeholders' investigation was conducted using a self-administrated survey to identify the most relevant control measures towards preventing foodborne outbreaks in the hotel premises in the DR. The technique allowed the study to identify from experts with knowledge and working experienced in the country. Health authorities and managers in the hotels can use these findings and contrast if their current standards are focus in the areas that in the findings from the previous studies were an issue. Hygiene and food safety and management practices in hotel premises can be more effectively improved if efforts are focused in specific areas. The level of education and literacy in hotels employees can influence the adoption of appropriate behaviours; furthermore, implementing training, education and refresher training program is essential. This can be supported with the training, education and refresh training programme in food safety. Promoting the adoption of hygiene protocols,

handbooks and artefacts and the adherence in following them in order to consistently deliver food safety is crucial. Implementing regular checks and monitoring of solid food disposal and wastewater is also important. The limitation of this study is related to incomplete responses in two questions in the survey. As a result, we could not determine a consensus among which of all the items was the most important, to have an idea about what experts will prioritise. A further research study should consider using a different online survey platform to design and host the questionnaire. This study was restricted to using the online survey platform approved for the university to comply with the policy data management. The online survey platform was strict and did not allow a clear design presentation of the questions, which could also interfere with the experts' understanding of how to complete certain the questions.

### 6.6. Summary

The stakeholder investigation was applied to evaluate and gather opinions about factors they considered relevant to prevent FBD. Findings from this approach showed that participants diverged in their opinion on the importance of food safety practices and management and that its compliance will prevent food safety issues. However, it was valuable to gather the judgment of professionals with different backgrounds and expertise in the hospitality and food safety areas. Similar recommendations could be drawn from the other approaches and other data assimilated which was of value. However, the mixed-methods approach used in this research does captures specific knowledge gaps identified in the literature review. In addition, the methods in this third phase addressed the stated objectives of the research. In summary, the triangulation approach was useful to gain supporting evidence rather than just rely on the opinions and viewpoints expressed by the participants. The combination of findings from each method provided a multi-faceted view and analysis of FBD outbreaks enabling us to understand the prevailing FSMS and FS-culture and how to improve the food safety performance in the hotel premise in the DR. By collectively capturing stakeholders' perspectives, the findings presented avoided the individual judgment of the researcher in this third phase, but instead gathered the judgment of professionals with different backgrounds and expertise in the hospitality and food safety areas. The following chapter discusses the overall findings from this research to inform the conclusions and recommendations that arise from this study.

# CHAPTER SEVEN: DISCUSION

## 7. Introduction

This chapter attempts to present the researcher's reflections, observations and thoughts derived throughout the research process. The chapter describes the main findings in terms of the objectives achieved through the methods applied. Furthermore, the chapter discusses the results derived from the several phases of the study. The conclusions drawn at the end of this chapter take into consideration the observed strengths and limitations of each method and suggest optimisation of their application in the food safety area to minimise the risk of FBD outbreaks in the DR.

The aim of this research was to assess the effectiveness, sensitivity, and appropriateness of systems-based approaches to explore and reflect on FBD outbreaks associated with the hospitality sector. The study will inform policy development, especially in developing economies such as the DR.

The specific research objectives are:

- To critically review selected sources and extract the available information related to the FBD outbreaks in the tourism and hospitality sector, with particular focus on the DR.
- To apply systems-based methodological approaches to identify the contributory factors that influence food safety management, hygiene practices and operational practices in the hospitality sector. Furthermore, this objective also encompasses a critical assessment of the multiple contributory factors, to try to reveal their interrelationships and their impact on FBD outbreaks.
- To use a stakeholder investigation to evaluate expert opinion about factors, such as hygiene, management and food safety practices, and in combination with the findings of the previous phases of the study to propose practical recommendations for prevention and reduction of FBD outbreaks in the hospitality sector of the DR.

## 7.1. Overview of the mixed-methods approach

The mixed-methods approach adopted in this research used research methods that are well-established and are considered reliable when applied, to some extent, in the areas of food safety management and the prevention of FBD outbreaks. The thesis has stated that FBD is a public health issue that could also affect the socioeconomic development of the hospitality sector in the DR. Although it is acknowledged in the academic literature that multiple realities can exist, to assess FBD outbreaks holistically and systematically, it was considered important to combine different perspectives and methods to provide richness of data and to allow triangulation.

In order to assess the effectiveness, sensitivity, and appropriateness of systems-based approaches to explore and reflect on FBD outbreaks associated with the hospitality sector and to inform policy development, especially in developing economies such as the DR, this study first used systematic mapping review to discover existing research gaps and to inform the study in terms of which systems level approaches could be used to consider FBD outbreaks. The use of the AcciMap uncovered systemic failures and contributory factors that were interacting in complex systems such as the hospitality sector. Additionally, the third phase, the online survey, provided a different, grounded perspective on the same topic focusing on participant expertise and voice. In this regard, Taylor and Rostron (2018) stated a significant benefit to using mixed-methods is where the qualitative approaches generated themes and content. This quantitative phase allowed reflection on key themes that emerged from the first two qualitative phases and a broader literature review. Such an approach provides a flexible process that could be integrated into the research design, data collection, and study analysis.

The primary rationale for employing a mixed-methods approach in the current study arose during the initial stages because the paucity of scientific, public, and official information was noted. Therefore, a mixed-methods approach would explore in-depth the available information and seek to gather rich and abundant data to understand the phenomenon's complexity. Zanin *et al.* (2021) stated that different approaches could also provide a different level of depth of analysis. Food safety practices, and the associated FSMS, can have a positive relationship with FS-culture (De Boeck 2017). Therefore, this study and its findings contribute to theoretical knowledge providing an alternative approach to assessing food safety inidents and FBD outbreaks in the hospitality sector in the DR. Furthermore, this study included a system analysis

approach method within the methodology. The system analysis approach has been proposed as an important determinant for conducting FS-culture research (Jespersen *et al.*, 2017; Nyarugwe *et al.*, 2016).

## 7.2. Summary of findings

Results from this study show the benefits of multi-level analysis (see also Nyarugwe *et al*. 2018) where a deeper understanding of the relationship between the different factors, behaviours and characteristics of the actors shapes how an 'accident' or incident can occur. The approaches adopted in this research led to three themes emerging Policy focus, Place focus and People focus, and these themes are now used to structure the research findings.

## 7.3. Policy focus: inspections programmes, diseases surveillance and reporting

As discussed in earlier chapters (Chapter 2 and Chapter 5), embedding surveillance and reporting systems and inspection programmes in a country with limited resources to fund regulation is a significant challenge faced by government authorities and also hotel managers. Irregular inspections, poorly defined government responsibility and inadequate/poor surveillance systems are all actions and activities associated with contributing to FBD outbreaks in hospitality settings. Similarly, Nyarugwe *et al.* (2016) stated that deficiencies in current food safety controls and management systems are attributing to and negating the impact of food safety enforcement measures, implementation, and practices. Findings in this research show violations in enforcement were common factors emerging from the three NoV studies. Moreover, inadequate inspections and the inability to take appropriate corrective actions regarding food incidents was a behaviour contributing to the outbreak in New Zealand (Chapter 5).

Audits and inspections can be valuable, reliable tools to measure and ensure food safety. However, Powell *et al*. (2013) stated that several limitations are attached to such activities, as they are only representing a snapshot in time. Similarly, Griffith (2005) mentioned some concerns about the efficacy of inspections related to a lack of consistency, inadequate resources, and a lack of transparency or openness to share information. This research captured through the use of the AcciMap that financial constraints also represent a barrier to delivering

effective food safety governance. Limited budgets at the government level hinder the efficient and proactive enforcement of food safety regulation and ensuring businesses' level of compliance. These limitations concur with the findings of Famah (2014) who reported that financial constraints could trigger risky, unsafe behaviours and decisions towards food safety. Consequently, the AcciMap analysis showed that sporadic regulatory and business checks compared with effective visits and follow-up visits and employees prioritising certain aspects of food safety and public health over others, where contributory factors that led to the NoV outbreaks. AcciMap analysis depicts the interconnections and how a decision made at the national level towards budget cuts for governance can lead to poor enforcement and compliance with the national food safety regulations at hotel premises. In addition, poor managerial decisions increase the impact of poor food safety (public health-related) behaviour among the people involved. Therefore, the national deficiency in food safety related governance in the DR of in implementing public health and food safety regulations has consequences at the local level, and failures in this sub-section of the AcciMap framework arose from the deficiency at the national level.

The findings in this research aligned with what is found in the literature in the DR in the food safety context about the consistency in gathering food safety information and the limited or non-existence information on hygiene standards on hotel premises. This is examined more fully in Chapter four. Regarding the openness to share information on inspections, it was concluded that transparency on how food safety is managed in hospitality settings, and how managers or policy-makers control the availability of such information for public scrutiny was a challenge (Díaz de Oleo et al., 2022a). Furthermore, when looking at the hospitality sector in particular, the scarcity of information limits the strategies available to address food safety and FBD issues. This research found limited studies in hygiene, food safety practices and management, specifically in the hospitality sector. Therefore, a practical contribution of this study is to provide more knowledge of FBD outbreaks in the tourism and hospitality sector in the DR by providing evidence-based information on the common risks associated with FBD and offering recommendations for food safety practices and management process that might be embedded in the hotel premises (see process and people sections).

Moreover, the deficiencies in the inspection programmes, disease surveillance, and reporting have negatively impacted the food safety surveillance system, procedures, and activities in the DR. Primarily, because incidents are not timely in their reporting, and data from epidemiological

investigations are inappropriately gathered. In addition, cooperation and collaboration between the health authorities and hotels in health and food safety surveillance us essential. The study's findings reflect the limited integration of government authorities and other stakeholders.

The analysis of the foodborne outbreaks through the AcciMap analysis observed that early warning systems in the DR are absent, hindering the ability to intervene in the event a potential FBD outbreak is suspected. For instance, a gastroenteritis incident can lead to an unmanageable NoV outbreak in a hotel (Doménech-Sánchez *et al.*, 2011). However, many actions and risk evaluations by government and hotel managers in this example failed to address, identify and prevent FBD. This failure shows the need for more preparedness and response to public health threats such as FBD outbreaks. As a result, these findings emphasise critical areas for further research using a holistic systems level approach to enhance food safety procedures, perform effective surveillance programmes and protect visitors' and citizens' health in countries such as the DR. Crotta *et al.* (2022) mentioned that food safety decisions could be made more thoroughly, be better organised, and transparent without the need for food safety data information.

This study found from the three NoV studies that verbal communication among the different hierarchical levels in the socio-technical system was inadequate and an issue contributing to FBD outbreaks. Poor communication in notifying authorities about FBD outbreak episodes and poor communication about hygiene protocol strategies to consumers, staff, and managers led to FBD (see Chapter 5 for a more in-depth analysis). Likewise, experts suggested that the flow of communication, notification and feedback is essential to prevent and manage FBD. However, the lack of communication in the socio-technical system and across all levels impeded coordination and cooperation during the outbreak. Inefficient communication also hinders individuals from taking the necessary measures to prevent the occurrence of events leading to the incident.

Chapman *et al*. (2010) discussed the positive influence on hygiene behaviours through signage, posters and info sheets. The use of these artefacts also underlies the vital importance of food safety communication and any strategy designed to accomplish food safety behaviour. Poor instruction of managers to deliver and demonstrate proper food safety behaviour and communication interfere with food safety performance (Chen *et al.*, 2015; Lee *et al.*, 2013).

Conversely, commitment from managers is a critical driver of food safety performance, which might motivate other employees to food safety practices executions. Moreover, this willingness to follow safe food behaviour is emphasised when they superiors observe others following safe food practices (Arendt *et al.*, 2011). Food safety communication as a systemic failure reveales the negative or reactive prevailing food safety culture in a food business (Griffith et al., 2010). Communication and the flow of information and feedback across the system levels strongly affects food safety performance. Therefore, improving communication between regulators, health authorities, the hotel industry, and other stakeholders is crucial. An effective communication culture can enhance the notification and surveillance systems by including data from the communication of multiple sources, such as hotels, local businesses, and national surveillance laboratories. The stakeholder communication and findings from the survey shed light and more details on these communication issues and food safety practices with visual and written communication (e.g., posters) about expected behaviours and descriptions in the hotel premises, considered not relevant to ensure food-safe behaviour by the experts interviewed (Chapter 6). This could be related which the literacy of the staff and employees, the low educational level of the staff.

## 7.4. Place focus: Considered the organisational workplace and managerial aspect of FBD outbreaks controls

The common unsafe practices identified through the data examined include improper food handling practices, lack of proper hygiene, inadequate sanitisation, equipment and utensils hygiene, and inadequate food storage. This failure in hygiene and sanitation behaviours and practices was constant in this study. However, each outbreak examined provides different layers as to where these unsafe practices were an issue. Similar to the finding of this study, negative personal hygiene and unsafe attitudes toward food safety control and sanitation practices are a concern (Da Cunha et al., 2014; Ko, 2013). The low level of hygiene and safety procedures on some hotel' premises make it complex reduce the risk of FBD outbreaks. Djekic *et al.* (2014) explained that in mitigating food safety hazards in food service establishments, achieving an acceptable food hygiene level is mandatory.

It was observed in this study that multiple factors led to the NoV outbreaks and created conflicts limiting the implementation of FSMS. Systemic failures such as lack of regular monitoring of the water supply quality, inadequate wastewater management and ineffective communication

led to each FBD incident across the hierarchical levels within a socio-technical system (Díaz De Oleo et al., 2022b). These factors were mainly associated with the organisation's government and physical/individual levels. Failure at the government level and the managerial action and decisions made at that level contribute to the food safety performance of the hotel and wider hospitality sector. Despite a given hotel's premises being geographically and organisationally distant from the governmental structure, the decisions made at regulatory level influenced the hotel's food safety outcomes. Deficiencies in organisational and government management burden the local government authorities to force them to work efficiently without adequate physical structures and human resources.

The first chapter of this study detailed the COVID-19 pandemic's effects on the DR tourism industry and its socio-economic development contribution to the country. However, the findings gathered from the stakeholder investigation in this research offered a fresh health and food safety perspective. The survey explored food hygiene, cleanliness and sanitation practices as important factors and how these have been executed in hospitality settings in the DR since past FBD outbreaks and the COVID-19 pandemic. It is relevant, first because the COVID-19 stay-at-home restrictions and lockdowns impacted this study. Secondly, the hospitality sector, primarily hotels, was directly affected by COVID-19 and the actions taken to constrain the outbreak. Consequently, this study aimed to identify which food hygiene, safety practices and management during and after the epidemic were relevant and implemented in the hotels. According to (Hao *et al.*, 2020; Jiang and Wen, 2020), food safety protocols, hygiene and sanitation have become the main focus in hotels. However, this study found that before and during COVID-19, there was no significant difference in the changes in food hygiene practices and safety controls. Activities such as appropriate surface sanitisers for food contact surfaces and frequently sanitising human touch areas, such as door handles and elevator buttons, were not implemented to maintain hygiene and safety after the lockdowns. These hygiene and food safety practices, among others, are relevant to any food safety hazards from a microbiology origin.

The initial literature review identified the water system as a potential risk and the most important potential source of FBD agents when analysing different FBD outbreak reviews. The findings of this study identified water supply, potable water and its quality as the most probable routes for transmission in the DR (Doménech-Sánchez et al., 2009, 2011) Fish poisoning outbreaks (CFP caused by ciguatoxins) were high in hotel settings associated with seafood, fish

consumption, and wastewater pollution. Wastewater issue management was also associated with underground water being contaminated by sewage through infrequent inspections and controls over the water supply sources and treatments (Brown *et al.*, 2001; Jack *et al.*, 2013; Ministerio de Salud Pública, 2016). Findings from this research evidenced that systemic failure in the organisational system due to poor risk management and little concern about water management led to a failure to safeguard the proper treatment of the drinking water supply and wastewater system. Furthermore, an agreement about the importance of this subject was confirmed by the experts with unanimity in terms of the importance of water management strategies along with other aspects that need to be implemented by government authorities, regulators, and hotel owners to prevent a food or waterborne outbreak.

This study found that FBD outbreaks in the hospitality sector in the DR were also associated with cross-contamination, which was discussed in (Chapters 2 and 4). Findings prove that the hygiene and food safety layout was not considered a vital element in the food safety practices and prevention of FBD according to the stakeholder's responses. This result indicates that poor performance in hotels kitchen and facilities, could be influenced by underestimating risk from the facilities' design and equipment. As outlined by Djekic *et al.* (2014), inadequate food hygiene and safety procedures are reinforced by a poor layout in food service facilities. This study's relevance was on using different methods to capture a deeper understanding of these interconnected resources that influence food safety outcomes because inadequate physical layouts do not support safe food practices on the premises (Famah *et al.*, 2014). The significance of hygiene and safety layout is also evident when it was included as a dimension to assess FS-culture by (Jespersen *et al.*, 2016). Fujisaki and Akamatsu (2020) also developed an assessment scale to evaluate FS-culture where facilities and equipment were among the sub-scales used in the assessment.

### 7.5. People focus: Staff health and hygiene, staff training

The lack of training was found in this study to be a systemic contributory factor which led to FBD outbreaks where at the organisational level there were inconsistent training programmes and little risk awareness by the employees. Therefore, this study asserts that in the hospitality setting in the DR, risk awareness and perception of risk should be enhanced among hotel staff, food handlers, managers, and cleaners. Food safety risk awareness is vital in food safety management (Taylor and Rostron, 2018) and its embedding within business practises

influences food safety performance (Griffith *et al.*, 2010b). For instance, the systematic mapping exercise showed that in the hospitality sector in the DR, the lack of hygiene or care in food handling is the most prevalent factor responsible for the contamination of the food (Jiménez *et al.*, 2011; Newton *et al.*, 2011; Sanner *et al.*, 1997; Thompson *et al.*, 2017). Furthermore, poor knowledge regarding infectious diseases observed in the work environment leads to hotel staff performing their duties with unsafe hygienic behaviours, and inadequate cleaning and disinfection in common areas and cross-contamination on the hotel premises. The findings demonstrated that individuals, e.g. health officials, managers, and hotel staff, have limited knowledge of good hygiene and food safety practices where FBD outbreaks occur. Perhaps low education level and low literacy levels also compromise food safety management. Consequently, from a stakeholder perspective, experts in the survey perceived artefacts as being of limited value in influencing food safety practices. Instead, experts suggested there should be reliance on training about cleaning, disinfection procedures, promotion of proper hand hygiene, training new staff and refresher training. The pre-existing levels of training and educational level will also influence the motivation of staff to adhere to food safety practices.

## 7.6. Summary

Another important finding in this research was that the understanding of FBD and its occurrence in the hospitality sector is limited if only considered from a cause-and-effect perspective and from what can be observed. However, adopting different triangulation methods in a mixed-methods approach agrees with the De Boeck *et al*. (2019) conclusion that combining data collection methods leads to a deeper understanding of FS-culture in the organisation. Despite the differences in data collection methods which are applied to verification, monitoring data, internal audits and the use of food safety climate self-assessment tools is of interest. However, the present study considered the limitations of food safety data related to records, logs, audits and inspections in hotel settings where there are advantages and drawbacks to combining data. The mixed-methods triangulation approach allows for a more comprehensive evaluation of the current food safety practices and prevailing FS-culture. Other research adopts a mixed-methods approach using observations and microbial analysis aim to assess the behaviour and microbial safety performance (Nyarugwe *et al.*, 2018). However, this research project was restrained from adopting direct observation due to COVID-19 restrictions and microbial analysis data is often lacking in less developed economies countries, as was discussed in Chapter 2.

This led to a reflection on the development of triangulation approaches when there is limited evidence.

The current research used the integration of multiple streams of data from past and present sources, identifying relevant pathogens from the document analysis through the systematic mapping review and AcciMap. A critique of similar research adopting mixed-methods is the challenge to address the deeper levels within the organisation (Nyarugwe *et al.*, 2016). Current research indicates that the mixed-methods approach provides insight into the visible aspect and perceived values of the prevailing FS-culture (Zanin et al., 2021), but by inference, this means that the unobservable elements of the culture or isolated contributing factors are not assessed  The systems approach used in this study offers a holistic approach to show the interaction, interdependency and interrelationships between the actor(s) at play and the elements of FS-culture, food safety management and food safety governance where weaknesses can occur. In this regard, the limited analysis of a cause-and-effect approach to analysing food safety incidents and FBD outbreaks can be addressed holistically through systems level analytical approaches such as the AcciMap.

By focusing beyond the linear associations, contextual or task-related factors in the wider socio-technical system can be identified that would otherwise often be ignored. A more rigorous systemic approach should be undertaken to capture a broad and deeper understanding of factors associated with FBD outbreaks. Furthermore, through a socio-technical lens, it is considered that the individual and organisational decisions and actions that could trigger an FBD outbreak are associated with contributory factors across all levels, from the government to individuals within a socio-technical system. Assessing and identifying these multi-level contributory factors is essential to prevent FBD outbreaks in the tourism sector in the DR.

Another important point to discuss from the findings of this research is that it was revealed that FBD outbreaks are complex and result from both anticipated and unanticipated chains of events and decision-making within a flawed socio-technical system. Results in this research align with published factors that are associated with FBD outbreaks and their complexity (Nayak and Waterson, 2016; Vicente and Christoffersen, 2006; Waterson, 2009; Woo and Vicente, 2003) and these systemic failures are not obvious when seen in isolation. However, multiple factors at specific levels were identified in this research when considering the whole sociotechnical system as an integrated unit. The interconnections and interactions across and between all

levels in the socio-technical system all can contribute to an FBD outbreak, and the different decisions and events that occur at different system levels. The findings of this study disagree with the research studies that emphatically point to an isolated cause, such as food handlers (Costalunga Lima *et al.*, 2013; Odonkor and Odonkor, 2020; Pichler *et al.*, 2014; Sharma *et al.*, 2021) as the main reasons for a FBO outbreak. In the same way, the findings of this research do not agree with or support isolated recommendations to prevent FBD outbreaks if these recommendations are not drawn from an evaluation and analysis of the entire organisational sociotechnical system beforehand. This study's findings state and conclude that an FBD outbreak does not generally occur as the result of a single causal incident, but rather as a chain of events that can lead to a food safety/public health incident. Therefore, adopting food safety management systems without first evaluating the socio-technical levels and interactions from a broader perspective will be limited in their efficacy and can fall short of improving the management and elimination of the food safety issues of concern. This finding is significant as all the levels involved in managing and controlling food safety and preventing FBO outbreaks are functionally positioned at different levels of the socio-technical system. Activities and interventions are carried out through the measures and tools available at that specific level, such as regulation and/or food handler instructions. This research contributes to food safety-related knowledge by presenting the functional importance of looking at the big picture to analyse the sequences of events contributing to FBD outbreaks and uncovering the potential contributory root causes of an outbreak and their interactions among and across the levels in a complex socio-technical organisational system.

The final chapter of the thesis will provide the conclusions and recommendations that arise from the study with specific focus on the DR.

# CHAPTER EIGHT: CONCLUSION AND RECOMMENDATIONS

## 8. Introduction

Will detail which guidelines and food safety strategies must be implemented holistically across the system's government, regulatory, and management physical/people levels. Furthermore, in an attempt that these strategies become a long-term habitual behaviour towards food safety of all actors involved in the hospitality sector in the DR. Finally, the section will summarise some of the conclusions and limitations faced in the research and suggest recommendations for future work.

### 8.1. Research objectives

The aim of this research is to assess the effectiveness, sensitivity, and appropriateness of systems-based approaches to explore and reflect on FBD outbreaks associated with the hospitality sector. The study will inform policy development, especially in developing economies such as the DR.

The specific research objectives are:

- To critically review selected sources and extract the available information related to the FBD outbreaks in the tourism and hospitality sector with particular focus on the DR.
- To apply systems-based methodological approaches to identify the contributory factors that influence food safety management, hygiene practices and operational practices in the hospitality sector. Furthermore, this objective also encompasses a critical assessment of the multiple contributory factors, and to try to reveal their interrelationships and their impact on the FBD outbreaks.
- To use a stakeholder investigation to evaluate expert opinion about factors, such as hygiene, management and food safety practices, and in combination with the findings of the previous phases of the study to propose practical recommendations for prevention and reduction of FBD outbreaks in the hospitality sector of the DR.

### 8.1.1. Research Objective One

In this research, the first chapter outlines the motivations of the study and then develops the research questions to guide the focus of the study, outlines the objectives and methodology used and provides a brief overview of the contributions of the research. The philosophical assumption on which this research was conducted is pragmatism. The pragmatic view supports a pluralistic approach to derive knowledge about a problem and then provide practical solutions on how to effectively address FBD outbreaks in hospitality settings in the DR. Three individual studies were conducted to attain this goal. The research journey started with systematically reviewing existing literature on the tourism sector in the DR in Chapter 1 and then food safety systems, system approaches and socio-technical approaches in Chapter 2. The study then introduced the rationale to shift the paradigm of assessing FBD outbreaks and food safety issues beyond the conventional approach to consider cause and effect, blame often for human error, behaviours, and what technical and organisational processes could be applied to improve food safety. As a result, an alternative perspective, the system approach to accident (incident) analysis formed the basis of the second element of the study.

The initial research question was:

What food safety and related outbreaks have affected the hospitality sector in the DR?
The first objective was to determine the evidence of reported food safety incidents in hospitality settings. Therefore, the mixed method approach adopted a systematic mapping review (study 1, Chapter 4) that provides evidence and insights into the current state of traveller-related FBD outbreaks in the hospitality sector (Objective 1). The study used secondary data from multiple electronic databases and also the grey literature available. The researcher observed that the frame of food safety hazards in the hospitality sector is diverse. However, according to the existing literature and the evidence available, this study was limited to retrieving microbiological hazards as the common risk to which locals and foreign visitors are exposed in Chapter 1.

### 8.1.2. Research Objective Two

The second research objective was to determine the extent to which unsafe practices in food handling and other safety decisions account for failures found in the literature and in the extracted information and findings from the systematic mapping review of the first study. The

system-based approach applied an AcciMap model (Chapter 5) to convey rich and in-depth information about the contributory factors, relationships and interconnections among different levels of particular FBD outbreaks (Objective 2). The etiological agent that was the focus of this phase of the study was Norovirus. This was due to the need for extensive publicly available information in the cases that were analysed using the AcciMap approach. The evidence analysis through applying the AcciMap technique depicted the big picture of multiple systemic failures contributing to the specific FBD outbreaks selected for this study. In addition, the system based-approach effectively explored the internal and external organisational characteristics influencing the FBD outbreaks considered.

### 8.1.3. Research Objective Three

Both of the previous two studies' findings identified key elements used to explore the stakeholders' perspectives on the relevant food safety, hygiene and practices for hospitality settings in the DR (Objective 3). The empirical study surveyed participants with relevant expertise in food safety related to the hospitality sector. Results from this approach allow the researcher to get deeper insights based on the previous findings and put in context the possible reasons why relevant food safety practices, according to regulators, auditors, educators and hotel staff, are not always adopted effectively on hotel premises. This study has uncovered a complex interrelated interaction that influences the food safety performance from actions, decisions and behaviours at a different level in the socio-technical system. The mixed-methods approach and especially the systems approach revealed insights regarding the stakeholders in the hospitality sector's knowledge and attitudes towards current food safety practices. Table 8.1 summarises the key research conclusions considering the 'problem' at each socio-technical level. Based on the majority of findings, the systemic failures identified and, therefore, the levels to focus resources on to address improvement of the country's food safety governance, management systems and performance.

*Table 8.1 Summary of conclusions derived of the findings in this thesis considering the socio-technical system and failures identified.*

| System level | Conclusions |
|---|---|
| **Government Regulatory bodies** | **Inadequate oversight and planning of food safety governance** |
| | From the governmental level, It was found that the majority of food safety hazards observed during the three studies in the research, suggest a need for research and more scientific and structured food safety investigations within the DR to address and manage food safety risks. More robust investigations will provide evidence for informed decisions to control and reduce food safety incidents, FBD outbreaks and improve the country's food safety performance, especially in the hospitality sector. Across the socio-technical levels, there is limited understanding of food safety risks and noncompliance that arises is related to regulatory inconsistency and a lack of regulatory oversight from both the regulated and the regulators.<br><br>Weaknesses in the food safety governance with the application of food safety guidelines, regulations, initiatives, enforcement and compliance are subsequently a public health risk. In addition, there is a weakness in the current evaluation, and inspection programmes and follow-up and corrective actions from the national, local government and management levels in food business operations. Moreover, the food safety assessment observed that in government authorities and hotels in the DR, food safety practices are not considered important regarding the hotel's business and brand recognition. Moreover, there is a lack of collaboration in sharing safety information among the health and local authorities and hotel owners. |
| **Organisational/ workplace** | **Supervisory violations and poor communication affecting operational management** |
| | In the hospitality sector in the DR, the findings indicated a poor commitment to food safety by all the actors from the top to the bottom sociotechnical level. Inside the hotel premises, this study shows where there is a lack of consistency in management on how food safety decisions are made, this has implementation for food safety controls, food |

| | |
|---|---|
| | safety practices and training. For instance, in the workplace, there was an absence of food safety management on hotel premises by the government and hotel operations. The lack of food safety communication across systemic levels in the NoV outbreaks such as with government, management and front-line staff, was a typical significant finding. The ineffective exchange of information and skills by expert bodies involved at different levels of the system is also detrimental to performing more reliably rapid and appropriate decision-making. |
| **Physical individual events, process and conditions** | **Failure to address and follow food safety practices**<br>The key findings in this research indicated little risk awareness and understanding of food safety and food safety risk across the sociotechnical systemic levels in the hospitality sector in the NoV outbreaks. This research raises a concern about whether employees in this critical sector for the DR's economy receive regular food safety training. Inadequate training by key personnel at the government, local and management levels, such as food inspectors, food safety managers and shop-floor employees, is a barrier towards achieving food safety. |

## 8.2. Recommendations

The recommendations that arise from this study were developed from a socio-technical viewpoint, i.e., that FBD and food safety more generally need to be managed in a systems-based approach. These recommendations can assist every stakeholder in the hospitality sector in implementing a holistic strategy to improve the country's public health and food safety performance and adapt the findings of this research in a comprehensive way that the government and regulators can use in the local context to inform national food safety policy. Generating better food safety standards and guidelines to implement in the hospitality sector will improve public health and food safety compliance in these settings and protect visitors' health and wellbeing. Figure 6.1 contains a series of study recommendations these have been characterised in terms of the policy focus, place focus and people focus themes highlighted in the previous chapter.

*Table 8.2 Description of potential recommendation to each socio-technical level.*

| System levels | | |
|---|---|---|
| **Policy focus: Government Regulatory bodies** | **Place focus: Organisational/ workplace** | **People focus: Physical individual events, process and conditions** |
| Government food safety national regulations reforms should be focus in adopting a risk-based compliance approach. | Enhance managers understanding of food safety and related regulations to hotels premises | Improve the perceptions and responsibility of the employee's food safety practices |

In accordance with what is stated in this research, the food safety regulations and legislation in the DR should be reviewed to support changes and improvements. The changes could be made based on integrating concepts such as a system approaches and governance based on an understanding of the interactions in the food safety related socio-technical system. As was evidenced in this research, a system-based approach will help to manage and prevent, in a broader approach, all the identified systemic failures related to hygiene, water management, food safety practices and operational management. The system approach and better food safety guidelines that consider all stakeholders and their role in reducing FBD outbreaks will improve the country's national, regional and local food safety and control systems.

In addition, government driven reforms of food safety national regulations should be focused on adopting a risk-based compliance approach. It is vital to emphasise and enhance food safety understanding at the management level. Food safety knowledge will significantly support managers/supervisors and employees' food safety attitudes and behaviours. Focusing on the middle level of the organisational system improves the perceptions and responsibility of the employee's food safety practices. A food safety training manual can be adopted to instruct food safety in business operations. However, implementing national practices, principles, guidelines, standards, and agreements governing food safety systems will be successful if stakeholders receive ongoing training, public education, and awareness of the existing national and local guidelines and food safety strategies.

All the identified hygiene, food safety practices and management in this study are necessary to manage and prevent food safety incidents in the hospitality sector in the DR. Notably, the research has shown that water and wastewater management is critical among all aspects and should be a priority for all stakeholders involved in the tourism and hospitality sector. The recommendations that arise from this study were developed from a socio-technical understanding, which could lead to more effective measures and plans for improving food safety and preventing similar events in the future related to water supply and wastewater management (Table 8.3).

*Table 8.3 Water and wastewater management recommendations corresponding to the specific level of the system.*

| System level | Water supply and wastewater management Recommendations |
|---|---|
| **External** | • Advocate the use of evidence-based practices |
| **Government** | • Review and elaborate policies and specific plans for the national operation of safe drinking water and wastewater.<br>• Develop multi-agency collaboration of institutions monitoring and surveillance of the quality of drinking water and waste management in the country (MA, MSP, INAPA).<br>• Increase resources for risk management programmes to reduce deficiencies in water sanitation and focus on deficiencies in water sanitation.<br>• Provide an informative platform that supports planning and contributes to the development of its efficient management. |
| **Regulatory bodies** | • Strengthen specialist skills and knowledge and technical support to ensure compliance with this policy and legislative requirements.<br>• Target regular, relevant and standardised cross-disciplinary training and education for all regulators.<br>• Monitor and inspect water quality and wastewater programmes and their effectiveness.<br>• Adherence to the national standards of water regulation for human consumption and water discharge control. |

| | |
|---|---|
| **Organisational workplace** | • Improve the health, environmental and hygiene education in hotel premises to contribute to the development of good practices and water culture.<br>• Develop and implement a programme to improve the knowledge of general managers, operational staff, kitchen and chef food handlers, concierges, maintenance personnel, and technician employees on the safe operation of the water supply system and wastewater operation.<br>• Provide guidance on acceptable and unacceptable behaviours and instruction on the reporting of incidents appropriately.<br>• Provide quality control procedures in the handling and analysis of water samples.<br>• Provide safe drinking water and effective drainage and waste disposal systems and facilities. |
| **Physical individual events, process and conditions** | • Implement communication and awareness mechanisms on the use of water, sanitation, and hygiene services.<br>• Implement educational campaigns for proper management and use of waste to avoid uncontrolled dumping.<br>• Train and designate those responsible for monitoring the quality of sources of drinking water (early warning system) and for the maintenance, chlorination and care of the facilities.<br>• Provide quality control coverage of treatment plants discharging sewage water. |
| **Outcomes** | • Effective control and management of drinking water, wastewater. |

Many of the findings reflect the fact that food safety management in hotel premises can be compromised by poor conditions, minimal operating controls, and low maintenance levels of the treatment plants and purification systems by the government and hotels operations. Furthermore, hotels without adequate sanitation systems and unregulated sewage discharge can create severe problems for individuals which can lead to FBD outbreaks. The recommendations provided are not limited to a specific cause and effect failure but have attempted to address all the contributory difficulties that are encountered at different levels of a socio-technical system that can lead to a FBD outbreak. The water and sanitation sector's

normative and policy formulation functions are highly fragmented involving several public and private agencies. Therefore, improving water systems and waste management will involve good communication between the different management system levels for adequate adherence and implementation of the current standards and regulations. This requires the engagement and cooperation of all the agencies regulating the water system and discharge control in the hospitality sector in the country. This good communication will also require the exchange of information and skills by expert bodies involved at different levels of the system to allow the team to perform more reliably and guarantee rapid and appropriate decision-making.

### 8.3. Limitation and recommendations for future work

This research has been systematic and pragmatic, using multiple methods in order to achieve the research objectives. However, some limitations have been found that might be addressed in future research work. The methods in the mixed-methods approach in study 1, Chapter 4 and study 2, Chapter 5 were flexible and accessible methods to gather data through several databases as desk research. Furthermore, they were efficient and effective regarding time, travel restrictions, lockdown restrictions, and cost during the COVID-19 pandemic disruptions. The first limitation is the dependency on secondary data, internet-based and publicly available data. If the methods do not exhaust every source of information, the data availability is limited and/or retrieval methods are not effective enough, or of low quality, this could influence the robustness of the findings. However, the specific PhD study design its strengths and limitations were addressed in detail in Chapter 4. A second limitation of this study was the level of thoroughness and insightfulness needed within the analysis stages of the different studies integrating quantitative and qualitative data. This requires a level of skill from the researcher. However, the sequential approach and the use of data analysis at different stages of this study did not represent an obstacle in terms of data triangulation.

Reflecting on the analysis process, in hindsight, it could have been possible to reduce the risk of researcher bias and subjectivity to some extent. For instance, a reflexive diary or journal could have been used. The journal is a simple but valuable practice that should have been used in the research, with more emphasis on the data analysis stage, which was the overwhelming and laborious part of the research. Using a reflective journal could have helped identify difficulties, challenges, and means to solve them, as well as assisting in critical decision making. Further, a journal could have provided evidence and details of the method of analysis

in light of the novelty of applying to FBD outbreaks and the researcher having limited experience in their use. Additionally, using the journal could enhance methodological rigour and robustness with the analysis and ensure research ethics are complied with.

Some limitations were also faced in the third (empirical) study related to the recruitment of participants and the possibility of response bias. If travelling around would have been possible at the data collection stage in this research, it would have been possible to undertake face-to-face interviews in the stakeholder investigation rather than an online survey. Thus, incomplete responses to some questions in the online questionnaire would have been avoided. Another limitation is that experts might not disclose information that could negatively impact their respective organisations, despite being assured of anonymity. Some participants felt more compelled to participate due to prior relationships with the researcher. There was low engagement from experts affiliated with international hotel chains. As a result, results from the stakeholders did not adequately capture the sector's opinions. In order to have a more representative sample size to minimise such limitations, another sample strategy should be adopted for participant recruitment in the future.

There is also a limitation in the ability to generalise the current research findings based on the specificity of the conducted solely in the DR; the data collection in the first two studies Chapters 4 and 5 was not primary data and did not involve recent or updated data; therefore, does not capture the current reality. In addition, the questionnaire developed in the study Chapter 6 was developed from findings of previous studies focused on the hospitality sector in the DR. This means that the ability to generalise the findings to other hotel settings or regions is limited. Future avenues of research in FBD and food safety management might extend these findings in a different context or sampling, research method and unit of analysis. However, it will be interesting to see how the results of these findings can be further developed. Moreover, researcher in food safety might extend these findings with field research in water and waste management in the hospitality sector in the Caribbean. Undertaking empirical research, participant observations and microbiological sampling and confirm the compliance of the hotel's management with the water regulations would be useful. This work could be further developed and extend the scope of the systematic mapping and identify if there are other food safety hazards that might affect visitors and locals using a similar approach to uncover casual and contributory factors.

The evaluation of external organisational influence in the socio-technical system could be further evaluated. For instance, the use of the system approach to evaluate and test some of the current food safety assessment tools and compare the results of the ability or effectiveness of the AcciMap alone to examine how many FS-culture dimensions and elements this model can evaluate. The current research provides insights into some cultural dimensions. However, future research could design a framework adapting the AcciMap as an approach to reinforce FS-culture. therefore, these findings could lead to the development of a tool kit to evaluate FS-culture in the hospitality sector in the DR, and more widely.

### 8.4. Summary and personal reflection

This chapter presented the overall research conclusion. The conclusion of the research was driven to inform and guide the development of food safety governance in the DR. Applying a mixed-methods approach with a particular emphasis on the system approach successfully achieved the research aims and objectives. The suggested recommendations could lead to applying a holistic approach to improve the country's food safety outcomes, reduce the occurrence of FBD and protect the national tourism and hospitality economy and make a contribution to public health. It also provides insight into the future direction for insightful research in food safety and FS-culture.

To meet the objectives of the research and to provide an answer to the research question the researcher needed to upgrade their critical, creative, and analytical thinking and expertise in social research methods. This improvement was possible due to the commitment of the supervisory team and the extensive expertise in the team that was made available to the researcher in a one-to-one meeting with on-going assistance and close follow-up of the preliminary analysis at each study stage. The mixed-methods approach applied in this research has strengthened my hard and soft analytical skills immersing myself and thinking about what the issues, key questions, what people think about this subject, what I do need to think about this, what I do want to find out. Mastering the iterative process of reflection and being reflexive informs the thinking, analysis and presentation of research findings. Training is vital when looking at research questions holistically and analysing the data, causal and contributory factors, interrelationships and connections of systemic failures leading to FBD outbreaks.

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# 10. APPENDIX

## 10.1. Informed Consent Form.

# Informed Consent Form

I am Dileyni Diaz De Oleo, a Postgraduate Researcher in Food, Land and Agribusiness Management Department at Harper Adams University. I can be contacted at ddiazdeoleo@harper-adams.ac.uk. Currently, I am working on my research regarding food safety practices in the hospitality sector in the Dominican Republic. Predominantly, this research is based on experts consultations and views in hospitality sector.

This stage of the research aims to identify which hygiene and food safety practices are relevant for the prevention of foodborne disease in hotel premises. It involves online survey based on the Delphi technique.

Initially, online survey with the experts in hygiene and food safety practices in the hospitality sector will be conducted. Furthermore, if this research will need some more details, participants will be contacted again for further interviews.

The survey should take no longer than 15 minutes, and participation will be completely voluntary, and respondents will be free to withdraw from the research at any stage of the interview and can ask recordings to be deleted prior to the merge of transcribed data. It is not envisaged that there are any risks to participants arising from involvement in the study.

All respondents will be anonymised. No company or individual will be identifiable in any form of reports. Data will be stored in HAU's password protected cloud drive and will be stored for the duration of the study period. On completion of the study, the data collected will be deleted.

By submitting your response, I will assume that you have read the above statement and consent to the data being uses in this study and for potential publication.

I would really appreciate your contribution in my academics and also for my country by filling this survey.

If participants have concerns about this study and wish to contact an independent person, please contact: Dr Lynn McIntyre BSc (Hons), PhD, FHEA
Senior Lecturer in Food Safety
Department of Food, Land and Agribusiness Management
Harper Adams University
Email: lmcintyre@harper-adams.ac.uk

Thank you very much for taking the time to participate in this questionnaire!

## 10.2. Plain Language Statement

### Plain Language Statement

I am Dileyni Diaz De Oleo, a Postgraduate Researcher in Food, Land and Agribusiness Management Department at Harper Adams University. I can be contacted at ddiazdeoleo@harper-adams.ac.uk. Currently, I am working on my research regarding food safety practices in the hospitality sector in the Dominican Republic. Predominantly, this research is based on experts consultations and views in hospitality sector.

This stage of the research aims to identify which hygiene and food safety practices are relevant for the prevention of foodborne disease in hotel premises. It involves online survey based on the Delphi technique. It is envisaged that primary data collection will take place March 2022.

Initially, online survey with the experts in hygiene and food safety practices in the hospitality sector will be conducted. Furthermore, if this research will need some more details, participants will be contacted again for further interviews.

These interviews will be conducted either online or face-to-face depending on the situation regarding travel risk. If physical travel is deemed appropriate, a risk assessment with Health and Safety officer at Harper Adams University will be conducted prior to the travel. The contingency plan will be online meetings on Microsoft TEAMS.

Participation will be completely voluntary, and respondents will be free to withdraw from the research at any stage of the interview and can ask recordings to be deleted prior to the merge of transcribed data. All interviews will be fully transcribed and no commercially sensitive information will be disclosed. All respondents will be anonymised. No company or individual will be identifiable in any form of reports. It is not envisaged that there are any risks to participants arising from involvement in the study. It is not envisaged that there are any risks to participants arising from involvement in the study.

Data will be stored in HAU's password protected cloud drive and will be stored for the duration of the study period. On completion of the study, the recordings will be deleted.

If participants have concerns about this study and wish to contact an independent person, please contact:

Dr Lynn McIntyre BSc (Hons), PhD, FHEA
Senior Lecturer in Food Safety
Department of Food, Land and Agribusiness Management
Harper Adams University
Email: lmcintyre@harper-adams.ac.uk

Thank you very much for taking the time to participate in this questionnaire!

### 10.3. Online Survey stakeholders' consultation

**A Delphi Style Approach to evaluate expert opinion towards relevant and appropriate good hygiene and food safety practices in hotel premises.**

**Your informed Consent**

I am Dileyni Diaz De Oleo, a Postgraduate Researcher in Food, Land and Agribusiness Management Department at Harper Adams University. I can be contacted at ddiazdeoleo@harper-adams.ac.uk. Currently, I am working on my research regarding food safety practices in the hospitality sector in the Dominican Republic. Predominantly, this research is based on expert's consultations and views in hospitality sector. This stage of the research aims to identify which hygiene and food safety practices are relevant for the prevention of foodborne disease outbreaks in hotel premises. It involves an online survey based on the Delphi technique.

Initially, an online survey with experts in hygiene and food safety practices in the hospitality sector will be conducted. In addition, there is a second phase if experts indicate they are willing to take part that participants will be contacted again for further interviews.

This online survey should take no longer than 20 minutes, and participation will be completely voluntary. Respondents will be free to withdraw from the research at any stage including the interview and can ask that recordings of the interviews are deleted prior to the merging of transcribed data. It is not envisaged that there are any risks to participants arising from involvement in the study.

All respondent's data will be anonymised. No company or individual will be identifiable in any form of reports. Data will be stored in HAU's password protected cloud drive and will be stored for the duration of the study period. On completion of the PhD study, the recordings will be deleted.

By submitting your response to this survey, it is accepted that you have read the above statement and consent to the data being uses in this study and for potential publication.

I would really appreciate your contribution to my study and also for my country in how they develop their food safety governance in the future.

If participants have concerns about this study and wish to contact an independent person, please contact: Dr Lynn McIntyre BSc (Hons), PhD, FHEA
Senior Lecturer in Food Safety
Department of Food, Land and Agribusiness Management
Harper Adams University
Email: lmcintyre@harper-adams.ac.uk

Thank you very much for taking the time to participate in this questionnaire.

**1. Please click yes to confirm that you have read the above and given your informed consent to participate in this study.**
Yes

## Demographic information

**2. Which country are you living in? _____**

**3. What would best describe your area of expertise? Please click all that apply**
Food safety
Food science
Risk assessment
Planning and policy implementation
Hospitality Management
Other

**4. How many years of experience do you have in food safety/good hygienic practice/public health/regulation?**
Less than 1 year
2 to 5 years
6 to 10 years
Over 11 years

**5. What is your institutional affiliation with your current job role? Please click on one response.**
Educational institution
Hospitality/food service sector
Hotel chains specifically
International organisations
Private consultation company
Regulatory institution
Research institution
Other

## General Good Hygiene Practices (pre-covid/during)

**6. Indicate which of the following elements of cleaning and disinfection procedures in common areas are/were usually implemented in a hospitality environment prior to any Covid-related protocols having been introduced. Click on a number from 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented 4= very likely to be implemented, and 5= always implemented.**

Daily cleaning of common areas
Disinfection routinely of food contact areas
Disinfection routinely of bathrooms, toilets and high hand-contact areas
Disinfection of surfaces and contact areas such as telephones, and handrails.
Disinfection of floors, or walls
Monitoring the effectiveness of the cleaning and sanitation procedures (audits, inspections)
Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning
Regular cleaning and maintenance of water systems especially water storage
Strengthening of the procedure for decontamination during an outbreak, e.g. cleaning and disinfection of rooms associated with sick people

**7. Indicate which of the following elements of cleaning and disinfection procedures in common areas are usually implemented in a hospitality environment during the Covid pandemic. Click on a number from 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented 4= very likely to be implemented, and 5= always implemented.**

Daily cleaning of common areas
Disinfection routinely of food contact areas
Disinfection routinely of bathrooms, toilets and high hand-contact areas
Disinfection of surfaces and contact areas such as telephones, and handrails.
Disinfection of floors, or walls
Monitoring the effectiveness of the cleaning and sanitation procedures (audits, inspections)
Regular cleaning and maintenance for air filters, ventilation systems or duct cleaning
Regular cleaning and maintenance of water systems especially water storage
Strengthening of the procedure for decontamination during an outbreak, e.g. cleaning and disinfection of rooms associated with sick people

**8. Indicate which of the following aspects of good hygienic practice in food preparation areas, kitchens and restaurants are usually implemented in a hospitality environment. Click on a number from 1 to 5 for each statement where 1= not implemented, 2= very unlikely to be implemented, 3= likely to be implemented 4= very likely to be implemented, and 5= always implemented.**

Adoption of appropriate time/temperature controls
Cleaning and sanitising training for staff
Consideration for handwashing stations (Handwashing sinks and automatic handwashing facilities)
Designing areas to ensure the appropriate layout
Goods inwards food inspection procedures
Implementation of written standard operating procedures
Preventive measures for cross-contamination
Safe food-handling practice

## Professional appraisal of good hygienic practise in the hospitality business

**9. Indicate which of the following elements should be included in a good hygienic practice guide for procedures that need to be in place in a hospitality businesses. Click on yes or no for each item for the Staff and hygiene section**

Good hygiene personal practices protocol
Protocols for cleaning/disinfection of tools, equipment
Clearance for health return-to-work policies protocol
Adequate layout for hygiene facilities e.g. wash basins, lavatories changing facilities
Sanitiser and equipment purchasing protocol
Personal Protective Clothing (PPE) protocol

**10. Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. Click on yes or no for each item for the staff training section.**

Cleaning and disinfection procedures
Induction training guide
Guidance for employee refresher training
Guidance on training in basic handwashing and promotion of proper hand hygiene
Guidance on developing employee food safety training
Guidance for provision of a staff handbook addressing principles of food safety and hygiene
Guidance for signage/posters about expected behaviours and descriptions

**11. Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. Click on yes or no for each item for water supply section.**

Guidance on ensuring an adequate supply of hot and/or cold potable water
Policies for adherence to water national regulations
Guidance on appropriate facilities for water storage
Policies for regular inspections of water quality and records
Policies for regular sanitation of water storage systems
Policies for residual chlorine monitoring at critical points in water systems
Guidance on the proper use of potable and non-potable water
Guidance on the sanitation of drinking fountains
Guidance for signage for the proper identification of potable water and non-potable water systems
Guidance for standards for implementation of different water treatment processes (e.g. filters, reverse osmosis, ozone)
Guidance on the use of water system pipes of the correct hygienic design

**12. Indicate which of the following elements should be included in a good hygienic practice guide for hospitality businesses. Click on yes or no for each item for water waste management section**

Guidance for providing adequate drainage and waste disposal systems and facilities
Guidance on ensuring system protection is in place for wastewater especially cross-connections, backflow and disinfection protocols
Policies and monitoring processes for waste water and sewage treatment
Guidance for adequate and appropriate maintenance and cleaning of waste water systems.
Policies for the monitoring of the effectiveness of maintenance and sanitation procedures for waste water systems

**13. The following list summarises some of the controls associated with management of food safety practices in the hospitality sector. Please rank from 1 to 9, in order of importance with 1 being the most important to 9.being the least important to be implemented.**

Adopting cleaning and disinfection procedures in common areas
Implementing disease surveillance & reporting procedures for staff and guests
Implementing inspection and audit programmes
Implementing sanitation protocols and associated procedures for kitchens and restaurants.
Implementing staff health and hygiene procedures
Implementing staff training procedures
Implementing water supply controls and water quality assessment procedures
Implementing water waste management procedures
Work instructions for food preparation for kitchen and restaurants

14. The following list summarises some of the controls associated with disease surveillance & reporting in the hospitality sector. Please rank from 1 to 7, with 1 being the most important.

Developing an outbreak prevention and management policy.
Establishing a surveillance and case / incident management policy.
Implementing inspection programmes for disease surveillance and reporting.
Monitoring of water safety/quality programmes and their effectiveness.
Monitoring for relevant and suitable training of staff.
Periodic audit/inspections of hospitality settings to ensure compliance with disease surveillance and reporting policies and legislative requirements
Review of processes to report a foodborne illness outbreak

15. Are there any other aspects that should be included in a code of practice/guidance for the hospitality sector to prevent foodborne disease outbreaks? Please list/comment below

_____

16. Follow up interviews. In order to gain further insight into the research topic, I will be conducting follow-up interviews with respondents. If you are happy to be contacted for a one on one interview, please leave your email address in the box below; otherwise, click on finish.

Final page

Thank you very much for participating in this study, your help and comments have been invaluable to this study. If you have any further questions, please feel free to contact me at ddiazdeoleo@harper-adams.ac.uk.

# Research Ethics

## Application for the approval of a research project

## PART A

| | |
|---|---|
| **Researcher Name** | Dileyni Diaz de Oleo |
| **Reasearcher ID** | 00761190 |
| **Researcher email address** | DDiazdeOleo@harper-adams.ac.uk |
| **Supervisor/Line Manager/Approved Person** | 00700800 |
| **Supervisor/Line Manager/Approved Person Email** | lmcintyre@harper-adams.ac.uk |
| **Working title of research project** | Assessing food safety practices in the hospitality sector in the Dominican Republic. |
| **Project number** | 0176-202202-PGMPHD |
| **Experiment title** | Stakeholder's consultation |
| **Objectives** | This stage of the research aims to identify which hygiene and food safety practices are relevant for the prevention of foodborne disease in hotel premises. It involves online survey based on the Delphi technique. Initially, online survey with the experts in hygiene and food safety practices in the hospitality sector will be conducted. Furthermore, if this research will need some more details, participants will be contacted again for further interviews. |

### Declaration by Researcher

- ☑ I have completed all relevant questions in this form.
- ☑ I have read the University's Research Ethics Policy and my research will be carried out in accordance with this policy and, where relevant, will be compatible with local rules for non UK research. For contracts which cross national boundaries, where there are tensions or discrepancies, for the avoidance of doubt, I confirm that the more exacting standards will prevail.
- ☑ To the best of my knowledge, the information I have provided is accurate.
- ☑ If there are substantial changes required for this research I will resubmit my Application for Research Approval.

Signature of Student/Researcher:

Date

### 10.5. Stakeholder's consultation: participant recruitment e-mail

Dear
Greetings.
I hope this email find you well.

I am Dileyni Diaz de Oleo, a doctorate student, from the Dominican Republic at Harper Adams University, UK. Currently, I am working on my research regarding food safety practices in the hospitality sector in the Dominican Republic. Predominantly, this research is based on experts' consultations and views in hospitality sector.

I have found you one of the most appropriate persons with relevant experience and expertise in this subject while exploring your organization's website.

I would like to send you an online survey link to find out your views and to identify which hygiene and food safety practices you feel are relevant for the prevention of foodborne disease in hotel premises. Your expert views are extremely important for the reliability of this research.

Furthermore, if this research will need some more details, I would like to contact you again if needed for the follow up interviews according to your consent. I am happy to answer any questions you might have before filling this survey.

Please be aware, confidentiality of your identity will be maintained, and it will be highly anonymous as research ethics are the most important part of my university. There are no known risks associated with this study.

I would really appreciate your contribution in my academics and also for my country by filling this survey.

Sincerely,

Dileyni Diaz De Oleo, MSc

## 10.6. Systematic Map Protocol

**Systematic Map Protocol**

# Systematic mapping of food safety outbreaks in the hospitality sector in the Dominican Republic

Dileyni Diaz[a], Lynn McIntyre[a], Nicola Randall[a], Rounaq Nayak[a], and Louise Manning[b,*]

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[b]Royal Agriculture University, Stroud Road, Cirencester, Gloucestershire, GL7 6JS, UK

*Corresponding Author; louise.manning@rau.ac.uk

## Guidelines for Protocol Preparation

The systematic methodology process and protocol used in this study was performed according to the Collaboration for Environmental Evidence (CEE) Guidelines for Systematic Reviews (Collaboration for Environmental Evidence, 2013; James et al., 2016). This review began by defining the research questions according to the scope and objective of the research, and an a -priori protocol was prepared, prior to commencing the work.

## Objectives of the review

The systematic map aimed to provide evidence of the food safety outbreaks affecting the hospitality sector in the Dominican Republic (DR) and describe what specific food safety practices have been of influence. This was to identify the research studies that have been undertaken to date regarding food safety outbreaks and related food safety practices; The systematic map defines the knowledge and data gaps in the literature, specifically with reference to the DR. It can also be used to inform potential future research priorities to improve food safety practices within the hospitality sector, with specific emphasis on the Caribbean using the DR as the lens of enquiry. In this context food safety outbreaks defines outbreaks caused both by foodborne diseases (FBD) and food poisoning.

## The research questions

The primary question of this systematic mapping is: What food safety outbreaks have affected the hospitality sector in the DR? This question has the following components:

**Systematic Map Protocol**

**Population (s):** Food safety outbreaks
**Occurrence (s):** The high or low occurrence of food safety outbreaks in the DR

The secondary questions of this systematic mapping are:
What food safety practices have influenced food safety outbreaks in the DR?
What evidence is there that any food safety outbreaks were caused specifically by a weakness in food safety practices?

**Population (s)** Areas in the foodservice/hospitality sector in the DR where food safety incidents have occurred.
**Intervention (s)** different food safety practices
**Comparator (s)** None
**Outcome(s)** outbreaks

**Background**

Globalisation of food systems has driven the need for compliance with defined food safety practices (Nayak and Waterson, 2019). Moreover, novel strategies have been proposed worldwide in the food industry to tackle food safety issues in production systems, which have also been applied to the hospitality sector. These approaches have been focused on the improvement of the quality of raw foodstuffs by the promotion of pre-requisite programmes (PRPs) such as Good Agricultural Practices (GAPs), Good Manufacturing Practices (GMPs) and Good Hygienic Practices (GHPs) including the use of food processing technology (Machado-Moreira *et al.*, 2019). PRPs such as GHP, staff training and documented standard operating procedures provide the formal foundation for, and assist in, the successful implementation of Hazard Analysis Critical Control Point (HACCP) (Ricci *et al.,* 2017). HACCP is used as a tool to ensure the safety of food products and to reduce, to an acceptable level, the risk of a food safety issue occurring (Taylor and Forte, 2008). Additionally, national and international food safety legislation, international food safety guidelines such as Codex standards, development of organisational food safety systems, training and the use of audits and inspections have been adopted to prevent food hazards, cross-contamination, foodborne diseases and outbreaks (Scott, 2003; Haapala *et al.*, 2004; Powell *et al.,* 2011). Despite all the efforts employed to

implement, verify and audit food safety systems throughout the food chain (Manning, 2013; Manning and Soon, 2013) the occurrence and incidence of foodborne disease (caused by bacteria, parasites, viruses, and other biological hazards) remains as a significant personal and economic threat to public health, food business and national economies worldwide.

Due to the existing and many emerging or newly identified pathogens in food, the global population is at constant risk of unsafe food and drink (Fung *et al.*, 2018). Torrens *et al.* (2015) state that about 200 pathogens affect humans through contaminated food and beverage items and 30% of emerging infectious diseases in the last 60 years have been caused by microorganisms that are transmitted through edible products. Enteritis and other diarrhoeal diseases are among the top five causes of mortality in Latin American and Caribbean countries (Newell *et al.*, 2010; Havelaar *et al.*, 2015; Olson *et al.*, 2019). The Dominican Republic (DR), the second-largest country in the Caribbean region, is classified as an upper-middle-income country (USAID, 2013). In common with other Latin and Central American countries and Caribbean islands, economic growth relies on agriculture trade, services and tourism. Therefore, government and health authorities have been working in adoption and implementation of food safety guidelines to faithfully comply with the national regulations to guarantees the health of the inhabitants of the DR (De la Cruz, 2018). However, it was identified in a report a decade ago from the Caribbean Epidemiology Centre (CAREC) that Caribbean countries have a high incidence of foodborne diseases (CAREC 2010). However, in 23% of food safety outbreaks, the implicated food could not be specified. Moreover, outbreaks and cases of FBD reported in the Caribbean are not representative of the reality as there is a severe issue with underreporting (Hull-Jackson and Adesiyun, 2019). It can be concluded that infections and intoxications as a result of food safety outbreaks are a growing matter causing a public health subject with significant damage to public health, the local and international economy of the countries concerned and also generating losses in all the sectors involved (Yeni *et al.*, 2016). However, non-industrialised countries face the additional challenge of limited foodborne disease surveillance data because, as other authors state, there is no systematic approach available to determine food safety incidents in real-time such as population surveys, reported cases from surveillance studies, epidemiological

studies, or active laboratory surveillance (Akhtar *et al*.,2012; Indar and Perez, 2015; Lupin, 2015). Thus, this systematic mapping exercise is proposed to provide an overview of the available literature to date. The aim of this paper is to examine the publicly available evidence of the microbiologically related food safety outbreaks affecting the hospitality sector, contextualise the evidence and then determine what specific food safety practices have been of influence in the Dominican Republic.

**Inclusion Criteria**

Inclusion and exclusion criteria were used to identify relevant food safety outbreaks occurring in the DR hospitality sector in this review. Published articles and grey literature will be screened according to the following criteria shown in table 1.

Table 1. Defined inclusion and exclusion criteria to identify relevant articles of foodborne disease in the hospitality sector in the DR.

| **Inclusion criteria:** | **Exclusion criteria:** |
|---|---|
| Relevant subjects are hospitality sector and all the food settings that might encompass food production and serving (, e.g. restaurants, canteen, schools, hospitals, buffet, hotels) Any person or people that have been subject to a food-based disease (secondary question) | Studies which specified the Caribbean, but the country is unclear will be included until it becomes clear the DR was not included at a later stage. |
| Relevant interventions (secondary questions) the eligible intervention in question is the food safety practices. This can include standards, guidelines, procedures, programmes or policy that regulate food safety practices in a food service premise. | Studies of diseases not caused by any bacterial, chemical, allergens or physical food contamination will be excluded |
| Relevant outcomes (secondary questions only): Alternative practices | |
| Outcomes outbreak | |
| Studies focused on the risks, diagnosis, management or consequences of infection, poisoning, the virulence of foodborne illness in the DR. | |
| Relevant types of study design all study designs will be included. | |
| Relevant languages primary research study published mainly in English or Spanish and any other language with relevant information was considered for inclusion | |

Source: Adapted from Gonzalez and Montoya (2019

**Systematic Map Protocol**

## Search Strategy

A scoping exercise in Bibliographic databases was carried out to test the specificity and sensitivity of alternate terms. Searches were performed across the following bibliographic databases sources: Web of Science, PubMed, Wiley online library and EBSCOhost (includes: CAB Abstracts, Food Science Source, Library, Information Science & Technology Abstracts (LISTA) using the predefined search string. A search of published articles was performed from the 26th of February to 3rd of April 2020 and grey literature from 27th October to 2nd November. These searches had no date restrictions. Truncation (*) symbol used to broaden the search:

(food*) AND TOPIC: (disease* OR outbreak* OR contamination OR intoxication OR poison* OR pathogen* "gastrointestinal disorder" OR infection* OR allergy OR hygiene OR sanitation OR Campylobacter* OR Cryptosporidi* OR Cyclospor*OR "Escherichia coli" OR "E. coli " OR "Hemolytic Uremic Syndrome" OR Giardia* OR Listeri* OR Salmonell* OR Shigell* OR Toxoplasm*OR Vibrio OR cholera* OR Yersini* OR Norovirus OR Hepatitis OR Staphylococcus OR "waterborne" OR diarr* OR vomiting OR "Ciguatoxins" OR epidemic OR epidemiology or pandemic) AND TOPIC: (Caribbean Or Dominican Republic).

A complementary search using a combination of key elements from the search strings (e.g. foodborne outbreaks in the Dominican Republic) were used to searched for grey literature documents (e.g. government research reports) through search engines such as Google advanced search, Google Scholar and PubMed, as well as, databases from World Health Organization (WHO) and its regional offices Pan American Health Organization (PAHO/WHO) and Food and Agriculture Organization of the United Nations (FAO). Organizational websites from the DR (e.g. Health of Ministry) and international such as the U.S. Centers for Disease Control and Prevention (CDC). Additionally, Dissertations and Theses from ProQuest and EThOS and an Institutional Repository from a Technological Institute of Santo Domingo (INTEC) in the DR.

### Screening

All articles retrieved were assessed to evaluate their relevance according to predefined inclusion criteria and initially carried out by screening article titles and abstracts concurrently, followed by the full text of potentially relevant articles. Where the relevance of articles was unclear at the title and abstract assessment stage, the articles were included and assessed during the full-text review. Articles were assessed for inclusion by one reviewer where there were any queries regarding inclusion at any stage and second reviewer also screened the article and its inclusion/exclusion was resolved through discussion. If an article describing a given outbreak provided formal evidence of laboratory confirmation in both human cases and foodstuffs, that outbreak was classed as definitely foodborne (food or water rather than another vehicle or mode of transmission). Reasons for exclusion at the full text level together with details of articles that cannot be located or accessed will be reported in the final review.

### Data coding strategy

Following the full-text screening, meta-data will be extracted as crucial information, e.g. study location, author, year, risk factor(s), outbreak, with variables: year outbreak, food incriminated, food category, the main reason, number of cases, number of laboratory-confirmed cases, number of hospitalisations, deaths and location and cases, incidence, prevalence, food safety practices, Socio-demographic characteristics of targeted participants.

### Synthesis

The synthesis process has produced a narrative systematic map. Metadata extraction from studies will be presented together with a searchable database of studies. Results will be summarised visually and with descriptive statistics in this section.

### Reporting

Descriptive statistics (proportions, medians and interquartile ranges) will be used to explore the data extracted from articles that met the inclusion criteria.

## Review management

Search results were exported into the web-based citation management software RefWorks (RefWorks, 2009). After removing duplicates citations, all articles were screened out articles using titles and abstracts against the inclusion and exclusion criteria. All the studies with data on the occurrence of FBD were retained and exported to Microsoft Excel version 16.37 to create descriptive statistics.

The systematic map will be reported in a manuscript that will be submitted to a peer review journal. The goal of the manuscript will be to both report the systematic map with discussion aimed to enhancing food safety practices within local food premises, and strengthening national surveillance systems to target potential risk, together with raising awareness among international travellers and locals regarding endemic pathogens and food hazards requires effective food safety governance to be in place.

## Funding sources/sponsors

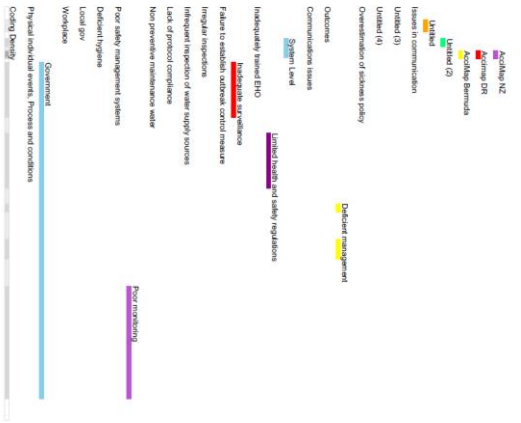
The work is sponsored by the Ministry of Higher Education Science and Technology, Dominican Republic Government.

## 10.7. Example of Nvivo coding

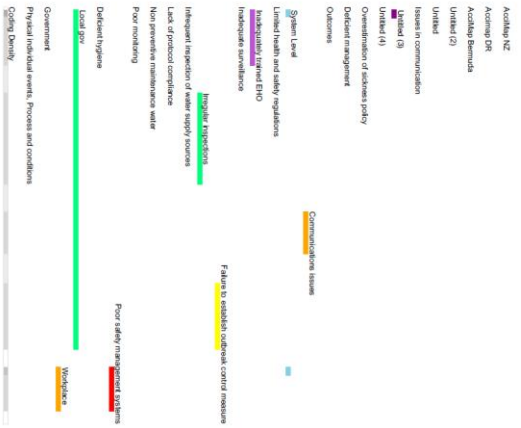
Coding example for the AcciMap analysis

**Common contributory factors among the three different outbreaks**

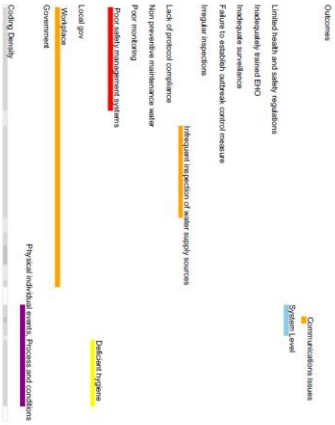
| System level | Casual factors | | | Codes factors |
|---|---|---|---|---|
| **Government** | **AcciMap 1 DR** | **AcciMap 2 NZ** | **AcciMap 3 BD** | |
| Inadequate surveillance systems<br>Poor surveillance of water quality<br>Non active surveillance system | Inadequate surveillance systems | Poor surveillance of water quality | Non active surveillance system | **Inadequate/poor surveillance system**<br>Inadequate surveillance systems<br>Poor surveillance of water quality<br>Non active surveillance system |
| | Unsupportive management | poorly defined responsibility | Deficient water management | |
| | Poor health and safety regulations | Limited regulations | Limited regulations sewage/ wastewater system | **Limited health and safety regulations**<br>Poor health and safety regulations<br>Limited regulations sewage/ wastewater system |
| | Irregular inspections/ monitoring water supply systems | Non-stringent drinking water monitoring program | Poor drinking water quality standards | **Deficient management**<br>**Poor health/ sewage/wastewater limited regulations**<br>Unsupportive management<br>Deficient water management |
| | | | Unregulated drinking water supply sources | **Poor drinking, standards monitoring, inspections**<br>Irregular inspections/ monitoring water supply systems<br>Non-stringent drinking water monitoring program<br>Poor drinking water quality standards<br>Unregulated drinking water supply sources |
| | | | | |




| | | | | |
|---|---|---|---|---|
| **Local** | Limited availability of EHO | Inadequately trained EHO | EHO lack of knowledge | **Inadequately trained EHO**<br>Limited availability of EHO<br>Inadequately trained EHO<br>EHO lack of knowledge<br>Inadequately trained EHO |
| | Inadequately trained EHO | Irregular local inspections | Irregular inspections, monitoring water supply systems | **Irregular inspections**<br>Irregular inspections, monitoring water supply systems<br>Insufficient control measure<br>Unregulated drinking water supply sources<br>Weak enforcement local health regulations |
| | Communication and information flow deficiency | Communications issues | Insufficient control measure | |
| | Weak enforcement local health regulations | Unregulated drinking water supply sources | No establish procedure to response and control the outbreak | |
| | Failure to establish outbreak control measure | No established procedure to notify infectious disease | | **Communications issues**<br>Communication and information flow deficiency<br>Communications issues |
| | | Insufficient control measure | | **Failure to establish outbreak control measure**<br>Not procedure to response and control the outbreak<br>No established procedure to notify infectious disease |
| | | | | |
| **Organisational/workplace** | Safety management system not embedded | Limited water treatment resources | No legal requirements to water chlorination | **Poor safety management systems**<br>Safety management system not embedded<br>Poor management risk |
| | No established | Failure in the | Poor safety | |



| | | | | |
|---|---|---|---|---|
| | outbreak control protocols | chlorination system | management | Non-compliance with the drinking water supply registration |
| | Issues in communications | Poor management risk | Infrequent inspection of water supply sources | No established outbreak control protocols<br>Inefficient cleaning protocols<br>Inadequate water treatment conditions<br>No established outbreak control protocols<br><br>**Infrequent inspection of water supply sources**<br>Failure in the chlorination system<br>Resort poor control over multiple water sources<br>No established outbreak control protocols<br>Inefficient cleaning protocols<br><br>**Overestimation of sickness policy**<br>Irregular employee health check ups<br><br>**Issues in communication** |
| | | Deficient water treatment methods | Inadequate water treatment conditions | |
| | | Poor standards for water supply | Irregular employee health check ups | |
| | | Overestimation of sickness policy | Resort poor control over multiple water sources | |
| | | Non-compliance with the drinking water supply registration | No established outbreak control protocols | |
| | | | Inefficient cleaning protocols | |
| | | | Issues in communication | |
| | | | | |
| **Physical individual events, Process and conditions** | Poor information flow | Poor communication | Failure to prevent person to person transmission | **Poor communication**<br>Poor information flow<br><br>**Deficient hygiene procedure**<br>Weak hygiene safety practices from the staff<br>Staff did no use PPE<br>Failure to prevent person to person transmission |
| | Weak hygiene safety practices from the staff | Lack of protocol compliance | Lack of protocol | |
| | Staff did no use PPE | Person-to person transmission | Inefficient water treatment | |
| | Inadequate water treatment conditions | Deficient wastewater treatment | Poor maintenance water tank/ pipeline | |




| | | | | |
|---|---|---|---|---|
| | | | system | Person-to person transmission |
| | Deficient hygiene procedure | Delayed to identify the route/ source of contamination | No records/ log of water supply maintenance | Ineffective cleaning disinfections agents<br>Lack of outbreak control team<br>Delayed outbreak identification<br>Difficulties to stop person-to-person transmission<br><br>**Lack of protocol compliance**<br>Lack of protocol<br>Government chlorination guidelines no followed<br>Inadequate duty care towards employees<br>Delayed outbreak identification<br>Delayed closure of new visitor's admissions<br><br>**Non preventive maintenance water**<br>Not effective filtration system<br>Poor maintenance of the sewerage system<br>Poor maintenance water tank/ pipeline system<br>No records/ log of water supply maintenance<br>Deficient wastewater treatment |
| | Ineffective cleaning disinfections agents | Inadequate duty care towards employees | Government chlorination guidelines no followed | |
| | Lack of outbreak control team | Non preventive maintenance water | Not effective filtration system | |
| | Delayed outbreak identification | Inadequate monitoring of the resort water supply | | |
| | Difficulties to stop person-to-person transmission | Poor maintenance of the sewerage system | | |
| | Delayed closure of new visitor's admissions | | | |
| | Deficient wastewater treatment | | | |
| Outcomes | | | | Widespread/faecal contamination<br>Waterborne transmission<br>Cross-contamination |
| | | | | |