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Solução digital de sistema de segurança alimentar: uma revisão sistemática

Food safety system digital solution: a systematic review

Solución digital del sistema de inocuidade de los alimentos: uma revisión sistemática

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Resumo

Objetivo: Realizar uma revisão sistemática para identificar soluções digitais de saúde já desenvolvidas para apoiar a segurança alimentar, considerando o uso do sistema FSSC 22000. Metodologia: Revisão sistemática, onde estudos que adotaram o sistema FSSC 22000 por meio de soluções digitais em diferentes setores de alimentos foram considerados adequados. Resultados: Foi possível identificar que os sistemas de segurança alimentar podem ser aplicados desde as áreas rurais até a distribuição de alimentos. Conclusão: As propostas encontradas se restringiram à análise de métodos qualitativos e quantitativos de verificação, sem propor estratégias de correção, conforme previsto no sistema FSSC 22000. Portanto, as indústrias de alimentos e

bebidas devem mudar seu paradigma que atualmente está restrito a regras básicas e regulamentos.

Descritores: Segurança Alimentar; Alimentos e Bebidas; Saúde Digital

Abstract

Objective: A systematic review was carried out to identify digital health solutions already developed to support food security, considering the use of the FSSC 22000 system. Methodology: Systematic review, where studies that adopted the FSSC 22000 system through digital solutions in different sectors of food were considered adequate. Results: It was possible to identify that food security systems can be applied from rural areas to food distribution; however, there are few publications on the subject. Conclusion: The proposals found were restricted to the analysis of qualitative and quantitative verification methods, without proposing correction strategies, as provided for in the FSSC 22000 system. Therefore, the food and beverage industries must change their paradigm, which is currently restricted to basic rules and regulations.

Keywords: Food Security; Food and Beverages; Digital Health

Resumen

Objetivo: Realizar una revisión sistemática para identificar soluciones de salud digital ya desarrolladas para apoyar la seguridad alimentaria, considerando el uso del sistema FSSC 22000. Metodología: Revisión sistemática, donde se consideraron estudios que adoptaron el sistema FSSC 22000 a través de soluciones digitales en diferentes sectores de la salud alimentaria. Resultados: Se logró identificar que los sistemas de seguridad alimentaria pueden ser aplicados desde las zonas rurales hasta la distribución de alimentos. Conclusión: Las propuestas encontradas se restringieron al análisis de métodos de verificación cualitativos y cuantitativos, sin proponer estrategias de corrección, tal como lo establece el sistema FSSC 22000. Por lo tanto, las industrias de alimentos y bebidas deben cambiar su paradigma, que actualmente está restringido a reglas básicas y regulaciones.

Descriptores: Seguridad Alimentaria; Alimentos y Bebidas; Salud Digital

Introduction

Foodborne diseases have proliferated globally on a scale that is critical to food production, and accompanies worldwide urbanization (1).

Food Safety System Certification 22000 (FSSC 22000) was recognized by the Global Food Safety Initiative (GFSI) as a food safety standard in the international market in 2010. It is a complete certification. The particularities of its implementation in the routine and structure of industries and its benefits transcend aspects related to food safety. Moreover, it constitutes an important marketing factor for industries, fostering competitiveness in the market (2).

An important aspect in this context is the application of the food safety protocol in digital format. Artificial intelligence (AI), the internet of things (IoT) and associated technologies are revolutionizing the healthcare area, and this paradigm shift has meant that smartphones and other mobile devices have become the most common connection tools according to the Regional Center for the Development of Studies on the Information Society, which is linked to the Committee Internet Manager in Brazil(3,4).

So, technology and innovation are increasingly present in all human activities, in particular in the health care (5). which can contribute to the development of and compliance to digital tools related to food safety for food quality managers.

Therefore, a systematic review was conducted to identify digital health solutions that have already been developed to support food safety, considering the use of the FSSC 22000 system.

Methods

The protocol for this systematic review was registered on March 14, 2022 (DOI: 10.17605/OSF.IO/VTQ27). The findings were reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (6). The review aimed to answer the following research question: Are there any digital solutions implemented and validated for food safety developed from the FSSC 22000 system?

The eligibility criteria included being an original study and proposing a food safety management tool or solution. The exclusion criteria were having been written in Chinese, Japanese, Polish, or German.

The electronic databases were comprehensively searched for peer-reviewed articles reporting digital health solutions already developed to support food safety, considering the use of the FSSC 22000 system. Searches were performed on MEDLINE (Ovid), Embase (Ovid), Scopus, and Web of Science databases from inception to December 03, 2021. The reference lists of studies meeting the inclusion criteria and reviews were also searched to identify additional relevant studies. No restrictions were applied for dates. The searches performed in databases are described in Table 1.

Table 1: Search in Electronic Databases.

Medline via Ovid	exp food industry or exp food-processing industry or food industry.ti,ab. Or food security.ti,ab.
	AND
	exp certification or certification.ti,ab.
	AND
	FSSC 22000.ti,ab. Or food safety management syste*.ti,ab. Or ISO 22000.ti,ab. Or FSSC 22000.ti,ab. Or food safety syste*.ti,ab.
Embase	'food industry'/exp OR 'food-processing industry'/exp OR 'food industry':ti,ab OR 'food security':ti,ab
	AND
	'FSSC 22000':ti,ab OR 'food safety management syste*':ti,ab OR 'ISO 22000':ti,ab OR 'FSSC 22.000':ti,ab OR 'food safety syste*':ti,ab
Web of Science	TS=((“food industry” OR “food-processing industry”) AND (certification) AND (“FSSC 22000” OR “food safety management syste*” OR “ISO 22000” OR “FSSC 22.000” OR “food safety syste*”))
Scopus	(TITLE-ABS-KEY ((“food industry” OR “food-processing industry”)) AND TITLE-ABS-KEY (certification) AND TITLE-ABS-KEY ((“ssc 22000” OR “food safety management syste*” OR “ISO 22000” OR “ssc 22.000” OR “food safety syste*”)))

Duplicates were identified using the Endnote X9 Program. Thereafter, the results were transferred to the Rayyan QCRI. After establishing and applying the inclusion and exclusion criteria, a step-by-step analysis was performed using the title, abstract, and full text. Three authors separately read the titles of the papers retrieved from the search. The structured abstract was read if the paper was considered as adhering to the theme and the inclusion criteria, or if there was any concern about its relevance to the theme. The full-text paper was read if the structured abstract proved to be

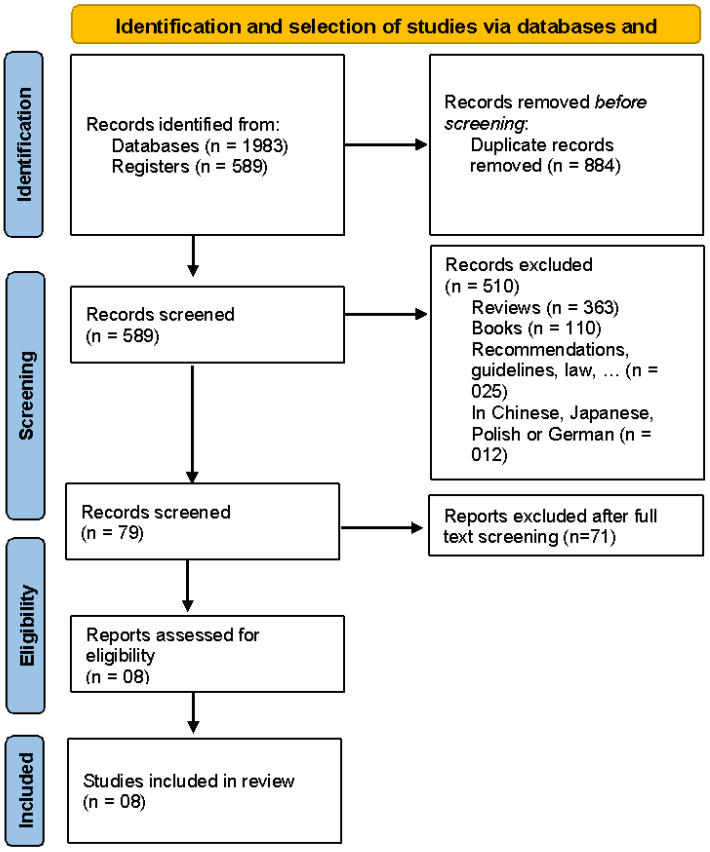
adequate or generated concerns. Of the papers read in full, only those that met the inclusion criteria were accepted for the systematic review. At each stage, another author reviewed all the authors' selections that were questioned and papers that generated any disagreement were included in the next stage of the analysis.

The following data were extracted from each study using standardized, piloted, data extraction forms: title of the studies, acronyms, authors, sources, items, ages, language, scales of measurement and published psychometric data based on previous reviews. We especially focused on norms, regulations, and systems that were introduced to measure food safety in companies/industries.

Results and discussion

This literature search retrieved a total of 1983 studies, of which 884 were removed as duplicates (identical), leaving 1099 studies for title and abstract screening. The PRISMA(6) flowchart of the selection process and the reasons for excluding studies read in full are shown in Figure 1.

Figure 1. Flowchart of the selection process of the included studies



After applying the exclusion criteria, eight studies were included in our systematic review; however, only one (7) digital proposal included the FSSC 22000 (Table 2). Moreover, we identified two (8,9) analog proposals about FSSC 22000, and five (10–14) digital solutions based on another food safety system or regulation (Table 2).

Thus, the systematic review yielded only one digital solution implemented and validated for food safety developed from the FSSC 22000 system. The studies' analog and digital solutions to food safety management using the FSSC 22000 system are presented in Table 2.

Eight solutions were proposed for industries and companies as follows: agribusiness companies – pig slaughtering and raspberry plantations (2), food delivery company (1), food service (1), dairy industry (1), food industries (1), manufacturer of food and beverages (1), and tea companies (1). Only three solutions used FSSC

22000 as a reference, with one and two solutions being in digital (food industries) and analog form (agribusiness companies), respectively.

Table 2: Analogue and digital solutions from studies for food safety management using the FSSC 22000 system

Title	Author	Solution	Area	Proposed solution	Regulatory Standard
Computerized monitoring of HACCP system from the dairy industry	(Serbanc ea e Casulschi 2011)	Digital	Dairy industry	Computerized monitoring of HACCP system from the dairy industry	HACCP
Development of a food safety verification risk model	(Manning 2013a)	Digital	Food industrie s	Qualitative and quantitative verification	FSSC 22000
Performance assessment of food safety management system in the pork slaughter plants of Chin	(Xiong et al. 2017)	Analog	Swine slaughte r and slaughte rhouse	Performance evaluation of the hygiene flow of environments, facilities and personnel in announced and unannounced audits	FSSC 22000
The performance of food safety management systems in the raspberries chain	(Rajkovic et al. 2017)	Analog	Raspber ry farms, meatpac kers and stores	Food safety instrument with 66 questions for face-to-face application, with situational descriptors of low, moderate, high and advanced risk	FSSC 22000
Content validation and semantic evaluation of a checklist elaborated for the prevention of gluten cross-contamination in food services	(Farage et al. 2017)	Digital	Food service	A checklist-type instrument, consisting of 84 items, divided into 12 sections, to assess food safety in the context of preventing cross-contamination by gluten in food services	RDC 216, RDC 275, ISO 22000 and Canadian Celiac Association Gluten Free Certification Program documents
Integrating Internet of Things, Provenance, and Blockchain to Enhance Trust in Last Mile Food Deliveries	(Markovic et al. 2020)	Digital	Food delivery compani es	Low cost open source food safety monitoring prototype to monitor food deliveries, manage and reason food safety provenance records and storage services	HACCP, Food Law Practice Guidance (England), Food Safety and Hygiene (England) Regulations 2013
Development and piloting of a support package to enable small and medium sized food and drink manufacturers to obtain third party food safety certification	(Evans, Lacey, e Taylor 2021)	Digital	Food and beverag e manufac turing compani es	Support for Food and beverage manufacturing businesses to obtain certification against the Safe and Local Supplier Approval (SALSA), scheme in EUA, with six mechanisms: (i) self-assessment tool, (ii) internal systems review, (iii) 'audit-ready' workshop, (iv) pre-audit factory inspection, (v) post-audit support and (vi) audit-fee contribution.	SALSA
Design of an iota tangle-based intelligent food safety service	(Ku, Chi, e Ling 2021b)	Digital	Tea compani es	Smart Food Safety Service Platform For Bubble Tea	HACCP

The main findings of this study were: a) food security systems can be applied in rural areas to food distribution; b) only one digital solution and two analog solutions using the FSSC 22000 system were developed.

Although we found studies that referred to the use of the FSSC 22000 system, they were restricted to questioning the factors that affect the implementation of the system, such as company size, number of employees, and the validity of certificates in contrast to their cost and benefit.

The implementation of the food safety system based on the FSSC 22000 promotes more than certification, as it promotes effective quality control in food and beverage companies. Its implementation includes raising the awareness of all company employees, regardless of position and function, about the importance of more efficient management practices. Therefore, there is a need to improve processes by providing greater clarity of responsibilities, improve internal communication, and enhance systems of internal audits and inspections. Additionally, its implementation generates increased productivity, improved quality of the final product, reduction of costs with defective products, and greater market competitiveness, thereby promoting greater customer satisfaction and a better external image of the company (15).

In addition to ISO 22000, health regulations and standards such as Critical Control Points (HACCP) and Good Manufacturing Practices (GMP) are part of the basic requirements of FSSC 22000.

That hazard analysis and critical control points (HACCP) is recognized as a food safety, quality, and integrity tool. The HACCP system is recognized as a key part of food safety management in the global food industry and can be applied at any stage of the food supply chain (16). When associated with prerequisite programs, such as good manufacturing practices (GMP) and standard operating procedures (SOP), it forms a set of essential tools for quality management in the food industry (17).

This review clarifies the choice of some companies to implement, at least initially, food safety protocols such as the FSMS, BRC, RDC 216, RDC 275. We theorize that this is because these protocols are less complex in structuring.

However, although the use of hazard analysis and critical control points (HACCP) or good manufacturing practices (GMP) are important steps in quality management, they do not solely guarantee a reliable standard of safety and quality. Meanwhile, the FSSC 22000 is a full certification scheme for food safety management systems based on ISO 22000:2005 and ISO/TS 22002-1:2009 (2). Despite these possibilities for implementing actions for quality management, it should be noted that several initiatives are necessary for the success of these steps, highlighting the demand for a satisfactory engagement of employees who will work in all stages of food production.

Furthermore, a positive external corporate image is essential in the modern globalized and interconnected world, where the population is more attentive to the quality of the food consumed, as already highlighted by Isanovic et al. (2023) (18).

Thus, food safety in the industrial and rural context concerns the reduction of critical points related to the production of food and beverages that jeopardize consumer health. As such, the FSSC 22000 system is an international certification that aims to guarantee food safety for consumers worldwide (19).

Food safety is easy to apply in different food sectors and is not only restricted to the food and beverage industry, but also requires a broad commitment from management for its success and proper implementation. For an industry to be FSSC 22000 certified, it is important to implement quality and food safety standards by imposing a very organized operational plan of evaluation and periodic monitoring of the food production chain. The industry must demonstrate its ability to control food safety hazards to ensure that the food is safe until the moment of human consumption.

Furthermore, for the food safety system to be adequate, it must be tailored to meet organizational needs regarding food safety, appropriate to the size and type of operation and the nature of the products being manufactured and/or handled, implemented across the entire production system, and approved by the management and food safety team (7). Therefore, it demands financial and time investments and training of personnel, among others (20)

There is an implied cost for obtaining and maintaining the certification, including time, organizational bureaucracy, and periodic audits. This includes hiring companies or

professionals experienced in implementing the correct standards and involves a greater workload until implementation (20). Therefore, the possibility of using digital strategies to optimize management solutions in food safety seems urgent.

Additionally, factors such as "checklist fatigue," which develops as a result of the individual being required to continually complete checklists or "tick sheets" in their work role, has been highlighted as one of the biggest gaps in the process of internal analog editorials, affecting the outcome of the management process. Moreover, with control of the mechanisms for reviewing and updating checklists, engagement and food safety culture are suggested factors for minimizing the effects of checklist fatigue (7).

Conclusion

Only one publication was found referring to the application of a digital solution for food safety management by FSSC 22000. The proposals found were restricted to the analysis of qualitative and quantitative verification methods, without proposing correction strategies, as provided for in the FSSC 22000 system. To achieve safety in food production factors such as the engagement of employees for the implementation of the system, and the solid implementation of Good Practices is key. Therefore, the food and beverage industries should aim to obtain FSSC 22000 certification, which will allow for more detailed control over all manufacturing stages.

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