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# Food Safety Culture in Food Manufacturing: Leadership, Training, and Internal Communication as Integrated Drivers of Safe Practices

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***Abstract***

Food safety culture has become a key determinant of effective food safety management in modern food manufacturing. Beyond formal compliance with HACCP and prerequisite programs, organizational factors shape how food safety is understood, prioritized, and practiced in daily operations. This integrative review synthesizes peer-reviewed literature published between 2015 and 2025 to examine how leadership, continuous training, and internal communication jointly influence food safety culture in production environments. From 436 identified records, 70 studies met the inclusion criteria after systematic screening and quality assessment. The evidence shows that leadership commitment and behavioural consistency provide the basis for safe practices, while ongoing, context-adapted training strengthens knowledge retention and risk awareness. Internal communication mechanisms, including incident and near-miss reporting, shift handovers, and routine safety discussions, support organizational learning and preventive action. Together, these elements act synergistically, reinforcing individual behaviour and collective responsibility for food safety.

***Keywords:*** food safety culture; food manufacturing; leadership; training; internal communication

## 1. Introduction

The psychosocial mechanisms through which leadership influences compliance represent a primary element of cultural architecture. Likewise, [1] is referenced for the negative effects of the laissez-faire style, while [2] and [3] attribute intrinsic motivation, open communication, and willingness to report to the transformational style, including in food service settings.

The development of leadership capacities at the managerial level constitutes a strategic intervention for strengthening organizational culture. With respect to leadership development, [4, 5], and [6] highlight that programs focused on transformational leadership, combined with experiential learning and managerial skill development, produce sustainable improvements in the maturity of safety culture. At the behavioural level, [2, 7], and [8] link transformational and ethical leadership to increased reporting intention, psychological safety, and open communication, while [7] and [9] show that a high-quality leader–member relationship strengthens promotive and prohibitive safety voice.

Internal incident-reporting systems complement food safety culture by facilitating organizational

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learning and continuous improvement. [10-12], and [13] describe internal reporting systems as vectors of organizational learning, feedback, and performance improvement, while [11] adds that closed communication loops and decentralized event management increase reporting rates and engagement. [14, 15], and [16] define just culture as a precondition for effective reporting, identifying barriers such as hierarchy, blame culture, and lack of anonymity, whereas [17] and [18] assign leadership and organizational climate the role of facilitating factors. [2] and [19] show that the behavioural integrity of leaders increases error reporting and the capacity to manage such errors, reducing safety violations, and [19] explicitly emphasizes the modelling role of managers.

Objectives

This integrative review aims to address the following research questions:

1. How do leadership styles and visible managerial practices influence food safety culture and employee safety behaviours in the food processing industry?
2. Which operational communication routines (shift huddles, shift handovers, escalations, safety moments) contribute to HACCP compliance, incident reporting, and audit performance?
3. What are the characteristics of effective incident and near-miss reporting systems, and how do just culture and leadership facilitate such reporting in the context of food safety?
4. How can emerging technologies (AI, IoT, blockchain) support preventive risk management, and how do they integrate with human expertise in hybrid systems?
5. Which tools and approaches for measuring food safety culture are validated, and what methodological challenges arise in assessing and comparing cultural maturity across organizations?

In the context of accelerated digitalization, traditional organizational factors (leadership, communication, reporting) interact with emerging technologies such as artificial intelligence, IoT sensors, and blockchain, which reshape decision-making flows and the distribution of responsibilities within HACCP systems. An integrated understanding of these human, organizational, and technological dimensions becomes essential for strengthening food safety culture in intelligent, interconnected production ecosystems.

## 2. Materials and Methods

### *2.1. Methodological Foundation*

This review used a structured literature synthesis approach designed to ensure transparency and reproducibility of the search and selection process, while allowing integrative thematic interpretation of evidence from diverse study designs. The approach combined structured database searching with an integrative thematic synthesis to capture both organizational and operational determinants of food safety culture across food manufacturing contexts.

### *2.2. Eligibility Criteria*

Studies were considered eligible if they met predefined inclusion criteria regarding design, population, thematic focus, publication period, and language. Eligible articles comprised empirical investigations employing quantitative methodologies, such as cross-sectional, cohort, or survey-based analytical designs, qualitative approaches including interviews, focus groups, or ethnographic case studies, as well as mixed-methods designs. The target population included employees, managers, or organizational units operating across all segments of the food industry, encompassing primary production, processing, distribution, retail, and food service (HoReCa). To ensure conceptual relevance, studies were required to explicitly examine relationships between at least two core constructs, namely food safety culture, internal communication, leadership, food safety training or education, and incident or error reporting. Only peer-reviewed articles published between 1 January 2015 and 31 December 2025 and written in English were included in the final synthesis.

Studies were excluded if they consisted of opinion papers, editorials, narrative reviews, letters to the editor, or conference abstracts, as well as publications that had not undergone peer review. Single case studies lacking rigorous methodological analysis were also excluded. In addition, articles published outside the predefined time frame or in languages other than English were deemed ineligible.

### *2.3. Review objectives and guiding questions*

Leadership and food safety culture maturity: How do transformational and ethical leadership styles influence food safety culture maturity and safety-related behaviors in food production environments?

Internal communication and HACCP adherence: How do formalized internal communication

practices (e.g., shift huddles, structured handovers, and routine safety moments) influence HACCP adherence, audit performance, and the continuity of risk-relevant information across shifts?
Continuous training and emerging technologies: What evidence exists regarding the effectiveness of continuous training approaches (including microlearning and augmented/virtual reality formats) on food safety knowledge retention and compliance-related behaviors?
Incident reporting and just culture: To what extent do reporting system characteristics (e.g., accessibility, confidentiality, feedback loops) and just culture principles influence reporting activity, psychological safety, and organizational learning in food safety contexts?
Integration of AI agents into HACCP/SOP: What potential roles and reported effects are described for AI-enabled tools (e.g., decision support, monitoring, anomaly detection) in supporting HACCP/SOP implementation, and what human–technology integration challenges are reported?
Synergies between leadership, training, and reporting: How do visible leadership practices, continuous training, and reporting systems interact to shape food safety culture maturity and sustain safe practices over time?

### *2.4. Selection Process*

A total of 436 articles were identified from the following databases: Scopus (142), ScienceDirect (128), Web of Science + Emerald + MDPI + Springer + Taylor & Francis (166). After automatic deduplication in EndNote, 75 duplicates were removed, resulting in 361 unique articles screened at the title and abstract level.
After duplicate removal, 361 records underwent title and abstract screening. At this stage, 290 records were excluded, and 70 studies meeting the predefined inclusion criteria were retained for the final synthesis.

### *2.5. Flow diagram of the study identification and selection process*

The identification and selection process is illustrated in Figure 1 (flow diagram) to provide a transparent overview of records identified, deduplicated, screened, excluded, and included. The diagram was generated using the PRISMA 2020 flow-diagram tool [20]. The diagram shows the sequence of stages: 436 initial records, 75 removed as duplicates, 361 screened, 290 excluded, and 70 included in the final synthesis.

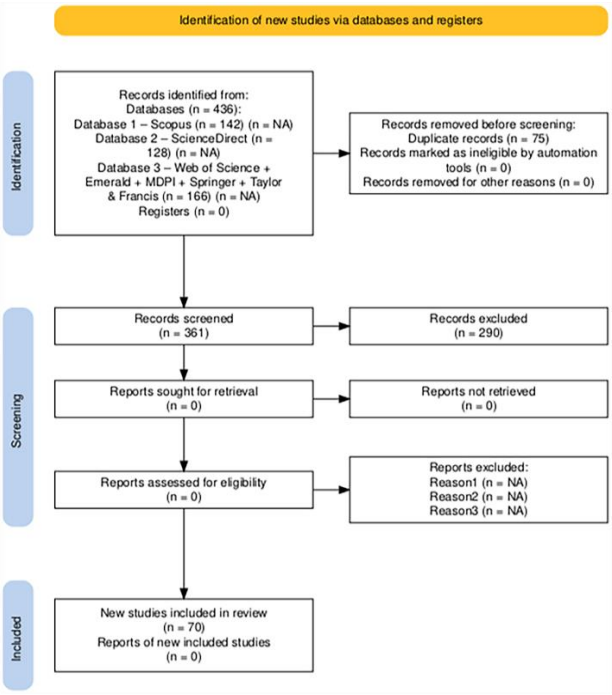


**Figure 1** – PRISMA 2020 Flow Diagram outlining the stages of identification, screening, and inclusion of the analyzed studies. The diagram was generated with the PRISMA 2020 application [20].

### *2.6. Data Synthesis and Analysis*

Due to the conceptual and methodological heterogeneity of the studies, a thematic narrative synthesis was adopted. Extracted data included: study design, population and context, analysed cultural dimensions, type of organizational practice or exposure, evaluated indicators, and main conclusions.
For each theme, convergent patterns, divergences, explanatory mechanisms, and knowledge gaps relevant to industrial practice were identified.
Based on a structured and transparent literature identification and synthesis process and the rigorous quality assessment, the following sections present the thematic synthesis of empirical findings organized along the five main dimensions identified in the literature.

## 3. Results and Discussion

The studies included in this review display substantial heterogeneity in methodological design, geographical context, and food industry sector. Most studies employed cross-sectional quantitative designs based on questionnaire data. Qualitative studies relied primarily on semi-structured interviews and focus groups, while a smaller subset of studies adopted mixed methods designs.

Geographically, the evidence base is dominated by studies conducted in Europe, North America, and Asia, with comparatively limited representation from Africa and South America. The reviewed literature spans food processing (notably meat and dairy), food service operations (restaurants and institutional catering), and food retail.

The analysis of the extracted data allowed the structuring of the results into three major themes, which reflect the objectives of this review.

The relationship between leadership styles and compliance with safety standards is consistently reported as being mediated by psychosocial factors. Organizational climate is frequently reported as a central mediating variable in leadership–compliance relationships. In this regard, [21] argues that the organizational climate of safety, integrity, and commitment fully mediates the link between leadership and compliance with food safety, which conceptually anchors leadership as an indirect determinant of operational behaviours.

Comparative analyses of leadership styles reveal differentiated effects on food safety culture. Negative associations with food safety culture are reported for laissez-faire leadership [1], whereas transformational leadership is linked to intrinsic motivation, open communication, and increased willingness to report across food sector contexts [2, 3].

The behavioral mechanisms linking transformational and ethical leadership to reporting behavior and open communication are extensively discussed in the literature. At the behavioral level, transformational and ethical leadership are associated with increased reporting intention, psychological safety, and open communication [2, 7, 8].

### *3.1. Incident reporting and "just culture"*

Effective incident and near-miss reporting systems constitute a core component of food safety culture by enabling organizational learning and preventive improvement. An organization's capacity to detect, report, and learn from errors and potentially hazardous situations is an indicator of cultural maturity. The function of internal reporting systems extends beyond compliance documentation to support active organizational learning. The dimension of internal incident reporting completes the cultural architecture. [10-12] and [13] describe internal reporting systems as vectors of organizational learning, feedback, and performance improvement, and [11] adds that closed communication loops and decentralized event management increase reporting rates and engagement.

The concept of "just culture" represents the essential cultural premise for voluntary reporting and honesty in communicating errors. [14, 15] and [16] define just culture as a precondition for effective reporting, identifying barriers related to hierarchy, blame culture, and lack of anonymity, while [17] and [18] attribute to leadership and organizational climate the role of facilitating factors.

The behavioural integrity of leaders directly shapes employees' willingness to report errors and to engage in resolving safety problems. [2] and [19] show that the behavioural integrity of leaders increases error reporting and the capacity to manage them, with a reduction in safety violations, and [19] explicitly highlights the role of managers as models.

### *3.2. Digitalization, AI, and hybrid systems in HACCP*

Emerging digital technologies enable continuous monitoring, risk prediction, and partial automation of compliance activities within HACCP systems. Internet of Things (IoT) sensors allow real-time monitoring of critical control parameters (temperature, humidity, pH, water activity) and generate automatic alerts in case of deviations, reducing detection latency and the need for continuous manual monitoring. This continuous monitoring not only improves compliance but also generates large volumes of data that can be analysed to identify patterns and optimize processes. Artificial intelligence and machine learning algorithms provide capabilities for risk prediction based on the analysis of historical patterns, sensor data, and contextual variables. These systems can identify combinations of factors that increase the probability of contamination or deviation, enabling preventive interventions before problems manifest. Blockchain technology for traceability offers complete transparency and immutability in complex supply chains, facilitating rapid identification of contamination sources in the event of incidents and increasing consumer confidence through the verifiability of information.

Hybrid systems combining automated monitoring with contextual human expertise are increasingly described as a pragmatic and effective approach for food organizations. Technology takes over repetitive and data-intensive tasks, allowing professionals to focus on contextual judgment, interpretation, complex problem solving, and decision-making that requires holistic understanding. This division of labour maximizes the advantages of each

component: the precision and consistency of technology, and the flexibility and contextual understanding of human experts.

### *3.3. Measuring safety culture*

The assessment of food safety culture has evolved from compliance-focused evaluations to multi-method approaches capturing both observable practices and underlying cultural dimensions.

The expansion of the assessment toolkit reflects recognition of the complexity of culture as a multidimensional phenomenon. The evaluation of food safety culture in processing units has expanded beyond technical control to include leadership, communication, and staff engagement, with direct implications for compliance and incident prevention [22, 23]. In the normative space, global standards and the European framework consolidate the need for systematic assessments, facilitating both operational risk management and continuous improvement through comparability between units and regions [24].

Empirical studies report associations between food safety culture indicators and compliance- and performance-related outcomes. The link between culture scores and food safety performance is empirically documented. The study [23] highlights a positive correlation between cultural maturity and compliance outcomes, and the same study [23] suggests potential reductions in incidents. In line with this, the study [25] shows that lower-risk units present higher culture scores and fewer non-conformities, while [26] examines the effects of targeted interventions, showing improvements in cultural dimensions after pre-assessment, group discussions, performance indicators, and recognition; the same study [26] emphasizes the pacing of interventions.

Organizational and contextual factors modulate both cultural levels and the effectiveness of interventions. Organizational characteristics modulate outcomes. From a behavioural perspective, the study [27] documents the influence of transformational leadership on employees' attitudes toward practices, reinforced by subsequent analyses in [28] and [2], where the ISO 22000:2018 context and certified food services strengthen the relationship between leadership and compliance; organizational climate as mediator is addressed in [21].

The specific challenges faced by SMEs in maturing culture require tailored support approaches. The specific challenges of SMEs are outlined in [29], with financial and informational barriers that hinder cultural maturation. The study [30] proposes a support package for third-party certification, and the same study [30] describes mentoring mechanisms and tailored training; the perspective of network learning is complemented by [31], which examines the implementation of quality management standards in an SME.

The operational elements of cultural assessment include the periodicity of measurements and methodological triangulation. Periodicity and observational triangulation are key operational elements. The study [32] compares perceptions of safety climate, supporting regular assessments in high-risk environments, and [33] provides an implementation strategy in distribution chains; sectoral frameworks are extended in [34] and [35], with an emphasis on feedback loops.

### *3.4. Limitations and future directions*

Research on food safety culture is affected by multiple methodological limitations that influence validity, generalizability, and practical applicability.

Methodological heterogeneity and reporting gaps represent a first category of limitations. Research on food safety culture, internal communication, and training exhibits significant methodological diversity, but also reporting gaps and bias that limit the comparability and applicability of results. The study [36] delineates the first contours of the field through a systematic review showing that the heterogeneity of approaches coexists with the need for standardization, and the same direction is supported by analyses applied to training practices and cultural assessment [37] and by an operational framework for developing educational interventions [35].

The specific challenges of qualitative study design require increased methodological attention. From a design perspective, [38] and [39] highlight the difficulties of integrating discrepant data, and qualitative analyses from related sectors signal risks of generalization and researcher bias [40, 41]. Validation remains uneven: the comparative evaluation and discussion of instrument reliability and validity highlighted in [42] contrast with the prioritization of "face" validation in some commercial solutions.

Specific gaps in methodological reporting affect the critical appraisal and reproducibility of studies. Reporting deficiencies are of notable magnitude. The assessment of methodological characteristics in pre-harvest observational studies indicates gaps in eligibility criteria, control of confounding, and

outcome definition [43], and in qualitative research, researcher reflexivity, ethical approvals, and analytical details are often missing [44]. The lack of standardized definitions in incident reporting reduces monitoring capacity [14], and incomplete demographic reporting affects generalization [45].

Discrepancies between self-reported measures and direct observations highlight the limitations of assessment instruments relying exclusively on perceptions. Differences between self-declared and observed behaviour are quantified: production observations indicate only 1% full protocol compliance in attempted hand hygiene [46], and a meta-regression shows that self-reported prevalence is significantly overestimated, with $\beta = 0.66$ [47]. Added to this is selection bias, visible in the recruitment and retention of vulnerable groups [48, 49], and insufficient control of confounding in observational studies [43, 50], a problem accentuated by the dominance of cross-sectional designs [50, 51].

Reflexive practice and attention to the ethical dimensions of research are essential for quality and credibility. Reflexive practice and research ethics constitute a second pillar of quality. Guidelines for qualitative writing underline the role of the reflexive journal, peer debriefing, and positionality statements [52-54], while work on qualitative ethics calls for continuous attention to emerging situations, not only to procedural compliance [55-58]. A relational perspective on ethics emphasizes responsibility toward participants [53, 59].

## 4. Conclusion

This review examined the organizational and behavioral factors that shape food safety culture in the processing industry, synthesizing evidence from 70 studies published between 2015 and 2025. The main findings articulate five interdependent dimensions: transformational leadership and organizational climate function as structural determinants of safety behaviours, operating through psychosocial mechanisms mediated by engagement and satisfaction; structured operational communication routines represent key mechanisms through which leadership and organizational culture are translated into daily food safety practices, maintaining risk awareness and facilitating coordination; effective incident-reporting systems require a “just culture” that encourages transparency and institutional learning without reprisals; emerging technologies provide new monitoring and prediction capabilities, but their optimal integration requires hybrid systems that balance automation with contextual human expertise; culture-measurement instruments have evolved toward multi-methodological approaches that triangulate perceptions with behavioural observations for convergent validation.

The distinct contribution of this synthesis lies in integrating these three complementary layers—strategic (leadership and communication), tactical (operational routines and coaching), and technological (digital monitoring systems)—demonstrating that the maturation of safety culture requires synchronized interventions at organizational, group, and individual levels. Unlike previous reviews that treated these dimensions in isolation, this synthesis highlights the mechanisms of interaction: how transformational leadership facilitates the adoption of structured communication routines, how just culture mediates the effects of reporting systems, and how technologies amplify monitoring capabilities without replacing contextual human judgment. This integrated perspective provides a more complete conceptual framework for understanding cultural phenomena as an emergent system rather than a sum of independent components. For practitioners in the food industry, these findings suggest several actionable implications. Investments in developing transformational leadership at the managerial level generate cascading effects on organizational climate and employee behaviours, justifying the prioritization of continuous training for supervisors and line managers. Implementing structured operational communication routines—brief start-of-shift huddles, formalized handovers between shifts, daily safety moments—offers concrete, immediately applicable mechanisms for translating cultural values into observable practices. The configuration of reporting systems must explicitly address psychological and organizational barriers: clear confidentiality assurances, accessible processes, rapid and transparent feedback, and non-punitive, learning-oriented responses. The adoption of automated monitoring technologies should be guided by the principle of complementarity rather than substitution: technology assumes repetitive tasks, freeing human capacity for contextual judgment and the resolution of complex problems. The interpretation of the findings of this review is subject to several inherent limitations that reflect the current stage of development of research on food safety culture. First, the evidence base is dominated by cross-sectional study designs, which limits the ability

to draw causal inferences and constrains insight into the temporal dynamics underlying cultural change processes. In addition, marked contextual heterogeneity across studies, encompassing differences in organizational size, food industry sectors, and national or cultural settings, reduces the comparability of findings and complicates the generalization of results beyond specific contexts. Furthermore, persistent shortcomings in methodological reporting within primary studies hinder robust critical appraisal, impede the assessment of evidence quality, and restrict the feasibility of quantitative synthesis through meta-analytic techniques.

Although these limitations do not undermine the overall coherence or internal validity of the main conclusions, they warrant caution when extrapolating the findings to populations, organizational settings, or regulatory environments that differ from those represented in the included studies.

Future research should focus on several priority directions. Longitudinal studies with repeated measures are needed to understand trajectories of cultural change, identify critical transition points, and assess the sustainability of interventions over time. Comparative intercultural studies can elucidate how national cultural values modulate leadership effects and the effectiveness of different interventions, informing the adaptation of strategies to diverse contexts. Convergent validation of measurement instruments through systematic methodological triangulation (surveys + interviews + behavioural observations) is essential for overcoming the limitations associated with each individual method. Implementation research that documents adoption processes, encountered barriers, and success facilitators in real-world contexts can reduce the gap between efficacy evidence and large-scale practice. Economic evaluation of cultural interventions, including cost-effectiveness and cost-benefit analysis, can inform investment prioritization and strengthen the business case for leadership and operational resources. Finally, integrating research on food safety culture with adjacent domains — safety culture in high-risk industries (aviation, healthcare, nuclear), applied organizational psychology, and behavioural sciences — can foster methodological cross-fertilization and accelerate the understanding of fundamental mechanisms.

In conclusion, food safety culture represents a complex, multidimensional organizational phenomenon that requires integrated approaches operating simultaneously at strategic, tactical, and operational levels. The evidence synthesized in this review demonstrates that cultural maturation is not the result of a single intervention or isolated component, but of the coherent configuration of transformational leadership, structured operational routines, reporting systems grounded in just culture, context-adapted monitoring technologies, and validated tools for continuous measurement and improvement. As the food industry navigates the challenges of global supply chains, a diverse workforce, and rising consumer expectations, investment in strengthening safety culture represents not merely a regulatory compliance requirement but a strategic capability essential for long-term sustainability and the protection of public health.

## Statements and Declarations

***Ethical Considerations.*** Not applicable. This study is based exclusively on published literature.

***Data availability.*** Data sharing is not applicable as no new datasets were generated or analysed.

***Conflict of Interest.*** The author declare that they have no conflict of interest.

***Declaration of author contributions (CRediT).*** Sole author: Conceptualization; Methodology; Investigation; Data Curation; Formal Analysis; Validation; Visualization; Writing – Original Draft; Writing – Review & Editing; Project Administration.

The author had full responsibility for the scientific content, interpretation of results, and the final version of the manuscript.

***AI Use Declaration.*** Artificial intelligence–based tools were used solely for language-related assistance, including improvements in grammar, spelling, and overall clarity of author-written text. No AI system was used to generate scientific content, perform data extraction, conduct analyses, or influence the interpretation of results. All methodological decisions, data synthesis, and conclusions were developed, verified, and approved by the authors, who take full responsibility for the accuracy and integrity of the manuscript.

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