FDA New Era of Smarter Food Safety

Food Safety Culture Systematic Literature Review

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An Employee-Owned Research Corporation®
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Appendix A. Search strategy and search terms: Contains a list of all databases searched and numerical results of each search permutation.

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Note on Citations

This review uses the Journal of the American Medical Association (JAMA) citation style. In-text references are noted with superscript Arabic numbers that correspond with the numbering in the reference list.

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Executive Summary

The Executive Summary provides a high-level summary of the food safety culture systematic literature review findings. For detailed results, see Section III of this report starting on page 18.

The Food and Drug Administration (FDA) launched the New Era of Smarter Food Safety blueprint in July 2020.[1] The blueprint outlines a ten-year plan to create a safer food system, one component of which is supporting and promoting food safety culture (FSC). As part of this effort, FDA commissioned a systematic literature review to produce a synthesis of the published literature to answer three overarching questions: 1. What is FSC?; 2. How is FSC developed and maintained?; and 3. How is FSC assessed?.

A specified search algorithm applied to literature published between January 1, 2009 and April 30, 2021, identified 2,293 citations, from which 715 were deemed potentially relevant. A review of the 715 abstracts revealed 152 articles pertinent to the literature review. Full text reading of the 152 articles resulted in 79 "in-scope" articles being retained for analysis and synthesized for this literature review.

1. What is Food Safety Culture?

Almost all the FSC literature included a definition of FSC, with most citing definitions provided in earlier works. In the literature reviewed, the most frequently cited definition is from Griffith, Livesey, and Clayton, who define FSC as:

> *The aggregation of the prevailing, relatively constant, learned, shared attitudes, values and beliefs contributing to the hygiene behaviours used within a particular food handling environment.*[2, p.435]

In his 2009 book *Food Safety Culture: Creating a Behavior-Based Food Safety Management System*, Frank Yiannas differentiates FSC from food safety management systems (FSMS) or employee knowledge of food safety practices: "While having a FSMS is critical, food safety culture looks beyond just processes to human behavior."[3] This distinction is found throughout the literature, and discussions of FSC focus on shared attitudes, values, and beliefs about food safety held by both employees and leadership in an organization.

Griffith, Livesey, and Clayton[4] conceptualize FSC as interacting with an organization's management systems, style, and processes to determine food safety performance. In

contrast, De Boeck et al. [5] conceptualize FSC as the interplay between FSMS and what they call a "food safety climate." De Boeck et al.'s definition of food safety climate closely mirrors Griffith, Livesey, and Clayton's definition of FSC. Despite this, FSC and food safety climate are not necessarily interchangeable. In a review of the literature conducted in 2020, Sharman et al. [6] found that, while there is considerable overlap between the two concepts, food safety climate tends to be associated with a temporary timeframe and is often framed as the attitudes and perceptions of individuals at a point in time. In contrast, FSC is associated with an extended period, often framed as the prevailing beliefs, behaviors, assumptions, and practices of the organization. The concept of FSC is almost exclusively discussed in the literature at the organizational level, in terms of businesses, including manufacturing, food processing, and retail. Very few studies look at FSC at the national level and none of the literature addresses FSC at the individual consumer level.

Although the term FSC predates him, Frank Yiannas is often credited with bringing the concept of FSC to the forefront of literature on food safety with his 2009 book.[3] Most of the conversation in the scientific literature, however, has been driven by academic researchers, including Christopher Griffith, E. De Boeck, Lone Jespersen, and Shingai Nyarugwe. In the food industry, the Global Food Safety Initiative (GFSI) is a key voice in the conversation around FSC, providing resources on FSC for its members. FSC has also begun appearing in trade magazines, with contributions from large food manufacturers, including Bush Brothers, ConAgra Foods, Dupont, Land O'Frost, Land O'Lakes, and Maple Leaf Foods.

2. How is FSC created and promoted?

While there is not just one approach to establishing, developing, and sustaining a FSC,[7] researchers have identified numerous key determinants (also referred to as elements or components) that contribute to a FSC. The key determinants identified consistently can be summarized as: leadership; communication; commitment to food safety; risk awareness; environment; accountability; and employee knowledge, attitudes, behaviors, and values. The literature also acknowledges challenges and barriers to establishing and maintaining a strong and effective FSC. Barriers identified in the literature include: over-reliance on food safety management systems, prioritization of cost-saving and money-earning; organization size; frequent staff turnover; and optimistic bias*.

The literature identifies a few publications that serve as guides for organizations looking to develop and maintain a positive FSC, including Yiannas' book *Food Safety Culture: Creating a Behavior-Based Food Safety Management System,* [3] Ades et al.'s book, *Food Safety, A Roadmap to Success*,[8] and the GFSI's publication *A Culture of Food*

Safety.[7] The literature also describes some best practices to promote FSC, including promoting FSC as a necessary and critical business matter for all employees; branding the organization's commitment to FSC; framing FSC with an "ownership mentality," and promoting FSC throughout the organization's supply chain.

International research has shown that government regulatory agencies' policies and procedures can influence an organization's FSC, with stronger FSC generally found in countries with more food safety regulations (e.g., public legislation, private standards, and public and private enforcement practices).[9,10] However, the literature does not distinguish specific elements of food safety regulation that promote a stronger FSC.

A scan of social media was conducted to examine how FSC is promoted among organizations, consumers, and government regulatory agencies. Results of the scan indicated that FSC was not actively discussed or promoted on social media.

3. How is FSC assessed?

About a quarter of the articles in this literature review discuss methods for assessing FSC within organizations. Most of the FSC assessment tools developed were survey instruments meant for dissemination to personnel at different levels within an organization, including upper management, middle management, and food handlers. Other methods mentioned in the literature for assessing FSC in an organization include third-party audits, verifications of certain kinds of data, focus groups, and observations of actual behavior.

Many survey instruments were developed and validated using mixed-methods, including literature reviews, focus groups with food safety experts, and psychometric analyses. Some researchers used a triangulation approach to develop and validate their FSC constructs, combining multiple methods such as surveys, interviews, and audits.[11-13] The reviewed literature does not indicate measurement constructs and scales would work equally throughout different organizations or food industries.

Many of the FSC assessment tools adapted concepts from organizational culture assessment tools and applied them within a food safety context and framework. Two of the earliest and most cited tools that applied this strategy were Ball et al.'s Food Safety Climate Tool[14] and De Boeck et al.'s Food Safety Climate Self-Assessment Tool.[5] While the tools differ, they measure similar constructs, including: leadership, communication, risk awareness, infrastructure or resources, and individual values or commitment. Most of the FSC assessment tools have built upon these two assessment tools, adding new constructs or sub-domains to previous constructs.[9,15-17] In contrast, Jespersen et al.'s Food Safety Maturity Models[12,18] assesses an organization's commitment to FSC on a

5-point continuum across five capability areas: values and mission; people systems; adaptability; consistency; and risks and hazards. The "maturity" continuum begins with "doubt," and passes through stages of commitment to FSC, ending with the organization being rated as having "internalized" the norms and values associated with FSC. Only one assessment tool—a 2012 toolkit from the United Kingdom's Food Standards Agency —was identified as having been developed by a regulatory agency. The goal of the toolkit was to help enforcement officers assess safety culture, attitudes, and behaviors. A qualitative study with thirty industry stakeholders found the toolkit complicated, repetitive, lacking employee feedback, and not adaptable to different sizes and types of businesses.[46]

Whether FSC is described along a continuum of weak to strong, low to high, negative to positive, immature to mature, etc., depends on the writer's or researcher's approach. Where appropriate in this review, we use "strong" or "good" to describe a fully established FSC and "weak" or "poor" to describe undeveloped FSC, unless we are referencing a specific works, in which case we use the descriptor used by the authors.

There are three prominent case studies of foodborne illness outbreaks that link poor FSC as a key contributor to those outbreaks.[19-21] While the authors of these studies hypothesize that food organizations with good FSC would better comply with food safety standards than organizations with poor FSC, no case studies in this literature review directly examined this presumption. Furthermore, the literature review identifies relatively few empirical studies (N=6) that directly examined the relationship between FSC and outcomes such as microbiological hygiene, safety behavior, and economic impact.[22-27] Two of the studies found that improved FSC or leadership support for FSC improved employee food safety behavior (i.e., hand washing and motivation).[22,25] One study found that restaurants with good FSC had fewer study-assessed food safety violations than restaurants with poor FSC.[23] Only one study found a significant positive relationship between FSC and risk associated with microbiological hygiene.[27]

Conclusion

Overall, there is general consensus in the literature on how to define FSC. Authors agree that FSC is something beyond a procedural FSMS, even if there is no agreement on how best to characterize FSC. Moreover, there is general agreement on the determinants of a strong and effective FSC: leadership; communication; commitment to food safety; risk awareness; environment; accountability; and employee knowledge, attitudes, behaviors, and values. The literature describes the importance of each in creating and maintaining a strong FSC but there are a limited number of tools designed specifically to help create and promote an effective FSC. There is also very little on how

government agencies can promote a strong FSC across the food supply chain, with only the FDA's implementation of the New Era of Smarter Food Safety[1] initiative and the EU's promulgation of FSC regulations[77] as examples.

There is a dearth of literature on FSC for the consumer or for food-related regulatory agencies, perhaps because the concept FSC itself draws upon theories of organizational culture. As a result, there is a gap in the literature about what a strong and effective FSC would look like among general consumers and about how FSC is defined in a regulatory agency. Similarly, the literature on FSC does not take into consideration employees' diverse political, familial, racial and other cultural identities or how these identities may influence an organization's FSC.

There are several measures designed to assess an organization's FSC, with researchers continuously building and expanding upon- earlier assessment tools. The tools share several constructs, including leadership, communication, risk awareness, infrastructure or resources, and individual values or commitment. However, more research is needed to assess the validity of these tools across different organizational settings, as well as across different countries.

While only a few studies have directly examined the relationship between FSC and outcomes, the research to date suggests that improving FSC within organizations does have some measurable positive effects. However, more empirical studies are needed to fully demonstrate the connection between FSC and outcomes, including microbiological environment and other risks for foodborne illness outbreaks, reductions in contamination incidents, and improved economic effects.

I. Background and Research Questions

The Food and Drug Administration launched the New Era of Smarter Food Safety blueprint in July 2020.[1] The blueprint outlines a ten-year plan to create a safer and more digital, traceable food system through new technologies (e.g., technology-enabled traceability), enhanced root cause analyses and predictive analytics, new business models, collaboration with the food industry, and promotion of a food safety culture throughout the food system and in the agency.

The goal of this systematic literature review on food safety culture (FSC) is to provide FDA with a synthesis of the available research on how FSC is defined, created, and assessed, as well as insight into the challenges and opportunities related to fostering FSC. The literature review also aims to provide a foundation for implementing other activities identified in the blueprint, such as developing training and education materials, creating tools for companies and inspectors, and collaborating with leaders and influencers to foster a strong FSC throughout the U.S. food system.

To achieve these goals, research questions were developed and refined based on initial scans of the literature. These research questions can be summarized into three overarching key questions:

1. What is FSC?
2. How is FSC created and promoted?
3. How is FSC assessed?

These overarching research questions are each divided into several specific questions that are further divided into detailed research questions (See. Exhibit 1).

Exhibit 1. Research questions developed for FDA Food Safety Culture literature review

Overarching Question	Specific Research Question	Detailed Research Question(s)
A. What is Food Safety Culture (FSC)?	**1. How is FSC defined and conceptualized?**	How is FSC described in the literature? Are FSC and "food safety climate," and "food safety program" synonyms? Is there any literature addressing FSC as "values-based"? What existing theoretical frameworks (e.g., organizational culture and industrial safety culture) have shaped the concept of FSC? How has the concept of FSC changed over time? How is the concept of FSC applied to general consumers? How does it relate to theories of public health communication? What is not FSC?
A. What is Food Safety Culture (FSC)?	**2. Who are FSC's key thought leaders?**	What organizations currently play a key role in researching and promoting FSC?
B. How is FSC created and promoted?	**1. How is FSC created?**	What are the key determinants (e.g., organizational culture, leadership, motivation, and employee behavior) in creating a strong and effective FSC? What are best practices in developing and maintaining a strong and effective FSC? Include case studies of organizations evincing best practices. What are the challenges and barriers to establishing and maintaining a strong and effective FSC?
B. How is FSC created and promoted?	**2. How is FSC promoted?**	How is FSC promoted among organizations? How is FSC promoted among consumers (e.g., general public education campaigns)? Is the approach facts-based or values-based?

Overarching Question	Specific Research Question	Detailed Research Question(s)
B. How is FSC created and promoted?	**3. How does a Government regulatory agency promote FSC?**	What initiatives have other regulatory agencies (U.S. and international) used to support, encourage, or assess FSC in the regulated industry? What activities, tools, and strategies have been used, and were they effective? How can inspections and regulatory procedures encourage FSC across industries?
C. How is FSC assessed?	**1. What are the existing measures of FSC?**	What methods and approaches have been developed to assess FSC? How do FSC measurement processes differ between organizations? How does a regulator evaluate FSC in industry and its own agency?
C. How is FSC assessed?	**2. What outcomes are associated with FSC?**	What outcomes have been studied in relation to FSC? What is the relationship between FSC and foodborne illnesses/outbreaks? How is the value of FSC measured and articulated?

II. Literature Review Methods

The literature review methods included identifying and reviewing peer-reviewed papers and presentations; grey literature (e.g., technical reports, white papers, and issue briefs) from government agencies and industry, public health, and not-for-profit organizations; and a scan of social media posts relevant to FSC.

Exhibit 2 presents an overview of the protocol employed for the literature review. It outlines the strategy used for searching and selecting articles as well as states how the articles were reviewed and then summarized. The documentation process followed the principles of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[28]

Exhibit 2. Protocol for systematic literature review

A. Developed Research Questions
Developed research questions in an iterative process, incorporating input and feedback from all members of the project team both before and after an initial scan of the literature.

B. Determined Search Parameters
Project team determined search parameters, including: 1. Identified relevant sources to search, including electronic databases, selected websites, and social media sites. 2. Generated a list of appropriate search terms. 3. Defined inclusion and exclusion criteria that establish study parameters.

C. Conducted Search
Conducted a comprehensive search of the literature, including: 1. Conducted iterative searches and refined search terms as appropriate. 2. Managed citations with EndNote™ to monitor results and remove duplicate citations.

D. Reviewed Abstracts
Reviewed abstracts to determine eligibility and incorporate project team guidance on final determination of included and excluded abstracts.

E. Reviewed Literature and Compiled Evidence Tables
Reviewed full-text manuscripts, grey literature, and social media posts, including: 1. Obtained full-text manuscripts for all eligible abstracts and confirm they are within the scope of the review. 2. Read full-text manuscripts, grey literature, and social media posts and extracted relevant study details for the evidence tables. 3. Scored articles using the FDA Social Science Research Scoring System where applicable. 4. Finalized evidence tables based on project team feedback.

F. Produced Literature Review Report
Synthesized findings into a systematic literature review report.

A. Literature Search

1. Search Strategy

Two types of sources were searched:

- Electronic databases of peer-reviewed papers, reports, and documents (see Exhibit 3); and
- Selected websites that may have contained grey literature of interest (see Exhibit 4).

Exhibit 3. Selected electronic databases searched for FSC-related literature and documents

Electronic Databases
- AGRICOLA   - Business Source Premier   - Google Scholar   - MEDLINE   - ProQuest   - Politics Collection   - PsycInfo   - Publicly Available Content   - Sociology Collection   - Social Science Database   - PubAg   - PubMed   - PubMed Central   - Science Direct   - WorldCat

Exhibit 4. Selected organizational websites searched for grey literature

Government Agencies	Industry, Public Health, and Nonprofit
- Food and Drug Administration (FDA) - Department of Agriculture (USDA) & Food Safety and Inspection Service (FSIS) - Environmental Protection Agency (EPA) - Department of Commerce & National Marine Fisheries Service (NMFS)	- Global Food Safety Initiative - International Food Protection Training Institute (IFPTI) - Food and Agricultural Organization of the United Nations (FAO) - Consumer Federation of America - National Restaurant Association - Foodservice Packaging Institute (FPI) - National Food Service Management Institute - American Public Health Association (APHA) - American Culinary Federation

As a starting point for the literature review, Westat employed an iterative search strategy to identify search terms and content and, when appropriate, identified database subject headings related to the following:

- Food safety or food safety regulation; and
- Organizational culture/behavior/climate.

The following parameters were applied for database searches:

- English language;
- January 1, 2009–April 30, 2021;
- Human subjects research;
- United States and international; and
- Exclusion of editorials, and book reviews.

The Westat team also conducted searches of key authors identified from preliminary searches of the literature and recommendations from the Food and Drug Administration. For reference, Appendix A documents the search strategy and search terms that were applied across databases.

2.   Inclusion and Exclusion Criteria

Selected articles and materials for this systematic review were relevant to the topic of FSC and addressed the research questions. Exhibit 5 lists the inclusion and exclusion criteria for selecting relevant articles and materials.

Exhibit 5. Inclusion and exclusion criteria for systematic review

Inclusion Criteria	Exclusion Criteria
• Peer-reviewed literature and full-text presentations • U.S. and international, English language literature • Grey literature (including technical reports, white papers, issue briefs, and related documents) • 2009 – Present, plus seminal works regardless of date of publication • Literature within the scope of the research questions	• Non-English language • Editorials, letters, and book reviews • Conference abstracts with no full text • Proprietary documents • Works prior to 2009 unless considered seminal • Literature outside of the scope of the research questions (e.g., literature which does not discuss food safety culture)

3.   Abstract Review

The Westat team initially screened 2,293 citations identified through the literature searches to determine if they met inclusion criteria and warranted full-text article review. Of these, 715 citations were selected for abstract review.

To ensure consistency among reviewers, Westat developed an inter-rater reliability process whereby all three reviewers reviewed a subset of 50 abstracts and then met to review and discuss inclusion and exclusion decisions. This process also allowed for the refinement of the exclusion criteria listed in Exhibit 5. The FDA research team participated in an assessment as to whether the criteria were being appropriately applied.

After the inclusion and exclusion criteria were finalized, each abstract was independently reviewed by two reviewers to determine if a citation should be included for the full-text article review. The independent review of each abstract by two reviewers provided a check on the quality of the review or potential bias about articles. Each two-person team met afterward to review decisions, discuss discrepancies, and reach consensus on abstracts. Of the 715 abstracts, 152 were selected for full-text review.

4.   Full-Text Review and Data Extraction Process

The Westat team reviewed 152 full-text articles and resources. Among these, Westat determined that 79 were considered "in-scope" and were included for in-depth analysis [2-18,22-27,29-83] applying the same inclusion criteria used during the abstract review, process. Three project staff members completed the full-text article review and data +extraction. To ensure consistency among reviewers, Westat developed an inter-rater reliability process whereby all three reviewers reviewed a subset of 20 articles to discuss the information to extract from the articles as well as the scoring of articles using the FDA Social Science Research Scoring System (SSRSS), when its use was appropriate.[84] Forty-two articles were reviewed using the SSRSS, with scores ranging from 3 to 12 (out of a range from -4 to +12), and an average score of 9.67.

The literature in the review varied by type: peer-reviewed journal articles (n=55), books (n=10), magazine articles (n=4), conference posters (n=4), trade publications (n=4), government report or regulation (n=2). Most publications were not specific to a single food environment (n=37); and the others covered a variety of food industries including: food service or hospitality (n=21), food manufacturing (n=12), and food processing (n=10).

All extracted data can be found in the evidence table in Appendix B.

5. Literature Included in Analysis

Exhibit 6 presents a PRISMA diagram outlining how the search of databases and review of articles resulted in 79 in-scope articles.

Exhibit 6. PRISMA flow diagram for systematic literature review of FSC
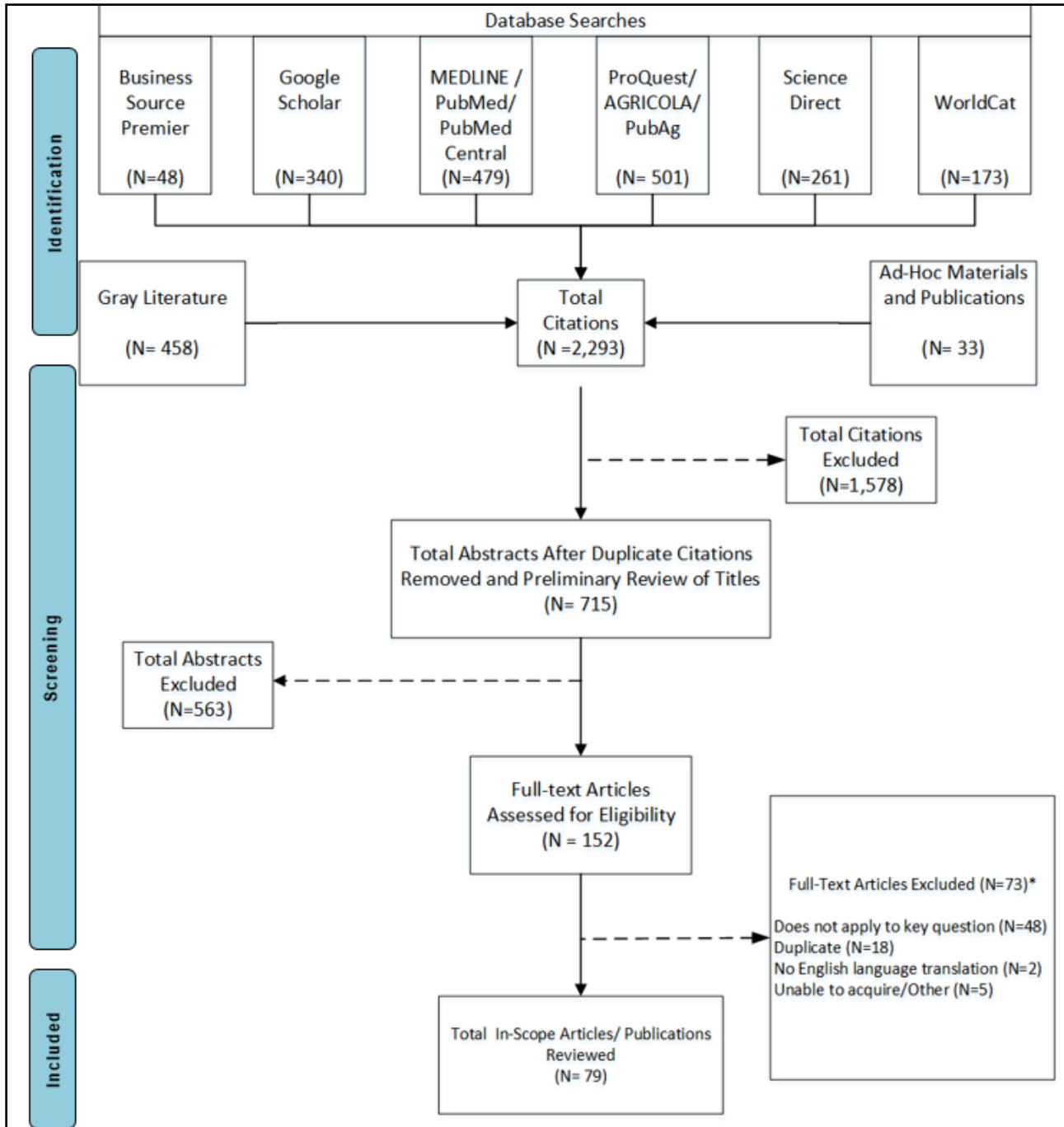
B. Social Media Scan

Westat conducted a social media scan to supplement the findings from the systematic literature review. The search was conducted to identify relevant, publicly available materials and conversations related to the promotion of FSC that were posted on social media.

Westat used the social listening tool Meltwater, with defined search terms within the past year (August 1, 2020 – July 31, 2021), which searched Twitter, Facebook fan pages, blogs, YouTube, and Reddit. In addition to the content of the post, Meltwater identifies the date the mention was posted, the source, and the "reach" of the content (i.e., the number of times it was viewed). The data includes duplicates and retweets, which allow us to assess the general 'impact' of the message and identify the top influencers and themes. Exhibit 7 outlines the search strings used in the Meltwater searches and the number of mentions per search.

Exhibit 7. Social media search strings and mentions

Research Question	Associated Search Strings	Mentions
How is FSC promoted among organizations?	(("food safety culture") OR ("food safety climate") OR ("#foodsafetyculture")) AND ((organization* OR industr** OR institution*))	420
How is FSC promoted among consumers (e.g., public education campaigns)?	(("food safety culture") OR ("food safety climate") OR ("#foodsafetyculture")) AND ((consumer*))	448
How does a government regulatory agency promote FSC?	(("food safety culture") OR ("food safety climate") OR ("#foodsafetyculture")) AND (government OR agency OR authority OR administration OR department OR minister)	470

The social media data extracted is limited to publicly available content and what the providers can collect. In other words, Meltwater is limited to collecting data from publicly available Facebook fan pages and cannot access personal Facebook pages. Since Meltwater's automated information extraction system is proprietary, there may be additional unknown limitations.

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* The asterisk (*) is a kind of wild card that tells the database to find multiple "endings" of a word. For example, *organization** would capture organization, *organizations*, and *organizational*.

III. Literature Review Findings

Our findings from the literature search and social media scan are organized by research question:

- A. What is FSC?
- B. How is FSC created and promoted?
- C. How is FSC assessed?

A. What is Food Safety Culture?

This section addresses the question "What is food safety culture?" We summarize the literature on how FSC is defined in the literature and discuss distinctions between FSC, food safety climate, and food safety management systems. We also review the role of values in FSC as described in the literature. We look at the history of FSC, including its theoretical underpinnings, and the context of FSC—national, organizational, and individual. Finally, we review the thought leaders identified in the literature.

1.   How is FSC defined and conceptualized?

Almost all of the literature provided a definition of FSC, with most citing definitions provided in earlier works. Explicit discussions about defining FSC were limited to academic works; industry literature tended to assume its audience was either familiar with FSC or that the meaning of the term was self-evident.

In the literature reviewed, the most frequently cited definition was from a 2010 article written by Griffith, Livesey, and Clayton. The authors defined FSC as:

> The aggregation of the prevailing, relatively constant, learned, shared attitudes, values and beliefs contributing to the hygiene behaviours used within a particular food handling environment.[2, pg. 435]

A 2019 literature review conducted by Samuel, Evans, and Richmond also found this definition to be the one most cited in the FSC literature.[35]

Conceptualizing FSC

In the late 1990s, research findings from multiple studies began to show that training workers in safe food handling practices was necessary, but not sufficient, to reduce the occurrences of foodborne illness. One study often referenced in the current literature, Ehiri et al.,[85] for example, evaluated a food hygiene training course and found no improvements in participants' knowledge after they took the training. They concluded

that food-safe behaviors and attitudes require changing organizational infrastructure, not just providing information to individuals.

In a survey of food handlers of ready-to-eat foods from small to medium-sized food businesses in Wales, Clayton et al.[86] found most food handlers generally understood the safety behaviors required of them. However, nearly two-thirds admitted to not always carrying out best practices. Eighty-five percent of respondents identified barriers to safe food handling practices, several of which were in the domain of inadequate resources (e.g., a workspace that was too small to prevent cross-contamination or sinks that were not conveniently located). The authors argued that leaderships' failure to remove the barriers to safe food handling practices created a workplace in which food safety was perceived not to be a priority.

Subsequent research on food safety began shifting the focus from employee food handling behaviors to the organizational context in which those behaviors take place. Drawing upon existing literature on organizational and safety culture, researchers developed a conceptual framework for what has become known as *food safety culture*.[22,39] Safety culture as a concept has its roots in organizational culture, defined by one of its leading researchers, Edgar Schein, as a "pattern of basic assumptions" shared by members of a group.[87] Safety culture, in turn, is the application of organizational culture to one specific area—safety. FSC then evolved from applying safety culture to one specific area—food.[2]

In 2009, Frank Yiannas published *Food Safety Culture: Creating a Behavior-Based Food Safety Management System*. His book drew from his own experiences working on food safety in global companies. In his book, Yiannas argues that food safety must be integral to an organization's culture, "going beyond traditional training, testing, and inspectional approaches to managing risks."[3] Yiannas differentiates FSC from a food safety management system, explaining that "a food safety management system (FSMS) is a system of processes that includes good manufacturing practices, a Hazard Analysis and Critical Control Point (HACCP) system, and a plan for recalling unsafe foods. While having a FSMS is critical, food safety culture looks beyond processes to human behavior."[3] He summarized, "Simply put, a food safety culture is how an organization or group does food safety."[3]

The focus on FSC as more than just a FSMS is echoed in a 2018 white paper from the Global Food Safety Initiative (GFSI), a private organization that provides guidance for businesses on food safety. The paper observes:

> *In contrast to the rule of law, culture draws its power from the unspoken and intuitive, from simple observation, and from beliefs as fundamental as 'This is the*

right thing to do" and 'We would never do this.' Rules state facts; culture lives through the human experience.[7, pg. 3]

Griffith, Livesey, and Clayton[4] conceptualize FSC as interacting with an organization's management systems, style, and processes to determine food safety performance. The authors provided a model illustrating the interplay of these concepts in the context of food safety, shown in Exhibit 8.[4] In the model, leadership influences (and connects) both FSMS and FSC, which co-exist under a more general umbrella of "food safety management." FSC itself reflects the interaction of several constructs: leadership; communication; commitment; environment; and risk awareness, perception, and risk-taking behavior.

Exhibit 8. Factors influencing food safety performance[4]
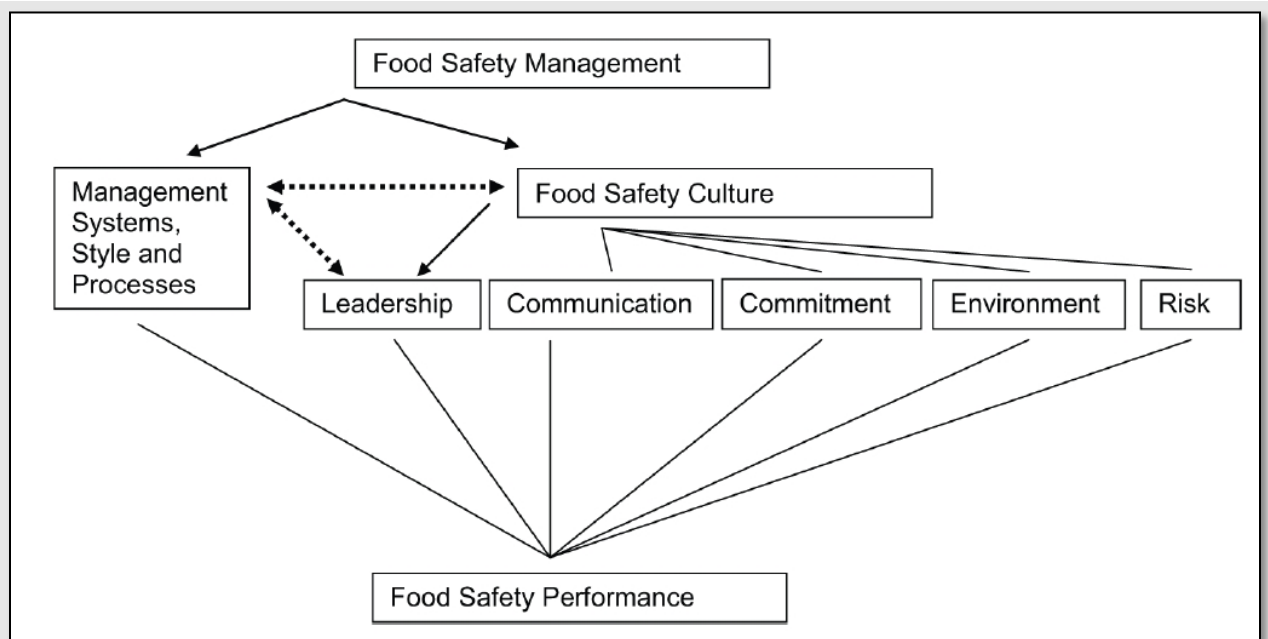
FSC and Food Safety Climate

De Boeck et al.[5] conceptualize FSC differently, by including the concept of food safety climate. In this model, shown in Exhibit 9, FSC is the overarching umbrella, encapsulating both FSMS and food safety climate. The authors define food safety climate as "employees' (shared) perception of leadership, communication, commitment, resources and risk awareness concerning food safety and hygiene within their current work organization."[5] In De Boeck's model, food safety climate is the "human route" within FSC. FSMS, on the other hand, is characterized as the "techno-managerial route" that reflects the larger context of the organization, process characteristics, and available

technology. An organization's FSC, they explain, is the overarching framework that is comprised of these two complementary "routes."

Exhibit 9. De Boeck et al. Food Safety Culture Conceptual Model[5, pg. 244]
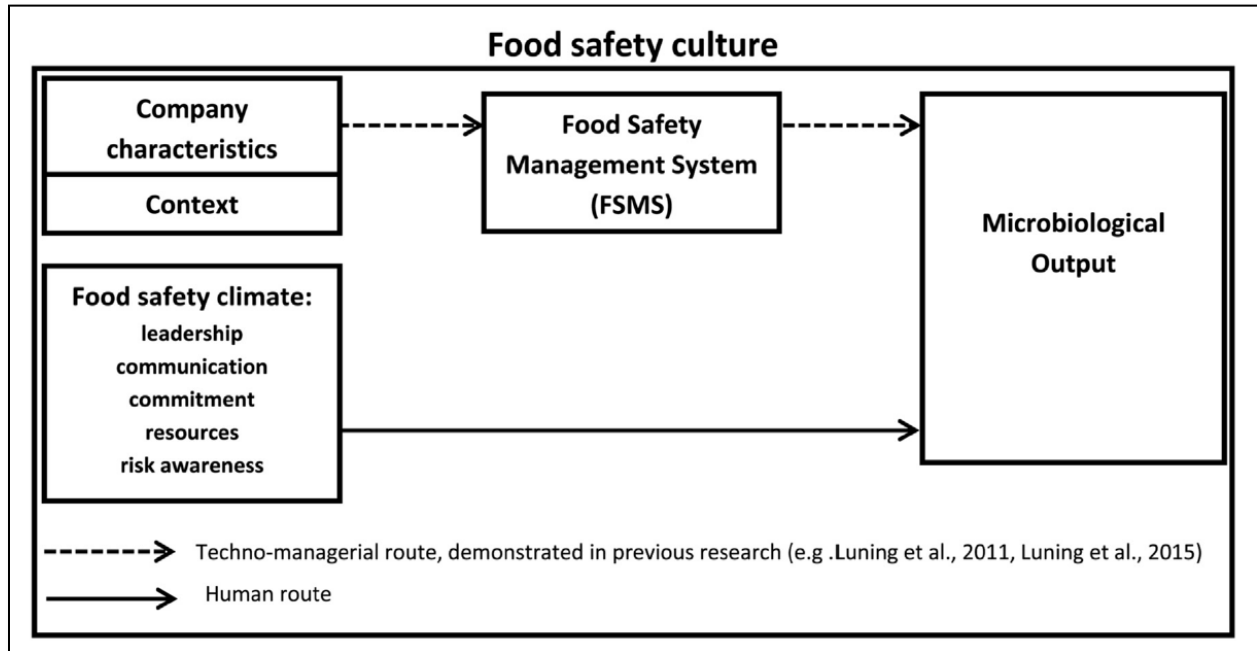
De Boeck et al.'s definition of food safety climate closely mirrors Griffith, Livesey, and Clayton's definition of FSC. Despite this, the two terms are not necessarily interchangeable.

In a review of the literature conducted in 2020, Sharman et al.[6] found that, while there was considerable overlap between FSC and food safety climate, there were also key differences. Food safety climate tended to be associated with a temporary timeframe and was often framed as the attitudes and perceptions of individuals at *a point in time*. In contrast, FSC was associated with an extended period, often framed as the enduring beliefs, behaviors, assumptions, and practices of the organization.

Based on their review of the literature, Sharman et al.[6] proposed these definitions:

Food safety culture is defined as a long-term construct existing at the organizational level relating to the deeply rooted beliefs, behaviors and assumptions that are learned and shared by all employees, which impact the food safety performance of the organization.

Food safety climate is a temporary construct existing at the individual level, relating to the perception and attitudes of individuals and how they influence

others in an organization to adhere to the food safety management systems and practically apply these in their working environment.[6, pg. 16]

Literature drawing primarily from the Griffith, Livesey, and Clayton model tends to use the term FSC. Those using the De Boeck et al. model use both terms, but tend to focus on tools measuring food safety climate when assessing a FSC.

Classifying a FSC

Across models of FSC, there is a recognition that an organization's FSC can have a positive or negative influence on food safety. In the reviewed literature, there were three approaches to classifying what type of FSC an organization possessed:

- Griffith et al.[4] describe an organization's FSC as on a continuum from positive to negative. A positive FSC places a priority on food safety as an important business objective and reflects compliance with food safety requirements. In contrast, a negative FSC is dominated by business objectives other than food safety and results in poor compliance with food safety requirements.

- Nyarugwe et al.[42] classifies FSC as reactive, active, or proactive. A reactive FSC acts only when there is a need, in response to a problem or an inspection finding. An active FSC adheres (at least partially) to food safety requirements but lacks a complete understanding of and commitment to food safety. A proactive FSC, on the other hand, focuses on anticipating and preventing problems.

- Jespersen et al.[12,18] characterizes FSC by its maturity, which is described in five stages: (1) doubt, (2), react to, (3) know of, (4) predict, and (5) internalize. FSCs with less maturity doubt the need to make food safety a priority and tend to react to specific situations. Those with more maturity make food safety a priority and attempt to predict problems before they happen, and (in the final stage) internalize the importance of food safety.

FSC at the Organizational, National, and Individual Level

Throughout the review, the concept of FSC is almost exclusively discussed at the organizational level, in terms of businesses, including manufacturing, food processing, and retail. However, Nyarugwe et al.[13] argue there is also a national FSC that incorporates both national values and a nation's food safety governance. Nyarugwe has employed this model in studies of FSC in Zimbabwe.[42,54] However, the concept of FSC at the national level was applied in only one other study, conducted in Central and Eastern European countries.[52] In this study, researchers assessed various FSC components of more than 500 food companies, finding that EU companies (versus non-EU companies) displayed the stronger FSC which the authors attributed to the less transitional economic environment of EU countries. Most of the literature discusses FSC

at the organizational level. The literature does not address the concept of FSC at the level of individual consumers.

2. Who are FSC's key thought leaders?

Frank Yiannas is often credited with bringing the concept of FSC to the forefront of the literature on food safety[79] with his 2009 book *Food Safety Culture: Creating a Behavior-Based Food Safety Management System*.[3] In addition to Yiannas, several researchers, including Christopher Griffith,[2,4,57,59,62,73] Gary Ades,[8] and Louise Manning (and their co-authors),[53,55,70,71,80] have published books and articles conceptualizing FSC and its key determinants. Similarly, several researchers, most notably E. De Boeck,[5,11,24,25,32,41] Lone Jespersen,[12,18,26,43,44] and Shingai Nyarugwe (and their co-authors),[10,13,42,54] developed FSC assessment tools that were used repeatedly in studies throughout the literature.

Most of the conversation in the literature has been driven by academic researchers. However, the Global Food Safety Initiative formed a working group in 2015 specifically to focus on FSC. In 2018, the working group published a position paper, *A Culture of Food Safety*,[7, pg. 3] as a "blueprint for embedding and maintaining a positive culture of food safety in any business, regardless of its size or focus."

In addition, individuals representing a variety of organizations led or contributed to publications or presentations that researched or promoted FSC [see page 29 for a discussion on how FSC is promoted]. These individuals were from several manufacturing organizations, including Bush Brothers,[26] Cargill inc.,[26] ConAgra Foods,[74] Dupont,[75] Glanbia,[29] Land O'Frost,[26,31] Land O'Lakes,[29] Maple Leaf Foods,[58] Red Diamond Coffee & Tea,[31] as well as one food service organization, JW Marriott Marquis.[64]

Summary of "What is Food Safety Culture?"

About four-fifths of the literature define FSC, with most citing definitions provided in earlier works. In the literature reviewed, the most frequently cited definition is from Griffith, Livesey, and Clayton, who define FSC as:

> *The aggregation of the prevailing, relatively constant, learned, shared attitudes, values and beliefs contributing to the hygiene behaviours used within a particular food handling environment.*[2, p.435]

In his 2009 book *Food Safety Culture: Creating a Behavior-Based Food Safety Management System*, Frank Yiannas differentiated FSC from a food safety management system (FSMS) or employee knowledge of food safety practices, writing, "While having a FSMS is critical, food safety culture looks beyond just processes to

human behavior."[3] This distinction is found throughout the literature, and discussions of FSC focus on shared attitudes, values, and beliefs about food safety held by both employees and leadership in an organization.

Griffith, Livesey, and Clayton[4] conceptualize FSC as interacting with food safety management, systems, style, and processes to determine food safety performance. In contrast, De Boeck et al.[5] conceptualize FSC as the interplay between FSMS and what they call a "food safety climate." De Boeck et al.'s definition of food safety climate closely mirrors Griffith, Livesey, and Clayton's definition of FSC. Despite this, the two terms are not necessarily interchangeable. In a review of the literature conducted in 2020, Sharman et al. [6] found that, while there was considerable overlap between the two concepts, food safety climate tended to be associated with a temporary timeframe and was often framed as the attitudes and perceptions of individuals at a point in time. In contrast, FSC was associated with an extended period of time, often framed as the beliefs, behaviors, assumptions, and practices of the organization as a whole.

Throughout the review, the concept of FSC is almost exclusively discussed at the organizational level, in terms of businesses, including manufacturing, food processing, and retail. Very few studies look at FSC at the national level and none of the literature addresses FSC at the individual consumer level.

Although the term FSC itself predates him, Frank Yiannas is often credited with bringing the concept of FSC to the forefront of literature on food safety.[3] Most of the conversation in the scientific literature has been driven by academic researchers, including Christopher Griffith, E. De Boeck, Lone Jespersen, and Shingai Nyarugwe. In industry, the Global Food Safety Initiative is a key voice in the conversation around FSC, providing resources on FSC for its members. FSC has also begun appearing in trade magazines, with contributions from large food manufacturers, including Bush Brothers, ConAgra Foods, Dupont, Land O'Frost, Land O'Lakes, and Maple Leaf Foods.

B. How is FSC created and promoted?

The section addresses how FSC is created, its key determinants, and best practices for (and challenges to) developing and maintaining an effective FSC. We also summarize the literature on how FSC is promoted among organizations and consumers. We look at how regulatory agencies promote FSC and examine the promotion of FSC on social media.

1.   How is FSC created?

More than half of the articles reviewed discussed key determinants, best practices, or challenges to creating a strong and effective FSC. Most of these articles do not include research methods in their summaries.

While there is not just one approach to creating and sustaining a positive FSC,[7] researchers identify numerous key determinants (also referred to as elements or components) that inform and contribute to an organization's FSC. There is general consensus in the literature on the determinants of FSC, although the terminology used to describe them varies across the literature. The key determinants identified consistently can be summarized as: A) leadership; B) communication; C) commitment to food safety; D) risk awareness; E) environment; F) accountability; and G) employee knowledge, attitudes, behaviors, and values.

A. Leadership is the most often cited key component of FSC. FSC starts with leaders and flows downward. This is because leaders have the power to establish what is important to the organizational system; employees can only embrace the principal FSC behaviors if leaders create and facilitate an environment conducive to learning and practicing them.[3,4] Leaders set the direction and tone for an organization's FSC by supporting, aligning, and contributing to the organization's overall vision and mission, as well as by motivating and supporting employees to address food safety.[7] Leaders must be "fully accessible, highly visible ambassadors and advocates for food safety excellence, both internally and externally."[29] Griffith et al. further expounded that top management should be aware of their own role and responsibilities in forming culture while providing their managers with the skills to create and maintain a positive FSC at all levels but particularly at the middle management or unit level.[4]

B. Communication refers to the quality of the transfer of food safety messages and information sharing across the organization. Organizations with a positive FSC have a well-defined food safety communication strategy that involves regular reiteration of the importance of food safety by employees at every position level.[38,73] When communicating food safety information, organizations should use multiple mediums and communication channels to increase the likelihood of reaching employees and to

demonstrate that food safety is an important part of the organization's culture.[3] However, beyond simply talking to employees about food safety, leaders should have food safety conversations with them where employees can provide feedback and have the freedom to challenge and discuss practices.[3,4,37,76] Communication should be regularly measured (e.g., via online surveys and employee focus groups) to ensure that food safety messaging is reaching and resonating with employees.[7] Exhibit 10 lists characteristics of effective communication as described by Ades et al.[8]

Exhibit 10. Characteristics of effective FSC messaging[8]

- Understandable
- Tangible
- Compelling
- Rapid
- Relevant
- Reliable
- Repeated
- Multilingual
- Culturally sensitive

C. Commitment to food safety is the extent to which an organization consistently values and prioritizes food safety. Ades et al.[8] described commitment as a critical ingredient to creating FSC where all employees, at every level, are "dedicated to doing everything within their power to ensure that food is grown, processed, prepared, handled, merchandized, and distributed properly so that the customer and consumer have the lowest possible risk of illness." Powell[49] further noted that organizations with good FSCs are committed to practicing risk reduction daily. To demonstrate commitment, organizations should make food safety a dominant business objective reflected in the organization's vision, mission, and values and regularly updated.[3,4]

D. Risk awareness is the perception as well as the understanding at all levels and functions of actual and potential hazards and risks associated with food safety.[7,37] Research[4,62] has shown that an "…individual's assessment of the chance of being affected will often dictate their subsequent behaviour to mitigate the risk in question."[76] Thus, all employees should know the risks associated with the products they produce, know why managing the risks is important, and be able to effectively manage those risks.[49] As such, training and education should be risk-based with emphasis on the topics, tasks, and behaviors that are more frequently associated with foodborne diseases.[3] In addition, organizations should adapt a proactive approach to meeting food safety requirements, including a mindset focused on prevention and collaboration within the organization and supply chain.[75,76]

E. Environment is the visible or evident organizational structures, processes, and activities (e.g., resources, equipment, buildings, staff, training) available within an organization that enables proper food safety.[4] This also includes the management systems and procedures in place to control food safety and remove barriers.[4,15,27,57] The food safety environment has a large effect on behavior. For example, if there are adequate facilities, food safety is perceived to be supported; conversely, a lack of adequate facilities communicates that food safety is not important. [76] To foster a sustainable FSC, it is also important for organizations to keep current on the latest industry intelligence, including market incidents, emerging food safety risks, changes to food safety legislation, and significant new technology.[7,49]

F. Accountability is the ability to hold employees at all levels responsible for food safety performance. This includes developing and documenting specific food safety performance expectations that are simple, clear, risk-based, and relevant.[3,7] Feedback on performance should be timely, regular, balanced, and consistent.[29] Some researchers[8,31,49,73] recommend using positive and negative consequences for noncompliance, with Yiannas[3] describing consequences as "one of the most important ways to shape or reinforce proper food safety behaviors." Meanwhile, others caution that overwhelming negative consequences can result in negative reactions and a disengaged workforce[31] and promote a "culture of punishment."[34] Research suggests using positive reinforcement such as incentives or rewards that fairly recognize individual and collective contributions[34,70] or a combination of both consequences and incentives.[3,49]

G. Employee characteristics such as knowledge, attitude, behavior, and values can impact a FSC**.** For example, higher personal trait conscientiousness has shown to predict both enhanced self-reported food safety behavior and a stronger perception of food safety climate in an organization.[33] Additionally, the way that food safety is socially constructed amongst peers within the work setting can strongly influence the value placed on it by the individual. Employees who emphasize food safety and teamwork positively influence their coworkers' food safety behaviors.[15,58] Thus, engaged, empowered, committed employees who feel they contribute to a safe food environment are essential for a positive food safety culture.[29,58,70]

Challenges and barriers to a strong and effective FSC

Among the articles that discuss key determinants, some researchers also identify challenges and barriers to establishing and maintaining a strong and effective FSC. However, challenges and barriers are not discussed by industry authors.

Over-reliance on FSMSs. FSMSs have an integral role in food safety within an organization; however, these systems do not address the human impact on food safety

and do not guarantee a good FSC.[4] In a case study examining the interplay between food safety climate and FSMS conducted by De Boeck et al.[24] researchers found that butcher shops were able to achieve a better microbiological hygiene and safety status with the implementation of a well elaborated FSMS and a favorable food safety climate. However, it was unclear if the food safety climate, FSMS, or their interplay was responsible for the achievement. They also found a good food safety climate may not be sufficient to counteract a lower performing FSMS.[24]

Prioritization of cost-saving and money-earning. Griffith noted cost-saving as the main rival to a positive FSC.[57] In reality,a food safety incident caused by a negative FSC could result in devastating economic losses for an organization.[61] For example, John Tudor & Sons, a catering butcher business focused on profit over food safety, ignored microbiological hazards that ultimately resulted in the largest E.coli outbreak in Wales and the company went bankrupt.[21] As stated above, a commitment to food safety must take precedence over other objectives and cultures that compete for priority within an organization, including the culture of saving money.[4]

Organization size. The impact of an organization's size on FSC is not clear within the literature. Some research has shown that it may be harder to improve FSC in smaller organizations because of intrinsic environmental characteristics such as a small workspace or a lack of resources.[23] Nyarugwe et al.[42] found that FSC was generally better in larger, centrally managed organizations. Conversely, Griffith [59] noted that there can be challenges with larger companies as a variety of sub-cultures can exist sometimes at different levels within the organization. For multi-site organizations, FSC often depends on the individual site manager and their beliefs and values.[59] However, organization size may not be a factor as De Boeck[41] found no significant difference in food safety climate scores by organization size.

Frequent staff turnover. Organizations in the food industry often deal with high staff turnover which then requires frequent and sufficient training and supervision of all incoming staff.[63,71] This continuous turnover can be detrimental to key determinants of FSC, such as risk awareness and accountability. De Boeck et al.[32] found food safety climate was positively correlated with employees who had either seniority or permanent contracts in the food industry but negatively correlated with employees who had temporary contracts.

Optimistic bias. Beyond risk awareness, some organizations or employees may be skeptical or have an "illusion of invulnerability"[63] which may hinder effective implementation of food safety behaviors. Without perceiving a susceptibility to food contamination, people often resist a focus on it unless they can see the value.[8]

2. How is FSC promoted?

A few of the articles reviewed went beyond discussing FSC's key determinants, describing specific strategies and best practices for promoting FSC in the food industry. None of the articles discuss how FSC is currently being promoted among consumers.

FSC Promotion in Organizations

The literature contained only a few publications that serve as guides for organizations looking to develop and maintain a positive FSC.

Yiannas' (2009) book[3] is a guide primarily for food safety professionals that introduces new ideas and concepts around FSC. Yiannas discusses behavior-based food safety and the need for organizations to create a FSC rather than a food safety program. The book describes the core elements, best practices, and importance of FSC.

Ades et al.'s book *Food Safety, A Roadmap to Success* is aimed at helping food safety professionals and food businesses build a strong FSC. The authors provide "step-by-step methods and easy-to-use 'roadmaps' to implement the principles and requirements of food safety culture into a food business."[8] Similarly, the GFSI has promoted FSC among businesses with its publication of *A Culture of Food Safety*.[7] GFSI describes this position paper as a "blueprint for embedding and maintaining a positive culture of food safety in any business, regardless of its size or focus." It is "designed to help food industry professionals promote and maintain a positive culture of food safety within their respective organizations."[7, pg. 3]

In addition to these guides published for organizations, the literature also describes some best practices for promoting FSC:

1. **FSC should be promoted as a necessary and critical business issue for all employees.**[76] Food safety should be a topmost goal of each member of the organization, not just a goal of a specific group in an organization.[8] However, researchers recognize that promoting FSC can be a challenge that requires a "balancing act among competing motivations for the company, the management, and the workers."[45]
2. **Organizations should brand their commitment to FSC and promote it everywhere.** This includes displaying food safety messaging in break rooms, hallways, elevators, parking lots, or anywhere employees congregate so employees don't forget it.[8] However, Yiannas cautions that simply putting up food safety posters, signs, and symbols may miss the mark, and notes that "to be effective, they [food safety messaging] should be simple, communicate what the desired behavior is, be placed where the desired behavior should occur, and changed often enough to prevent desensitizing."[3, pp.55]
3. **FSC should be promoted using the "owner mentality" concept**. Ultimately, the goal of promoting FSC is to "convince people to change their behavior" to achieve food safety

expectations. Aligning individuals' attitudes and values with those of an organization is a transformational process.[75] An organization's food safety messages should be built on the concept of 'we.' This collective consciousness can inspire employees to do the right thing, solve problems themselves, and help them assume ownership of their role in ensuring consumer safety and brand protection.[3,8] Moreover, when promoting FSC organizations should speak the language of their employees and clearly define how their job objectives align with food safety.[8]

4. **FSC should not only be promoted within an organization, but also within its supply chain**. A strong FSC is not limited to the organization; an organization requires a strong FSC across its supply chain. Powell et al. (2013) writes, "Open communication between suppliers and buyers including expectations and risk management practices is essential. Systems where retailers work with their suppliers to help them achieve objectives have had somewhat better buy-in from suppliers and may achieve better results because they reinforce that culture."[56]

FSC Promotion among Consumers

None of the articles examine or evaluate how FSC is promoted among consumers.[†] A few articles identified in the initial search discussed general food safety public education campaigns, but they were not related to FSC and were excluded from the review.

3.   How does a government regulatory agency promote FSC?

Two articles examined the relationship between government agencies' regulations and FSC. International research has shown that government regulatory agencies' policies and procedures can influence an organization's FSC, with stronger FSC generally found in countries with more food safety regulations. Tomasvic et al.[52] used De Boeck et al.'s Food Safety Climate Self-Assessment Tool[5,11] to survey food companies in Central and Eastern European countries. They found companies in European Union (EU) countries under extensive food safety legislation and strict enforcement practices, had significantly stronger food safety climates than non–EU Central and Eastern European food companies with less consistent regulation. Similarly, Nyarugwe et al.[10] compared the FSC in 17 food companies from four countries (Tanzania, Zambia, Greece, and China) and found national values and food safety governance (e.g., public legislation, private standards, and public and private enforcement practices) seemed to influence

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[†] One article briefly mentioned FSC among consumers. Bjelajac and Filipović argued, "Both the television and the new media that broadcast video content have the potential to inform, and then to promote values of food safety culture, not only through culinary or agricultural shows but values embedded in the rest of their programming."[37, pg. 616] In the discussion, however, the authors focused on the role media plays in unhealthy diet choices.

the prevailing FSC of the companies. However, there is a gap in the literature on what specific elements of food safety governance promote a stronger FSC.

Initiatives

Only two initiatives specific to promoting FSC in a regulated industry were identified in the review as being implemented by regulatory agencies. This includes FDA's "New Era of Smarter Food Safety" and a new regulation from the European Union (EU).

The U.S. Food and Drug Administration unveiled its blueprint for the "New Era of Smarter Food Safety" initiative in 2020. The initiative outlines "a new approach to food safety, including leveraging technology and other tools to create a safer and more digital, traceable food system."[78, pg. 1] One of the core elements of this initiative includes fostering, supporting, and strengthening FSCs on farms, in food facilities, and in homes. This involves promoting FSC throughout the food system and within the FDA, as well as developing and promoting FSC for consumers.

In 2021 the EU Commission revised their food safety regulations to introduce FSC as a general principle and global standard requiring food business operators in the EU to establish, maintain, and document an appropriate FSC.[77] The regulations require food business operators to provide evidence showing they meet the following (paraphrased or summarised) requirements:

(a) employee and management commitment to producing and distributing safe food;
(b) leadership and employee engagement in safe food practices
(c) all employees must be aware of food safety hazards and the importance of food safety
(d) open and clear communication between all employees
(e) sufficient resources to ensure safe food

The regulation further specifies multiple criteria for demonstrating management commitment ("a" from the general requirements above). Currently, there is no information beyond the regulation detailing exactly how food businesses are to comply.

Promotion of FSC on social media

A scan of social media was conducted to examine how FSC is promoted among organizations, consumers, and government regulatory agencies. Based on the results of the scan, it was determined that FSC was not highly promoted on social media. The social media search revealed fewer than 1500 mentions of FSC and organizations, consumers, or government agencies; 1500 "hits" is considered low for this type of social media review, suggesting the topic is not popular on social media. None of the mentions had significant engagement (e.g., shares, retweets). Most conversations were on blogs

or Twitter, and no organization, person, or agency was identified as having influential or robust FSC presence on social media.

Social media posts relevant for organizations included posts promoting food safety certifications (e.g., SALSA, HACCP, FSSC 22000), posts marketing FSC consulting services (see Exhibit 11), posts promoting conferences, white papers, and webinars, posts reviewing FDA's New Era of Smarter Food Safety, and European Union Commission legislation.

Exhibit 11. Example social media post promoting consulting services to build FSC

Social media posts intended for consumers were less directly related to FSC and more focused on food safety:

- FDA's New Era of Smarter Food Safety,
- News of Canada's ban on steak tartare,
- Publication of the United Kingdom's cold chain guide,
- UK survey showing the public is more aware of food safety since the COVID-19 pandemic began,
- Celebration of World Food Safety Day (Nestle Pakistan, McDonald's and Grab Philippines) (see Exhibit 12),
- The Partnership for Food Safety Education's Fight BAC! Campaign.

Exhibit 12. Example social media post directed toward consumers

The social media scan revealed very few government regulatory agency FSC discussions on social media. The most relevant social media posts during the one-year scan were: 1) promotion of food safety conferences (e.g., Food Safety Summit, Food Safety Consortium, FSA Regulatory Analysis Conference); 2) an announcement by the EU regarding its new FSC legislation; and 3) Janet Woodcock's and Frank Yiannas' FSC opinion piece, Summary of "How is Food Safety Culture Created and Promoted?"

Summary of "How is Food Safety Culture Created and Promoted?"

While there is not one approach to creating and sustaining a positive FSC,[7] researchers have identified numerous key determinants (also referred to as elements or components) that contribute to FSC. The key determinants identified consistently can be summarized as: leadership; communication; commitment to food safety; risk awareness; environment; accountability; and employee knowledge, attitudes, behaviors, and values. The literature also acknowledged challenges and barriers to establishing and maintaining a strong and effective FSC. Barriers identified in the literature include over-reliance on FSMS, prioritization of cost-saving and money-earning; organization size; frequent staff turnover; and optimistic bias*.*

The literature identified a few publications that serve as guides for organizations looking to develop and maintain a positive FSC, including Yiannas' book *Food Safety Culture,*[3] Ades et al.'s book, *Food Safety, A Roadmap to Success*,[8] and the GFSI's publication *A Culture of Food Safety*.[7] The literature also described some best practices for promoting FSC, including promoting FSC as a necessary and critical business issue for all employees, branding the organization's commitment to FSC, framing FSC with an "ownership mentality," and promoting FSC throughout the organization's supply chain.

International research has shown that government regulatory agencies' policies and procedures can influence an organization's FSC; however, this literature does not distinguish what specific elements of food safety governance promote a stronger FSC.[10,52]

C. How is FSC assessed?

This section addresses the question of how FSC has been assessed in the past decade. We summarize the literature on measures and approaches developed to assess FSC, how measurement processes may differ between organizations, and how a regulator might evaluate FSC in industry and in their own agency. We also discuss the outcomes studied and associated with FSC, particularly the relationship between FSC and foodborne illnesses or outbreaks. Finally, we look at how the value of FSC has been measured and articulated within the literature.

1.   What are the existing measures of FSC?

About a quarter of the articles in this literature review discussed measures for assessing FSC within organizations. Most of the FSC assessment tools developed were survey instruments that assessed different aspects and constructs of FSC, including leadership support, infrastructure and technology support, and individual attitudes and values.[5,9,11,14,15,17,18,26,39,43] These FSC constructs generally align with the determinants of FSC discussed in earlier sections of this literature review. Exhibit 13 presents FSC assessment tools that were identified by the literature search and highlights the FSC constructs assessed within each tool. The aims of these instruments were mostly to help organizations understand why employees may or may not perform safe food handling practices.[4,15,69] For that reason, the instruments generally surveyed personnel at different levels within an organization, including upper management, middle management, and food handlers. Other methods mentioned in the literature for assessing FSC in an organization include third-party audits, verifications of certain kinds of data, focus groups, and observations of employee behavior.

Many of the instruments were developed and validated using mixed-methods, including reviews of the literature, focus groups with food safety experts, and psychometric analyses. Some of the survey development efforts used a triangulation approach for developing and validating their FSC constructs, combining multiple methods such as surveys, interviews, and audits.[11-13] The tools usually focus on one organization or industry such as manufacturing,[12,26,43,74] food service,[11,15,39,51,65,68] and food processing.[14,16,42] There was no indication of whether the measurement constructs and scales would apply equally across different organizations or food industries. Some of the literature did not mention a specific type of food organization or industry when discussing FSC tools.[9,17,39,46,76,81] Some of the articles acknowledged that their assessment tools should undergo further validation within and between countries as different laws and regulations may mitigate the use and reliability of the FSC constructs.[9,11,26,39,52]

Many of the FSC assessment tools adapted concepts from traditional organizational culture assessment tools and applied them within a food safety context and framework. Two of the earliest and most common cited assessment tools that applied this strategy were Ball et al.'s Food Safety Climate Tool[14] and De Boeck et al.'s Food Safety Climate Self-Assessment Tool.[5] While the individual survey items and definitions for the constructs differed, there were overlapping themes that these tools aimed to monitor, including leadership, communication, risk awareness, infrastructure or resources, and individual values or commitment.

Most of the literature has continued building upon these two assessment tools, by adding new constructs or subdomains to previous constructs.[9,15-17] For example, Tomasevic et al.[9] added knowledge, business priorities, and legislation as components to De Boeck et al.'s Food Safety Climate Self-Assessment Tool. Other publications also focused on redefining or modifying previous constructs. For instance, Zabukosek's Food Safety Measurement Scale[16] addresses employee collaboration as opposed to the values and commitment construct, to focus on the concept of employees working with each other to promote food hygiene.

The assessment tools leveraging Ball et al. and De Boeck et al.'s framework aggregated the survey responses from participants and provided an average score for each of the measurement constructs assessed by the respective FSC tool. These scores provided an assessment of an organization's FSC at a given point in time (which both De Boeck et al.[5] and Griffith et al.[5] would define as the current food safety climate).

Jespersen et al.'s Food Safety Maturity Models[12,18] align survey responses with levels of maturity across five capability areas. Maturity models are traditionally used to evaluate the state of a given culture, system, business or process, and to develop improvement plans against a scale of maturity. Jespersen's model assesses an organization's FSC maturity across five capability areas: 1) Values and Mission, 2) People Systems, 3) Adaptability, 4) Consistency, and 5) Risk and Hazards. Although the complete Food Safety Maturity Model assessment tool was not publicly available, the authors described each stage of maturity as follows:

- Stage 1, "Doubt," is characterized by questions such as "Who messed up?" and "Food safety – quality assurance does that?"
- Stage 2, "React," is characterized by questions and statements such as "How much time will it take?" and "We are good at fire-fighting and reward it."
- Stage 3, "Know of," is characterized by statements such as "I know it is important but I can fix only one problem at a time."
- Stage 4, "Predict," is characterized by statements such as "Here we plan and execute with knowledge, data and patience."
- Stage 5, "Internalize," is characterized by situations such as "Food safety is an integral part of our business."

Another unique aspect of Jespersen et al.'s Food Safety Culture Maturity Model is that it accounts for potential social desirability bias (i.e., an employee's tendency to want to provide positive responses to FSC questions).

Only one assessment tool—a 2012 toolkit from the United Kingdom—was identified as being developed by a regulatory agency. The United Kingdom's Food Standards Agency (FSA) commissioned a toolkit in 2012 that was designed to help environmental health officers assess the 'softer' aspects of food safety risk, including safety culture, management attitudes and behaviors, and compliance with hygiene regulations. However, a qualitative study with thirty industry stakeholders found the toolkit complicated, repetitive, lacking employee feedback, and not adaptable to different sizes and types of businesses.[46]

Exhibit 13. Food Safety Culture and Climate Assessment Tools (in chronological order)

Tool Lead Author (Year) / Affiliation	Tool Description	Constructs (Sub constructs) Measured
Food Safety Climate Tool Ball (2010)[14]/Academia Neal (2012)[67]/Academia	2010 iteration consisted of 51 items using a seven-point Likert-scale (*strongly disagree to strongly agree*) 2012 iteration consisted of 44 items using a five-point Likert-scales (*strongly disagree to agree strongly; never to always*)	• Management commitment to food safety (including leadership and resource allocation) • Work unit commitment to food safety (including supervisor, co-worker and personal commitment) • Food safety training • Infrastructure for food safety • Worker food safety behavior
UK Food Standards Agency Toolkit Wright (2012)[76]/ Consulting firm	Constructs scaled on level of safety culture in an organization: • Calculative non-compliers • Doubting compliers • Dependent compliers • Proactive compliers • Leaders	• Leadership • Role of the owner • Competence • Employee engagement • Communication • Attitudes and priorities • Risk perception • Knowledge of and trust in the FSMS
Food Safety Culture Measurement Scale Abidin (2014)[15]/Academia	31 items using a seven-point Likert-scale (*strongly disagree to strongly agree*)	• Management and co-worker support • Communication • Self-commitment • Environmental support • Work pressure • Risk judgement
Food Safety Climate Self-Assessment Tool De Boeck (2015)[5]/Academia De Boeck (2019)[11]/Academia	28 items using a five-point Likert-scale (*strongly disagree to strongly agree*)	• Leadership • Communication • Commitment • Resources • Risk awareness
Food Safety Maturity Model (FSMD) Jespersen (2016)[18]/Academia Jespersen (2017)[12]/Academia	Proprietary instrument. Constructs scaled on level of food safety maturity of an organization: • Doubt • React to • Know of • Predict • Internalize	• Perceived value • People system • Process thinking • Technology enabled • Tools and infrastructure

Tool Lead Author (Year) / Affiliation	Tool Description	Constructs (Sub constructs) Measured
Food Safety Measurement Scale (adapted) Zabukošek (2016)[16]/Academia	39 items using a seven-point Likert-scale (*strongly disagree to strongly agree*)	• Leadership and employee support (Management commitment, Employee collaboration, and Management control) • Communication • Employee engagement and self-commitment (Compliance with rules, and Hygiene and food safety) • Support • Work pressure • Risk judgement • Training efficiency
Food Safety Desirability Response Scale (FSDSR) Jespersen (2017)[43]/Academia	19 items using a five-point semantic scale: • Not at all like me • Not like me • Neutral • Like me • Just like me	• Self-Deception – assertion of positives • Image Management • Self-Deception - denial of negatives
Food Safety Maturity Model V2 (FSMD v2) Jespersen (2019)[26]/Academia	Constructs scaled on level of food safety maturity of an organization: • Doubt • React to • Know of • Predict • Internalize	• Values and Mission (Integrity and trust, Being responsible, and Ethics) • People System (Reward and recognize, Competently communicating, and Together we make the difference) • Adaptability (Innovative, and Embrace and drive change) • Consistency (Data and reporting, Technology enabled success, and Quality of all we do) • Risks and Hazards (*Risk perception*)
The Culture Excellence Assessment Tool Taylor (2018)[17]/Consulting firm	Proprietary instrument	• People (Empowerment, Reward, Teamwork, Training, and Communication) • Process (Management control, Co-ordination, Consistency, Systems, and Premises) • Purpose (Vision, Values, Strategy, Targets, and Metrics) • Proactivity (External awareness, Risk foresight, Innovation and change, Organizational learning, and Investment)

Tool Lead Author (Year) / Affiliation	Tool Description	Constructs (Sub constructs) Measured
Food Safety Maturity Index (FSCMI) Tomei (2019)[39]/Academia	24 items using a five-point Likert scale (*totally disagree to totally agree*)	• Leadership • Risk Perception • Management System • Communication • Commitment • Pressure at Work • Teamwork
Food Safety Climate Self-Assessment Tool Tomasevic (2020)[9]/Academia	9 items using a five-point Likert-scale (*strongly disagree to strongly agree*)	• Knowledge • Business priorities • Legislation

2. What outcomes are associated with FSC?

Very few articles (less than 10) reported empirical outcomes associated with having a strong FSC. On the other hand, case studies of three large foodborne illness outbreak events cited weak FSCs as the reason (see cases descriptions in Exhibit 14). Across these case studies, organizational leaders had little regard for food hygiene and often prioritized cost savings over food safety, resulting in poor cleaning and maintenance of equipment and poor food safety behavior among employees. Based on their findings from these case studies, the authors hypothesize that employees in strong food safety cultures strongly comply with food safety standards, resulting in better food quality and less risk of foodborne illness outbreaks. However, none of the case studies identify a direct link between strong FSC and better food quality.

Exhibit 14. Case Studies Linking Poor FSC to Foodborne Illness Outbreaks

Company Name	Year of Event	Summary of Event	Cited in Reference Number
John Tudor & Son	2005	Meat in South Wales infected with E. coli O157:H7 caused 157 illnesses (primarily children).	21
Maple Leaf Foods, Inc.	2008	*L. monocytogenes*-contaminated deli meats caused 57 illnesses and resulted in 23 deaths	19
Peanut Corporation of America	2009	Peanuts infected with Salmonella serotype Typhimurium caused more than 700 illnesses and 9 deaths.	20

A few empirical studies (N=6) directly examined the relationship between FSC and outcomes. The outcomes examined included the presence of pathogens in food or on food equipment, handwashing, study-assessed violations of food safety regulations, and economic impact. Most researchers administered surveys to staff to assess an organization's FSC and the relationship of FSC to food safety outcomes. These studies covered various food environments, including delicatessens, restaurants, food manufacturers, and processors. Exhibit 15 summarizes the study outcomes.

Exhibit 15. Empirical studies examining outcomes associated with FSC

Lead Author (Year)[Citation No]	Outcome(s) Examined	Location	Study Details	Relationship between FSC and Outcome
Clark (2019)[22]	Hand washing (HW) frequency	USA	Surveyed 124 participants from 66 restaurants to assess Food Safety Climate (as an indicator of FSC) and hand washing frequency. Perceptions of managerial commitment to hand washing were significantly and positively correlated to employee handwashing. Authors also found that role overload was a mediating factor for managers, resulting in a lower priority for food safety.	Food Safety Climate is an aspect of the company's FSC at a point in time.
Jespersen[26] **(2019)**	Estimated economic impact (cost of poor quality – projected costs based on sales maturity models)	Multi-National (North American-based companies)	Data collected from 21 food manufacturing plants and 1273 participants of different functional roles and areas of the plants. A food maturity score was determined through self-report survey methods. A mean "cost of poor quality" was compared with the maturity assessment score resulting in an estimation of the economic impact of improving or weakening FSC.	Positive changes in FSC maturity could lead to potential economic gains.
De Boeck[25] **(2017)**	Compliance/ participation/ behavior	Belgium	Self-report surveys (N=85) from 2 vegetable processing companies. Investigated the relationship between food safety climate and food safety behavior as mediated by food safety knowledge and motivation.]	Food safety climate and food safety behaviors are a part of a complete model of FSC. Positive climate assessments directly and indirectly affect behaviors. Knowledge and motivation have different but positive mediating effects on behaviors.
De Boeck[24] **(2016)**	Microbiological hygiene (detection of *Listeria monocytogenes, Salmonella, E. Coli, Enterobacteria-ceae, Stapphylococcus aureus*)	Belgium	39 participants from 4 micro-scale and 4 large scale butcheries were assessed on food safety climate. FSC measured by combining measures of food safety climate, management systems, and microbiological hygiene status.	No significant relationship found between FSC and microbiological hygiene. FSMS may modify the relationship between FSC and microbiological hygiene.

Lead Author (Year)[Citation No]	Outcome(s) Examined	Location	Study Details	Relationship between FSC and Outcome
De Andrade[23] (2020)	Foodborne disease risk (i.e., the number of study-assessed violations of food safety legislation)	Sao Paolo, Brazil	63 managerial and 333 food handler survey respondents from 32 restaurants. Using self-report surveys and a restaurant risk categorization, elements of FSC were measured and reported and compared to the number of study-assessed regulatory violations.	Restaurants with higher scores on FSC (both the low-risk and high-risk restaurants) had fewer study-assessed food safety violations.
Wu (2020)[27]	Microbiological hygiene (risk of *Listeria monocytogenes*) and hand washing frequency	USA	498 participants from 60 retail delis surveyed on FSC. Self-report survey to assess relationship between FSC, hygiene, and risk of *Listeria monocytogenes* contamination.	Significant inverse relationship between FSC and risk of microbiological hygiene (i.e., delis with strong FSC had lower risk of *Listeria monocytogenes* contamination).

Summary of "How is Food Safety Culture Assessed?"

Nearly a quarter of the articles in this literature review discussed measures for assessing FSC within organizations. Most of the FSC assessment tools developed were survey instruments meant for dissemination to industry personnel at different levels within an organization, including upper management, middle management, and food handlers.

Many of the instruments were developed and validated using mixed methods, including literature reviews, focus groups with food safety experts, and psychometric analyses. Some researchers used a triangulation approach to develop and validate their FSC constructs, combining multiple methods such as surveys, interviews, and audits.[11-13] The literature does not indicate if measurement constructs and scales would work equally across different organizations, food industry sectors, or between countries.

Many of the FSC assessment tools adapted concepts from organizational culture assessment tools and applied them within a food safety context and framework. Two of the earliest and most common cited assessment tools that applied this strategy were Ball et al.'s Food Safety Climate Tool[14] and De Boeck et al.'s Food Safety Climate Self-Assessment Tool.[5] While the tools differ, they measure similar constructs, including: leadership, communication, risk awareness, infrastructure or resources, and individual values or commitment. Most FSC assessment tools in the literature build upon these two assessment tools, adding new constructs or sub-domains to previous constructs.[9,15-17] In contrast, Jespersen et al.'s Food Safety Maturity Models[12,18] assesses an organization's commitment to FSC on a 5-point continuum across five

capability areas: values and mission; people systems; adaptability; consistency; and risks and hazards. The "maturity" continuum begins with "doubt," and passes through stages of commitment to FSC, ending with the organization being rated as having "internalized" the norms and values associated with FSC. Only one assessment tool—a 2012 toolkit from the United Kingdom's Food Standards Agency —was identified as being developed by a regulatory agency, and this tool was found to be very difficult to use[46].

In the literature, three prominent case studies of foodborne illness outbreaks link poor FSC to those outbreaks.[19-21] While the authors of these studies hypothesize that food organizations with good FSC would better comply with food safety standards than organizations with poor FSC, none of the case studies provide empirical evidence for this presumption. Furthermore, relatively few empirical studies (N=6) directly examine the relationship between FSC and outcomes such as microbiological hygiene, safety behavior, and economic impact.[22-27] Most of these data, however, were self-report surveys of knowledge, attitudes, and perception of FSC. Two of the studies found that improved FSC or leadership support for FSC was associated with reports of improved employee food safety behavior (i.e., hand washing and motivation).[22,25] One study found that restaurants with a good FSC had fewer study-assessed food safety violations than restaurants with a poor FSC.[23] Only one study found a significant relationship between FSC and the detection of pathogens in the study environment.[27]

IV. Discussion

Overall, there is a general consensus in the literature on how to define FSC in industry. Authors agree that FSC is something beyond a procedural FSMS and that rules and regulations are insufficient to ensure the safety of the food; leaders and employees in organizations that handle food must have a set of values and beliefs dedicated to ensuring safe food.

However, a dearth of literature exists on FSC outside of the organizational context, perhaps because the concept of FSC itself draws upon theories of organizational culture. As a result, there is a gap in the literature about what a strong and effective FSC would look like among consumers. Similarly, most literature on FSC does not consider the diversity of employees' political, familial, racial, or other cultural identities, and that these identities may influence an organization's FSC.

Generally, researchers agree on the determinants of a strong and effective FSC: leadership; communication; commitment to food safety; risk awareness; environment; accountability; and employee knowledge, attitudes, behaviors, and values. The literature describes the importance of each in creating and maintaining a strong FSC. The literature describes some best practices for creating and maintaining a strong food safety culture, however there are a minimal number of tools or toolkits designed specifically to help the food industry with creating and promote an effective FSC. There is also very little on how government agencies can promote a strong FSC across the food supply chain.

Also, researchers in the literature reviewed assess an organization's FSC by building and expanding upon earlier assessment tools. The tools share several constructs (echoing the key determinants of FSC described above), including leadership, communication, risk awareness, infrastructure or resources, and individual values or commitment. However, more research is needed to assess the validity of these tools within different organizational settings as well as across different locations around the globe.

While only a few studies have directly examined the relationship between FSC and outcomes, the research to date suggests that improving FSC within organizations will improve food safety. More empirical studies are needed to fully demonstrate the connection between FSC and outcomes, including microbiological environment and other risks for foodborne illness outbreaks, reductions in contamination incidents, and improved economic effects.

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