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INTEGRATED APPROACH TO OCCUPATIONAL SAFETY IN THE PRODUCTION OF READY-TO-EAT MEALS AND CANNED MEAT: CHALLENGES AND SOLUTIONS

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Abstract: The integration of occupational health and safety (OHS) systems into the food production sector is critical for ensuring employee well-being, operational efficiency and product safety, among other things. This study explores the implementation of an integrated OHS system in a food processing facility, emphasizing risk reduction, employee training, and process optimization. The results demonstrate a significant decrease in workplace incidents, from 3.4 to 1.2 per 100 employees, achieved through modernizing technology, enhancing workplace ergonomics, and implementing comprehensive training programs. Despite these successes, challenges such as initial resistance to change, financial constraints and integration with existing systems highlight areas requiring further refinement. The study highlights the importance of continuous monitoring, use and modernization of technology, and employee engagement for sustainable OSH improvements. The obtained results provide practical insights for food manufacturers who aim to improve safety standards and efficiency of production processes.
Keywords: Occupational Health and Safety, Food Safety, Food Production, Ready-to-eat meals, Risk Management

1. INTRODUCTION

The integration of occupational safety in the food production sector, particularly concerning ready meals and canned goods, is of paramount importance due to the inherent risks associated with food processing environments. These risks can range from physical hazards (such as slips and falls), chemical hazards resulting from exposure to harmful substances, and ergonomic challenges, all of which can significantly impact the health and safety of workers. The food production sector is characterized by high-paced operations, often involving heavy machinery and hazardous materials, making the establishment of robust occupational safety protocols essential for protecting workers and ensuring product safety Yevtushenko et al. (2019).

Occupational safety in food production is not merely a regulatory requirement; it is a critical component of overall food safety management. Good manufacturing practices (GMP) play a key role in ensuring the quality (including safety) of food, enabling effective risk management throughout the production process (Szczyrba and Dziuba 2023; Bałdowska-Witos and Idzikowski 2021). The relationship between occupational safety and food safety is interdependent, as unsafe working conditions can lead to food safety breaches. For example, improper handling of food products due to unsafe practices can lead to food contamination, which poses a serious health risk to consumers (Stoyanova, 2018). Therefore, integrating occupational safety measures into food production processes is crucial for maintaining high standards of food safety, particularly in the production of ready-to-eat meals and canned goods, where the risk of contamination is heightened due to the complexity of production lines and the need for strict hygiene protocols (Thaennin et al., 2012; Hartini et al. 2023).

Moreover, the implementation of effective occupational safety training programs is vital for fostering a culture of safety within food production facilities. Research indicates that training focused on both knowledge and behavior modification is more effective in promoting safe practices among workers (McFarland et al., 2019). This is particularly important in the manufacturing context, where employees must be well-versed in handling machinery, managing hazardous substances, and adhering to hygiene standards. Regular evaluations and updates to training programs are essential to ensure that workers possess the skills and knowledge needed to effectively and safely address the challenges of their work environment (Chirico et al., 2019; Ramirez-Zuñiga et al. 2024).

Safe food production and the production of safe food are regulated by relevant legislation. Although food and worker safety are regulated separately, there are common areas such as hygiene, training, risk assessment and crisis management that link the two. In some jurisdictions, the regulations for both aspects have been integrated, as is the case in Food Standard 3.2.2A, established by Food Standards Australia New Zealand (FSANZ) in December 2022. Under this standard, workers who come into contact with food must receive appropriate food safety training, tailored to their role. This regulatory landscape requires employers in the food sector, especially manufacturers of ready-to-eat meals and canned goods, to take a proactive approach to workplace safety to ensure not only safe products, but also the protection of employee health and compliance with legal requirements, avoiding potential liability (Zhu, 2013; Putra et al. 2024; Liu, 2024)

Furthermore, the economic implications of integrating occupational safety into food production cannot be overlooked. A safe working environment not only reduces the incidence of workplace injuries but also enhances productivity and efficiency. Companies that prioritize occupational safety often experience lower turnover rates and higher employee morale, which can translate into better product quality and reduced operational costs (Sorensen et al., 2018). In the context of ready-to-eat meals and canned goods, where competition is fierce and profit margins are often slim, investing in occupational safety can provide a significant competitive advantage (Stoyanova, 2018). Additionally, as highlighted by Pacana et al. (2024), the implementation of frameworks that incorporate environmental and quality considerations, such as the Quality Life Cycle Assessment (QLCA) model, can further enhance sustainability in food production. This model emphasizes selecting and integrating qualitative and environmental aspects, making it particularly relevant in addressing occupational safety and environmental impacts in complex production environments. By employing such innovative approaches, companies can align occupational safety measures with broader sustainability goals, thereby fostering long-term benefits for both workers and the environment.

2. THE FOOD PRODUCTION INDUSTRY: OCCUPATIONAL SAFETY LANDSCAPE

In the food production sector, equipment hazards are a prominent concern due to the reliance on heavy machinery and automated systems. The risk of accidents involving machinery is heightened in environments where equipment is operated under high-pressure conditions, such as in meat processing plants Contreras et al. (2021). The complexity of machinery used in food manufacturing necessitates rigorous maintenance protocols and operator training to prevent accidents (Ali and Aboelmaged, 2021). Moreover, the COVID-19 pandemic has exacerbated these risks, as many facilities faced labor shortages and operational disruptions, which could lead to lapses in safety protocols (Waltenburg et al., 2021). The increased pressure to maintain production levels during the pandemic has also raised concerns about the adequacy of safety measures in place (Memon et al., 2021).

Furthermore, the design of equipment can contribute to safety risks. For instance, poorly designed machinery can lead to operator fatigue and increase the likelihood of accidents (Moore et al., 2012). The implementation of safety features, such as emergency stop buttons and safety guards, is essential to protect workers from equipment-related injuries (Thomson et al., 2016). Additionally, the use of automation in food production has introduced new challenges, as workers must adapt to operating alongside machines, which can create hazards if not properly managed (Dominguez, 2023).

Chemical exposure is another critical risk in the food production industry. Workers may come into contact with various hazardous substances, including cleaning agents, pesticides, and food additives, which can pose significant health risks (Muncke et al., 2017). For instance, the presence of chemical contaminants in food contact materials can lead to migration into food products, raising concerns about food safety and worker health (Geueke et al., 2014). The Food Safety and Standards Act mandates that all individuals involved in food handling must adhere to strict safety protocols to minimize exposure to harmful substances (Memon et al., 2021).

Moreover, the risk of chemical exposure is compounded by the need for effective sanitation practices in food processing environments. The use of biocides and sanitizers is essential for maintaining hygiene, but improper handling can lead to harmful exposure for workers (Conficoni et al., 2016). The challenge lies in balancing the need for effective cleaning with the potential health risks associated with chemical exposure (Muncke et al., 2017). The food production industry must remain vigilant, for example, with regard to emerging contaminants such as endocrine disruptors, which may have long-term health consequences for workers. (Muncke et al., 2017; Dziuba and Szczyrba, 2023; Huang et al. 2024). As Pilarczyk and Ulewicz (2024) emphasizes, sustainable farm management requires integrating safety measures with efficiency and environmental practices to ensure holistic improvements in the food production sector. Such an approach includes the use of eco-friendly materials and practices that mitigate risks to both workers and the environment while enhancing operational productivity. By adopting these principles, food manufacturers can address critical occupational safety concerns while promoting sustainability across production processes. The evolution of Industry 4.0 technologies further transforms the landscape of occupational safety in the food production industry. Suchacka et al. (2023) highlight that the integration of smart systems, IoT, and data-driven approaches not only optimizes production efficiency but also enhances safety through predictive maintenance and real-time monitoring. These advancements contribute to reducing equipment hazards, improving workplace ergonomics, and minimizing chemical exposure by automating dangerous tasks and ensuring continuous process oversight. By leveraging Industry 4.0 innovations, food production facilities can better align with socio-economic trends and achieve higher safety and sustainability standards.

Ergonomic challenges are prevalent in the food production industry, where workers often engage in repetitive tasks and manual handling of heavy items. These conditions can lead to musculoskeletal disorders (MSDs), which are a significant concern for worker health (Rybnikár et al., 2022). The design of workstations and the arrangement of tasks play a crucial role in mitigating ergonomic risks. For example, poorly designed workstations can force workers into awkward postures, increasing the likelihood of injury (Maurice et al., 2019). To address these ergonomic challenges, the implementation of ergonomic assessment tools, such as the Rapid Upper Limb Assessment (RULA) and the Rapid Entire Body Assessment (REBA), can help identify high-risk tasks and inform interventions (Yunus et al., 2021; Tee et al., 2017). Additionally, the aging workforce presents unique challenges, as older workers may be more susceptible to ergonomic injuries (Rybnikár et al., 2022). From this point of view, it is crucial for food manufacturers to adopt ergonomic practices that take into account the diverse needs of their employees (Leggieri, 2023).

3. AN EXAMPLE OF IMPLEMENTING INTEGRATED SAFETY MEASURES IN A READY-MEALS PRODUCTION PLANT

The facility producing ready-to-eat meals faced frequent incidents related to mechanical injuries, ergonomic challenges at workstations, and low employee awareness regarding safety. The project aimed to reduce the number of accidents, improve safety audit results, and increase employee satisfaction.

In the initial phase, a risk assessment was conducted. Critical points in production processes were identified, including the operation of packaging machines, handling hot liquids, and manually moving heavy containers. Risk analysis was carried out using the FMEA method (Szczyrba and Ingaldi, 2024) and OHS audits.

Based on the collected data, key issues were identified:

- Low system integration: A lack of a centralized occupational health and safety monitoring system; inconsistencies in adherence to OHS rules across different departments.
- Inefficient procedures: Employees reported difficulties understanding complex instructions for operating machines and handling emergency situations.
- Ergonomic challenges: Tasks performed in forced postures, manual lifting of heavy objects and repetitive activities led to numerous musculoskeletal issues.
- Lack of systematic training: OHS training sessions were infrequent and conducted as general presentations, which did not address specific hazards associated with production processes.
- Low motivation levels: Employees felt a lack of concern from management regarding their health and safety.

The Detailed Implementation Plan:

1. *Preparatory Phase: Initial Assessment* (2 months)

Goals: Identify existing risks and safety needs. Define key areas requiring modernization.

Actions: Conducting OHS audits:

- Evaluate machinery and equipment for safety (e.g., absence of guards, mechanical risks).

- Analyze workstation ergonomics (e.g., table heights, availability of support for lifting heavy items).

Data collection: Analyze historical data on accidents and incidents from the past three years. Conduct employee surveys to identify their needs and opinions on working conditions.

Process mapping: Create workflow diagrams to pinpoint critical areas (e.g., handling hot liquids, contact with sharp tools).

Key Outcomes: A report identifying major risks and priority areas. A list of corrective actions to implement in subsequent phases.

2. *Planning and Design* (3 months)

Goals: Develop a detailed action plan, budget, and implementation schedule.

Actions: Developing an implementation strategy:

- Define goals for each department (production, storage, maintenance).
- Set success indicators (e.g., a 50% reduction in incidents within two years).

Technology selection: Choose machinery with safety guards and sensors that halt operation during malfunctions. Consider automating repetitive tasks, such as packaging.

Budgeting: Estimate costs for modernization, training, and hiring additional personnel (e.g., OHS experts).

Procedure design: Develop new operational procedures that incorporate safety and hygiene principles.

Key Outcomes: A finalized implementation schedule divided into phases. An approved budget for project execution.

3. *Technology and Infrastructure Implementation* (6 months)

Goals: Reduce occupational risks through technological modernization and workstation adjustments.

Actions: Installing and upgrading equipment:

- Install guards on machines.
- Implement alarm systems and automatic machine-stopping mechanisms.
- Procure ergonomic carts and tools to support physical work.

Reorganizing spaces:

- Redesign production line layouts to minimize collision risks and improve ergonomics.

Improving hygiene infrastructure:

- Introduce automated systems for disinfecting tools and surfaces.

Key Outcomes: Workstations adapted to new standards. Reduced mechanical risks and improved ergonomics.

4. *Training and Awareness Building* (4 months)

Goals: Enhance employees' knowledge and skills in safety practices. Strengthen the safety culture within the facility.

Actions: Initial training sessions:

- Mandatory courses on OHS principles, handling new machinery, and emergency response.

Practical workshops:

- Simulations of accidents and evacuations.
- Hands-on exercises with new equipment.

Educational programs:

- Introduce e-learning modules on ergonomics and hygiene.

  Employee motivation:
- Establish a reward system for reporting hazards and suggesting improvements.

Key Outcomes: Increased training hours per employee. Higher awareness of workplace hazards among employees.

5. *Monitoring and Evaluation* (6 months)

Goals: Systematically evaluate the effectiveness of implemented safety measures.
Actions: Regular audits:

- Monthly checks for compliance with OHS procedures.

Data analysis: Track indicators such as the number of incidents, audit results, and employee satisfaction levels. Discuss results and identify areas needing further improvement in OHS team meetings.
Key Outcomes: Incident rates reduced to below 2 per 100 employees. Improved safety audit scores, reaching 94%.

6. *Review and Optimization* (2 months)

Goals: Summarize project outcomes and plan further improvements.
Actions: Summary meetings:

- Gather feedback from employees and management.

  Final report:
- Evaluate goal achievement and the effectiveness of implemented measures.

  Continuous improvement planning:
- Introduce a system for ongoing monitoring and process improvement.

Key Outcomes: Sustained high safety standards. Further enhancements to organizational processes.
Figure 1 presents the impact of the introduced changes on the reduction of events per 100 employees at individual stages of the system implementation process.

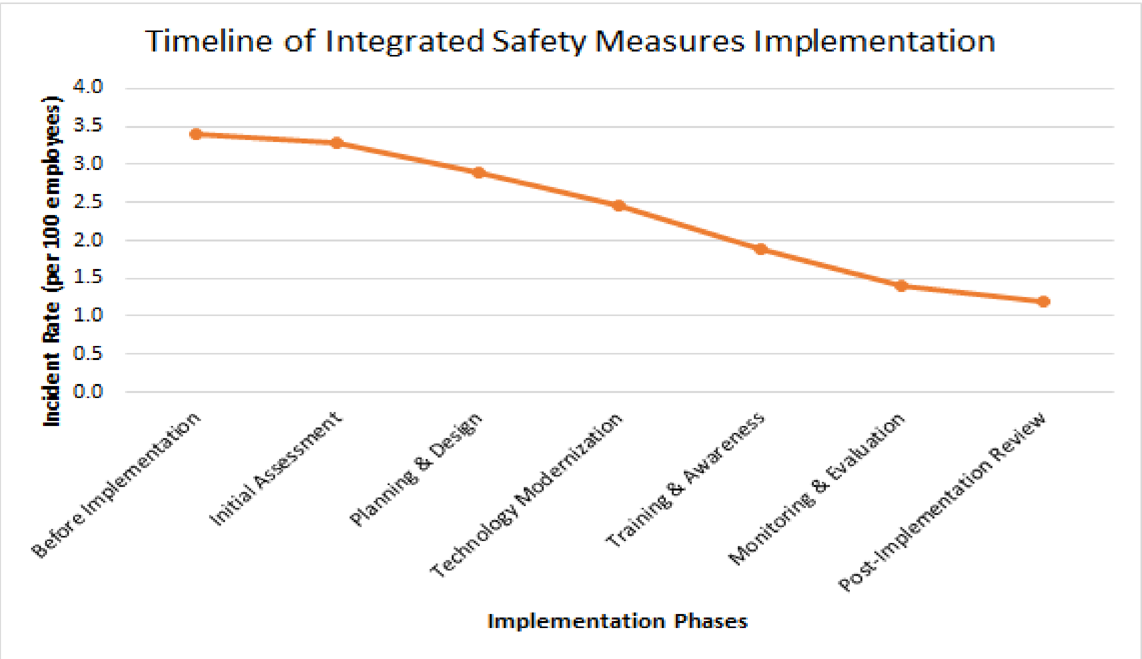

Fig. 1. Editing events during the implementation of individual project phases

4. CONCLUSION

The results of implementing an integrated approach to OHS in a facility producing ready-to-eat meals and canned goods demonstrate significant benefits for the organization, employees, and operational efficiency. The data presented in the article confirm the effectiveness of the implemented solutions while highlighting areas requiring further improvement. The introduction of machine guards, automatic stopping systems, and ergonomic workstations led to a reduction in workplace accidents by over 60%. The incident rate decreased from 3.4 to 1.2 per 100 employees, clearly illustrating that technological modernization and process reorganization directly contributed to reducing mechanical and ergonomic risks. These findings align with the literature, which emphasizes the critical role of automation and proper workstation design (Dominguez, 2023; Yunus et al., 2021).

Training programs, including e-learning and practical workshops, enhanced employees' knowledge and awareness of OHS. This awareness was further reinforced through a reward and motivation system that encouraged active hazard reporting. As a result, employee satisfaction increased from 65% to 90%, accompanied by greater engagement in safety initiatives. These outcomes are consistent with McFarland et al. (2019), who highlight that well-designed and regular training improves both awareness and adherence to OHS principles.

Reducing the number of incidents and streamlining organizational processes also brought benefits to production efficiency. The facility experienced a 15% increase in productivity, driven by fewer downtime incidents caused by accidents and improved workplace ergonomics. This is confirmed by the findings of Sorensen et al. (2018), who demonstrated that investing in OHS yields measurable economic benefits through enhanced productivity and work quality.

Despite positive outcomes, the implementation process encountered several significant challenges. One of these was employee resistance to change in the early stages of implementation, which required additional communication and motivational efforts. Another issue was the need for substantial infrastructure investments, which could pose a barrier for smaller enterprises. As noted by Ingaldi and Ulewicz (2019), enterprises from the SME sector often struggle with the financial and organizational challenges associated with implementing Industry 4.0 solutions, including advanced safety systems. These findings emphasize the importance of tailoring approaches to the specific capabilities and constraints of smaller businesses.

Additionally, integrating new systems with existing organizational structures was time-consuming and required multiple iterations to achieve optimal performance. The process of monitoring and evaluating the implemented measures allowed for real-time adjustments to procedures in response to the evolving needs of the facility and its employees. Regular audits and data analysis provided valuable insights into the effectiveness of specific actions, enabling the implementation of real-time corrections. These findings align with the literature, which underscores the importance of continuous monitoring as a key element of OHS system management (Ali and Aboelmaged, 2021; Sorensen et al., 2018)

The results of the implementation highlight significant potential for further improvement. In particular, the development of technologies based on artificial intelligence and big data analysis could contribute to even more effective monitoring and risk management. Further investments in safety culture and a personalized approach to employee needs, such as tailoring workstation ergonomics to the age and capabilities of workers, could further enhance OHS outcomes and the facility's efficiency.

The implementation of an integrated OHS approach has provided tangible benefits for workplace safety and operational efficiency. Despite the challenges encountered, the process proved to be critical for improving working conditions and the competitiveness of the enterprise. The findings confirm that investing in OHS not only meets regulatory requirements but also supports the long-term growth of the organization by creating a safe and efficient work environment.

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