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Department of Quality Management

Krakow University of Economics, Poland

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Foreword

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The future of quality is a topic of paramount importance as we navigate the rapidly evolving landscape of technology, innovation, and societal change. Conference, "Quality of the Future - Future of Quality," brings together leading experts, researchers, and practitioners to explore the multifaceted aspects of quality management in the context of the challenges and opportunities that lie ahead.

Quality has long been a cornerstone of organizational success, driving efficiency, competitiveness, and customer satisfaction. However, the future demands a more holistic and integrated approach to quality, one that not only addresses operational excellence but also embraces the principles of sustainable development, economic security, and social responsibility.

As we look to the future, the conference participants have identified critical success factors for the effective implementation of quality management programs, emphasizing the importance of leadership, organizational culture, and employee engagement. The case studies presented demonstrate the tangible benefits that can be achieved through the adoption of lean management and other quality-focused approaches, serving as inspiration for organizations seeking to enhance their overall excellence.

The future of quality is not merely about achieving operational perfection; it is about cultivating a culture of continuous improvement, innovation, and a deep commitment to sustainable development. The insights shared in these proceedings will undoubtedly contribute to the ongoing dialogue and drive the advancement of quality management practices, empowering organizations to navigate the challenges and seize the opportunities that lie ahead.

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COSTS OF CONSUMER COMPLAINTS IN THE QUALITY COSTS MANAGEMENT

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Summary: Complaints are an expression of customer dissatisfaction with the quality of a product. In the context of a complaint, the customer expects the repair or replacement of a defective product with a good quality, defect-free product. Companies often approach complaints negatively. For them, these are costs and also a deterioration of their market image. The aim of the article is to show the connections between the costs of complaints and the costs of quality, and to demonstrate that the costs of complaints affect the costs of quality. The analyzes conducted show that complaints, if properly managed, could be valuable information about the quality—or rather, the lack of quality—of the product. Based on these considerations, it can be inferred that complaint costs, as costs of non-conformity, impact quality costs and also contribute to improving the quality of products offered in the market.

Keywords: complaint costs, complaint management, quality costs, non-conformance costs, quality cost optimization

1. Introduction

Enterprises that want to operate successfully in the market must pay attention to consumers, their expectations, and their satisfaction or dissatisfaction with purchased products or services. When customers are dissatisfied with the quality of purchased products or services, they file complaints. Many enterprises have a negative attitude towards complaints (Chwist & Ingaldi, 2024). However, this should be important information for them, indicating the weaknesses of

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the product and the reasons for customer dissatisfaction. Complaints that are properly considered and analyzed can be a valuable source of information for the company about the product, customer satisfaction and customer service. Based on the complaint, it is possible to determine what product defects were noticed by the customer and what should be improved. Complaints also provide greater insight into customer requirements, making it easier to plan actions to increase customer satisfaction (Balon & Dziadkowiec, 2012).Enterprises should use this information to make informed decisions, not perceive it as a negative phenomenon. Companies that prioritize product quality can gain a competitive advantage and earn customer trust. Furthermore, product quality contributes to building the company's image as a producer of reliable, innovative, and durable goods. Product quality is important for both customers and enterprises. Companies that focus on quality can achieve market success by minimizing costs associated with complaints and repairs, increasing production efficiency, and fostering better relationships with suppliers. Product quality is a crucial factor in determining a company's success or failure in the market (Chwist & Ingaldi, 2024).

Based on the submitted complaint, an enterprise should analyze the non-conformance and the production process to determine the point of defect origin. Most non-conformances and errors in products occur during the production process (Skotnicka-Zasadzień, 2010). Therefore, it is essential to analyze all stages of this process to avoid complaints about the finished product, which in turn leads to increased costs for the company. Properly conducted complaint analysis can bring numerous benefits to the company, including providing high-quality products to customers, increasing customer satisfaction, and boosting sales. Through complaints, enterprises gain insight into how to improve products or services to better meet customer needs (Barlow & Moller, 2001; Balon, 2016; Balon, 2017; Chwist & Ingaldi, 2024).

Proper handling of complaints, their analysis, and the implementation of improvement actions constitute the complaint management process. Effective complaint management can result in numerous benefits for both the customer and the organization.

Actions related to handling a non-conforming product, especially if the non-conformance is revealed by the customer through a complaint, incur costs for the enterprise. These costs fall under the category of quality costs, which can be optimized through appropriate actions.

Many authors analyze complaints within enterprises from the perspective of the enterprise-customer relationship (Johnston & Mehra, 2002). They examine consumer behaviors, loyalty, and customer churn if a defective product is purchased and subsequently complained about. There are few publications that analyze complaints and the costs of complaints and complaint management from the enterprise's perspective. The aim of this article is to show the connections between the costs of complaints and the costs of quality, and to demonstrate that the costs of complaints affect the costs of quality.

2. Complaint Cost Management

According to ISO 10002:2018, complaints are defined as "an expression of dissatisfaction made to an organization, related to its products or service, or the complaints-handling process itself, where a response or resolution is explicitly or implicitly expected". Handling complaints in accordance with the guidelines provided in this standard enhances customer satisfaction. Encouraging customers to provide feedback regarding product quality can positively impact customer retention and loyalty, as well as the company's competitiveness in the industry. Furthermore, actions taken within the complaints-handling process and efforts aimed at increasing customer satisfaction contribute to the improvement of organizational processes.

For organizations that want to offer compliant products and constantly improve the quality level, quality management solutions are crucial. Therefore, the company's activities should be focused on improving comprehensive systems. Systems that meet customer expectations improve the flexibility of responding to customer needs. In a situation where both internal and external recipients receive a non-compliant product, an effective complaint management system is essential to solve the problem so that it does not reoccur. (Szczerba & Białecka, 2016; Kumar & Kaur, 2021).

Most manufacturing enterprises have a defined complaint management process. This process is typically outlined in quality management system procedures, as required by ISO 9001. Complaint management is a process and procedure through which companies systematically resolve customer issues. It holds strategic significance for customer relationship management, as it can enhance customer satisfaction and loyalty. Additionally, companies can use the information gathered from complaints to improve the production process and product quality (Hansen et al., 2009; Kumar & Kaur, 2021). Complaint management involves the following actions:

- receiving and registering the complaint,
- verifying whether the complaint is justified,
- analyzing the causes of the complaint—examining the defective product, identifying the causes, and locating the defect's origin within the production process,
- proposing and implementing corrective and remedial actions,
- introducing continuous improvement and preventive measures for the future,
- preventing future customer complaints and recovering customers.

The complaint management system should be integrated with three key areas: production, quality control, and reverse logistics of defective products (Szczerba & Białecka, 2016; Huk, 2020). These areas should be closely interconnected. Production encompasses the manufacturing of products, where defects often originate. It is critical to monitor and improve

production processes to minimize defects. Quality Control verifies product quality against established standards to ensure compliance. If discrepancies are found, quality controllers initiate an internal complaint on the product and follow the procedure for managing non-conforming products. Reverse Logistics allows customers to return defective products to the company for analysis and investigation of the detected non-conformance (Szczerba & Białecka, 2016). Integrating these areas ensures a comprehensive approach to managing complaints, addressing issues promptly, and continuously improving product quality and customer satisfaction.

Actions related to customer complaints incur costs within a company. According to Stauss & Seidel (2004), these costs can generally be categorized as follows:

1. Personnel Costs: These include the expenses related to the labor of individuals involved in handling complaints and directly associated with the complaint management process.
2. Administrative Costs: These encompass expenditures such as office space, office equipment, and other administrative overhead required for managing complaints.
3. Communication Costs: These cover all expenses associated with communication processes necessary to resolve customer issues, such as telephone or postage costs.
4. Response Costs: These include all costs incurred in the context of resolving the problem. There are three types of response costs:
   a) Compensation Costs: These arise from voluntary compensations provided to customers who have experienced problems (e.g., costs of gifts or vouchers).
   b) Warranty Costs: These encompass all expenses related to contractual obligations (e.g., activated warranties).
   c) Goodwill Costs: These result from voluntary actions that are not covered by warranties but aim to improve customer relations.

Enterprises that have implemented a quality management system (QMS) and a complaint management system (CMS) incur various costs after a complaint is filed. These costs typically include:

1. Costs related to complaint analysis: Expenses associated with analyzing the reported complaint, including identifying non-conformities in the product and determining the root causes of these non-conformities.
2. Costs of analyzing the production process: Expenses incurred in examining the production process to pinpoint where the non-conformity originated.
3. Quality control costs: Costs involved in quality checks during the production process and after repairing the product.
4. Product or component repair costs: Expenses for repairing the defective product or component.

5. Costs of producing a new, identical product: Costs associated with manufacturing a new product needed to replace the defective one with a defect-free product.
6. Potential costs of voluntary compensation: Expenses related to offering voluntary compensation to the customer to retain their trust and loyalty.
7. Costs of corrective actions: Expenses incurred in implementing corrective actions to prevent the recurrence of similar defects in future products.
8. Costs of preventive actions: Expenses for preventive measures aimed at preventing the reoccurrence of the identified non-conformities in future production.
9. Warranty-related costs and other associated costs: Costs related to fulfilling warranty obligations and other related expenses.
10. Additional costs: Miscellaneous expenses such as customer communication costs and shipping costs related to product returns.

Additionally, companies incur costs related to the development of a complaint management system, including the costs of system development, implementation, adherence to procedures, and training conducted in this area.

Not every enterprise has implemented a well-functioning complaint management system. Organizations without such systems still process, analyze, and incur costs related to complaints (Balon et al., 2015). Complaints can originate from:

- Customers: These are external complaints where a customer dissatisfied with the quality of a received product informs the company of their dissatisfaction.
- Employees: Internal complaints where an employee identifies a discrepancy and reports it.

In such situations, the enterprise also bears costs associated with repairing the defective product, inspecting the product after repair, analyzing the causes and origin of the non-conformity, and implementing corrective and improvement actions.

3. Quality Costs

The concept of quality costs is not precisely defined by practitioners and theorists in the field of quality management. Differences exist regarding the content, scope, and areas where quality costs arise. Quality costs refer to the expenses incurred by a company to perform necessary actions to achieve a desired level of quality (Balon, 2006). Generally, these are the costs borne by the enterprise in relation to producing products or services at a specified level of quality according to established requirements. There are numerous definitions and models of quality costs in the literature. Among the most frequently described models are: the PAF Model

(Prevention, Appraisal, Failure), Process Model, Feigenbaum Model, Sloan Model, and Quality Costs in TQM (Total Quality Management) (Kister, 2005; Ciechan-Kujawa, 2005; Sadkowski & Kołodziejczuk, 2017; Sansalvador & Brotons, 2017).

All these models share a common part, which involves distinguishing between costs of conformance and costs of non-conformance. Conformance costs are the costs that an organization incurs, and should incur, to produce products that meet requirements and satisfy customer needs and expectations. These costs are often referred to as investment costs as well. Included in this category are prevention costs and appraisal costs (testing, quality control).

Prevention costs are those costs associated with efforts in design and manufacturing that are directed toward the prevention of non-conformance. These costs are incurred in an effort to make it right the first time (Chiadamrong, 2003). Prevention costs are expenses incurred by an organization to develop processes aimed at preventing potential non-conformities. The primary goal of these actions is to design the production process in a way that reduces or eliminates the occurrence of non-conformities. Companies should invest in prevention costs because they are expected to bring tangible benefits to the organization by reducing or even eliminating non-conformities and the associated costs.

Appraisal costs are the costs incurred while performing measuring, evaluating, or auditing to assure the quality conformance (Vakilifard & Khozein, 2012). Appraisal costs are expenses incurred for quality control of produced products and services, starting from the inspection of incoming materials through production, to the inspection of the finished product.

Internal failures costs are the costs incurred due to scrapping or reworking defective product or compensation for delays in delivery, etc.; and external failures are the costs incurred after delivery of a product to the customer – costs of repairs, returns, dealing with complaints and compensation (Barber et al., 2000). Costs of non-conformance are often referred to as losses within a company because they represent the costs incurred due to the detection of non-conformities. If a non-conformity is detected within the company, typically by an employee or quality controller before the product is delivered to the customer, these are internal non-conformance costs. On the other hand, if the non-conformity is detected by the customer, these costs are termed as external non-conformance costs.

The identification of quality costs allows for a comparison of benefits and costs in financial terms. Quality costs serve as a tool to pinpoint weaknesses in both core and support processes within an organization. They are essential for evaluating the effectiveness of quality management within an organization. Quality costs provide critical information that is fundamental to quality policy and addressing specific quality-related issues. Management should utilize this information to assess their decisions effectively, thereby justifying the efforts involved in recording quality costs. The quality cost system is a valuable tool that assists in identifying the majority of significant areas that require improvement.

4. Complaint Costs and Quality Costs

Complaints serve as feedback from customers to the company regarding inadequate quality levels in purchased products. Costs related to customer complaints are categorized as external non-conformance costs. Conversely, costs associated with complaints raised by employees are considered internal non-conformance costs. Management perceives non-conformance costs as losses that should be minimized.

Proper management of complaints, or more precisely, effective complaint handling, significantly impacts the level of quality costs, customer satisfaction, sales volume, and ultimately the company's profit (Figure 1).

Filing a complaint initiates the complaint handling procedure and related actions. The complaint form includes a description of the defect, often accompanied by the defective product. Based on this, employees analyze the production process and the quality of input materials to identify the cause and location of the non-conformity. These actions generate costs classified as non-conformity costs. Meanwhile, employees repair the defective product or replace it with a new one free from defects, which also generates non-conformity costs. Subsequently, corrective and preventive actions are implemented to ensure that subsequent product units do not have the same defect. Concurrently, preventive actions are introduced to eliminate this and similar non-conformities in the future. These actions include implementing tools, methods, techniques to support defect prevention, and training. The costs of these activities are categorized as prevention costs. Training aims to enhance employees' competencies and raise awareness about their role in disclosing non-conformities at their workplace and the role of quality costs in the company. Every employee should be aware that the earlier a non-conformity in the production process is disclosed, the lower the costs incurred by the company. Additionally, disclosing non-conformities at the point of their occurrence facilitates identifying their causes and developing corrective-preventive actions. The costs of these actions are already classified as prevention costs.

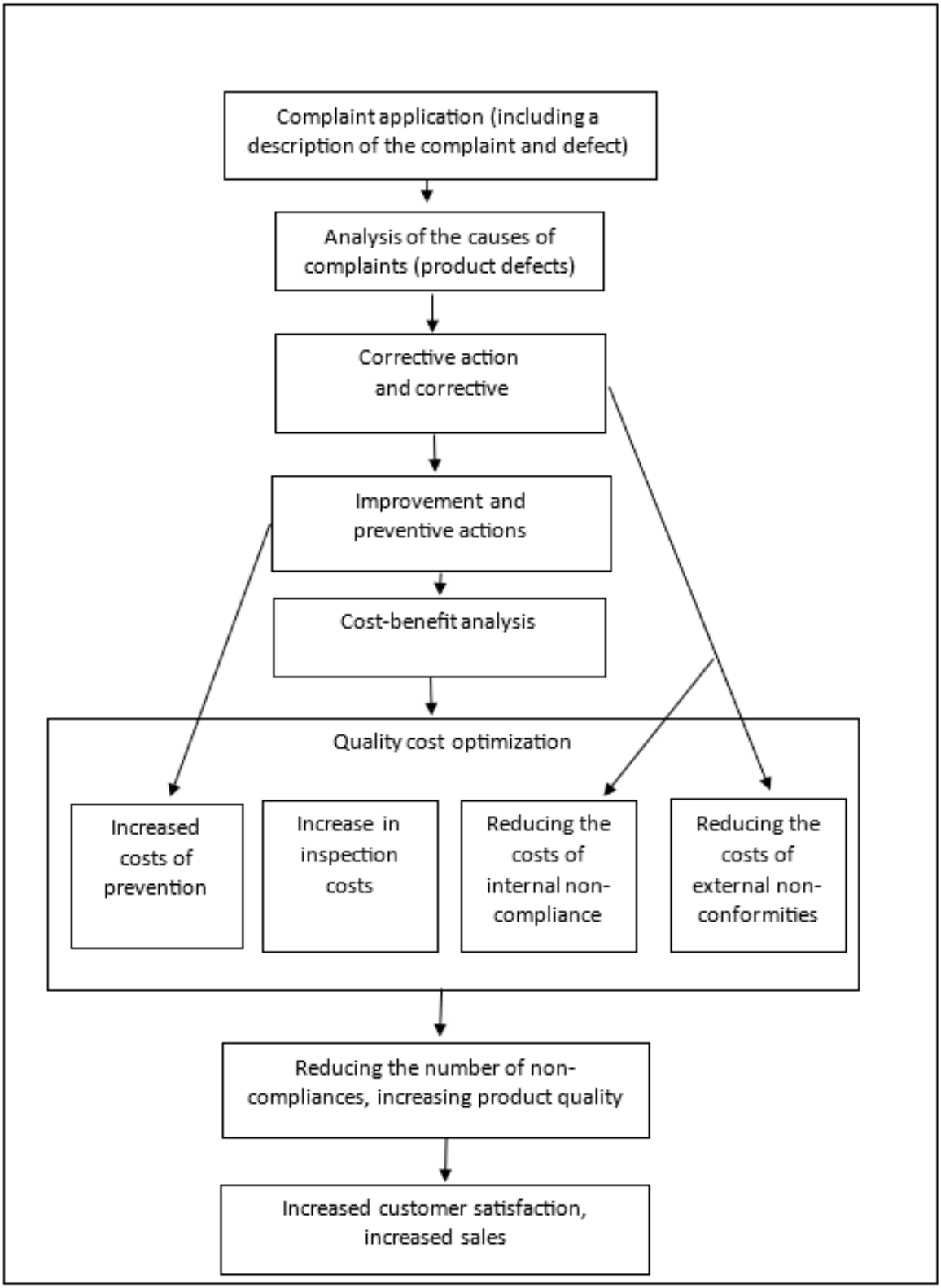

Figure 1. The Impact of Complaint Costs on Quality Costs

Source: own elaboration

In a company, optimizing quality costs involves investing in preventive actions while minimizing costs related to non-conformities. Increasing expenditures on preventive measures helps reduce the number of non-conformities, thereby decreasing both internal and external non-conformity costs. Limiting the sale of defective products to customers contributes to improving the quality of products entering the market. As a result, customers perceive the products as higher quality, making them more willing to purchase and recommend them to others. This leads to increased sales and the capture of new markets. In this simplified sense, the company is able to generate greater profits.

Additionally, investments made in preventing errors are much lower than the costs incurred due to those errors. The greatest opportunities to influence error costs occur during the design and production startup stages, whereas the smallest opportunities are during the product's use by the customer, known as the operational stage. The costs of correcting errors increase in subsequent phases of the product's lifecycle.

5. Conclusion

Complaints are often perceived by companies as failures, negative feedback from customers on product quality. However, companies should use this information to improve the quality of the products they sell, as well as to optimize quality costs.

Costs associated with complaints, as well as the costs of complaint management, include the expenses incurred during the process of managing complaints, analyzing them, searching for causes and points of origin, as well as repairing or replacing the defective product. Complaint costs are a part of quality costs, specifically the costs of non-conformance. However, in the final stage of complaint management, improvement and preventive actions are undertaken to enhance the product and process. The purpose of preventive actions is to prevent non-conformances from occurring. These actions should lead to a reduction in non-conformance costs, quality costs, and an increase in sales and customer satisfaction and loyalty due to the good quality of the product.

Based on these considerations, it can be inferred that complaint costs, as costs of non-conformity, impact quality costs and also contribute to improving the quality of products offered in the market.

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LEAN MANAGEMENT PRACTICES IN FOOD INDUSTRY: SYNERGIES BETWEEN 5S STEPS AND HACCP PRINCIPLES

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Summary: The concept of Lean Management has gained significant attention in various industries, including the food sector. However, the implementation of Lean Management in the food industry has been limited, primarily due to the unique challenges and regulatory requirements, particularly in ensuring food safety and quality. This study aims to analyze the potential synergies between the Lean Management concept, specifically the 5S method, and the Hazard Analysis and Critical Control Point (HACCP) principles. A comparative analysis was conducted to examine how the implementation of the 5S steps can support and complement the HACCP principles. The findings of the study reveal that the 5S method and the HACCP principles have numerous common elements, such as the elimination and monitoring of hazards, maintaining order, cleanliness, and hygiene, implementing corrective actions, and maintaining documentation and records. The analysis shows that the implementation of the 5S steps can effectively support various HACCP principles.

Keywords: HACCP, 5S, Lean Management

1. Introduction

The concept of Lean Management has gained significant attention in various industries but despite the widespread adoption of Lean Management in other industries, its implementation in the food sector has been relatively limited. This may be attributed to the unique challenges and

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regulatory requirements faced by the food industry, particularly in ensuring food safety and quality.

This paper aims to analyse the potential synergies between the Lean Management concept, specifically the 5S method, and the HACCP principles. The 5S method, which is a fundamental component of Lean Management, focuses on organizing, cleaning, and standardizing the workplace to improve efficiency and productivity. The comparative analysis examines how the implementation of the 5S steps can support and complement the HACCP principles, thereby enhancing food safety and quality management in the food industry.

2. Lean Management Concept

The term Lean Production - the foundation of the Lean Management concept - was first used in 1988 by J. Krafcik (1988), and then popularized by J.P. Womack, D.T. Jones, and D. Ross in their book "The Machine that Changed the World" (Womack et al., 1990). The idea of this concept was production while maintaining the highest level of customer satisfaction during the proper functioning of the company, while simultaneously eliminating waste. The Lean Management concept was an extension of Lean Production, and the basis for its implementation was five principles (Dekier, 2012). The five key principles of Lean Management are: defining value from the customer's perspective, identifying the value stream and eliminating waste, ensuring the flow of processes, implementing a pull system based on customer demand (Helmold, 2020).

The literature review shows that Lean Management is most often implemented in various industrial sectors, such as automotive (Mamat et al., 2015; da Silva et al., 2022), the metallurgical industry (Todorut et al., 2016), mining (Castillo et al., 2015; Flynn & Flok, 2015; Kęsek et al., 2023), plastic product manufacturing (Koterwa et al., 2024; Pranckevicius at al., 2009), or the textile industry (Hussain & Figueiredo, 2023).

Lean Management in the food industry is not very popular method. This may be due to the fact that food production is different from other production sectors, mainly due to the impact on human health and safety. Therefore, the food industry is subject to extensive regulations and standards to ensure food safety and quality. Consequently, companies must primarily focus on implementing the obligatory HACCP system, and any subsequent systems, such as Lean Management, must be compatible with it and must not disrupt the implemented food safety procedures.

These factors make food production a highly specialized and regulated sector, with unique challenges and requirements that differentiate it from other types of manufacturing and production.

3. Hazard Analysis and Critical Control Point

Hazard Analysis and Critical Control Point (HACCP) is a systematic approach to the identification, assessment and control of hazards. The HACCP procedure was developed by the Pillsbury Company in the 1960s, as a practical means of ensuring the safety of foodstuffs for space flights (Pillsbury Company 1973). The foundations of HACCP were first published in 1971 by the National Advisory Committee on Microbiological Criteria for Foods (NACMCF) in the United States.

In 1983, the Codex Alimentarius Commission adopted guidelines for the application of the HACCP system, giving it the status of an international standard (Mortimore & Wallace, 2013). Codex Alimentarius gives basic requirements that are needed to implement the food safety system. These requirements are: basic conceptions, definitions, system rules, stages of implementation, decision tree and Critical Control Points data sheets. The idea of HACCP system designing is that the food operator according to it (Sikora & Nowicki, 2007). Since the 1990s, the European Union has begun to consistently develop and issue regulations regarding HACCP. Initially, HACCP was implemented as a recommended solution (Council Directive, 1993), to later become mandatory for all food production entities in the European Union under Regulation (Regulation, 2004).

HACC is applied by taking a number of straightforward steps, often referred to as "HACCP principles" (Ropkins & Beck, 2000):

1. Conduct hazard analysis, considering all ingredients, processing steps, handling procedures and other activities involved in a foodstuff's production.
2. Identify Critical Control Points (CCP).
3. Define critical limits for ensuring the control of each CCP.
4. Establish monitoring procedures to determine if critical limits have been exceeded and define procedure(s) for maintaining control.
5. Define corrective actions to be taken if control is lost (i.e., monitoring indicates that critical limits have been exceeded).
6. Establish effective documentation and record-keeping procedures for developed HACCP procedure.

7. Establish verification procedures for routinely assessing the effectiveness of the HACCP procedure, once implemented.

The HACCP system, when applied as part of an overall quality assurance systems based on the Codex General Principles of Food Hygiene, become a tool to enhance food safety by focusing on identifying significant hazards and critical control points where control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level (Orriss, & Whitehead, 2000).

Food sector organizations often do not stop at the implementation of a mandatory system, such as HACCP, a literature review shows that there are many examples of successful integration with other systems. The most frequently implemented systems are: ISO 22000 (Chen at al., 2020; Purwanto et al., 2020; Awuchi, 2023) and ISO 9001 (Kmiećkowiak & Lesiów, 2009; Purwanto et al., 2020; Harini, 2022). There are also examples of the implementation of Lean Management in the food processing industry (Dora et al., 2013; Maalouf & Zaduminska, 2019) and the food services sector (Gładysz et al., 2020), yet Lean Management is not a frequently implemented solution in this industry. However, it appears that Lean Management may effectively support the food sector not only in more efficient production management, but also in safety management.

The purpose of this paper is to analyze whether and how Lean Management can support the implementation of HACCP principles. The analysis was carried out using the example of example of the 5S method, one of the fundamental elements of Lean Management.

4. 5S Steps and HACCP Principles - Comparative Analysis

5S concept is intended to organize, clean, standardized and maintain the discipline at workplace in pursuit of sustainable improvements in the productivity, efficiency cost optimization and reduction of waste in an organization (Marasinghe, 2012). 5S steps are designed to improve efficiency, strengthen performance and provide continuous improvement in virtually all segments of the organization (Randhawa &Ahuja, 2017).

The 5S programme consists of the following steps:

1. SEIRI – Sorting – making the difference between necessary and useless things, giving up the useless ones.
2. SEITON – Ordering/Arrangement – the ordering of all the items after SEIRI.
3. SEISO – Cleaning and disturbance detection – the working areas/equipments will be clean.

4. SEIKETSU - Standardizing– the extension of the cleaning concept to each individual alongside with the continuous practice of the three steps 3S.
5. SHITSUKE – Disciplining – getting self-discipline and getting used to be each involved in the 5S actions through standard application.

The 5S method was chosen for analysis as it is the foundation of the Lean Management concept, and it is also the most commonly implemented tool in practice. An additional motive is that the 5S philosophy develops discipline and work standards among employees (Hilton and Sohal, 2012), which is also at the center of the HACCP system's interest. The 5S method was chosen for analysis because it is the foundation of the Lean Management concept (Koterwa at al., 2024). It is base concept of lean because it brings stability and keeps up improvement in a continuous way and become the first preference for many companies to start lean transformation with it Randhawa &Ahuja, 2017). An important motive is that the 5S philosophy develops discipline and work standards among employees (Hilton and Sohal, 2012), which is also at the center of the HACCP system's interest.

To realize the goal of the paper, an analysis of the similarities and differences in the functioning of the HACCP system principles and the 5S tool was carried out. The point of view adopted was that of a food company, i.e., a situation where HACCP has been implemented, and 5S needs to be implemented in accordance with the mandatory principles. A systematic analysis of the successive steps of 5S was carried out in relation to each of the 7 HACCP principles.

4.1. SEIRI (Sorting) versus HACCP Principles

The 1S step (Seiri - selection, sorting) of 5S method refers to sorting and selecting unnecessary things and removing them from the workplace.

Selection and sorting is used in the HACCP system already during the preparation of a list of all potential hazards and a list of all preventive measures to control hazards (HACCP principle 1). Sorting can be helpful in identifying objects that may pose a hazard in the workplace (e.g., jewellery of production workers, unnecessary objects not placed in their place). By eliminating/removing them, potential hazards can be significantly reduced.

The next HACCP principle (principle 2) is to identify critical control points (CCP) - places or activities in the process that are particularly/critically important for the health safety of food. The implementation of step 1S helps to eliminate unnecessary elements at the workplace, which minimizes the low risk of hazards. It also facilitates the identification of control points and critical control points.

HACCP principle 3 is to establish objectives and tolerance limits for identified CCPs. Parameters should be measurable with defined target values. Target values should guarantee the effective elimination of the threat or its reduction to an acceptable level. The implementation of step 1S has no significant relationship to this HACCP principle. There are no critical limits

in the 5S method - unwanted items are either present at the workplace or have been effectively removed.

After establishing CCPs, a monitoring system should be developed (HACCP principle 4). Sorting (1S step) helps to create a more organized workplace, which facilitates the monitoring and control of CCPs in the production process.

The implementation of step 1S supports the HACCP monitoring system in identifying areas where hazards may occur. Information about the occurrence of threats is, in turn, an element initiating corrective actions (HACCP principle 5), just like in the 5S method, this is the common point of both methods.

The next HACCP principle (principle 6) is to establish verification procedures. A typical verification tool is an audit. Audits are also effective in the case of the 5S method. If items that may pose a risk to the health safety of products are identified in Step 1S, HACCP and 5S monitoring can occur simultaneously. This will create a more organized workplace and ensure the health safety of food products.

According to principle 7, in the HACCP system, documentation and records concerning the functioning and actions taken should be kept. The documentation should also include information on sorting (1S principle) and isolation of hazards and unnecessary objects. By applying the 1S - Sorting principle, it is possible to limit or even eliminate unnecessary documents and objects, as well as sort and organize the existing documentation and records related to HACCP.

4.2. SEITON (Systematization) versus HACCP Principles

The 2S principle (Seiton – Ordering/Arrangement/Systematization) involves developing an organized and justified arrangement of documents and tools. Items and their storage locations should be marked for quick identification. The location, arrangement and storage of these items should remain consistent. Systematic, rational and ergonomic organization increases operational efficiency.

Step 2S can definitely support when preparing a hazard list (HACCP Principle 1), because it allows the company to organize, arrange and label objects, tools and materials in the workplace. Tidiness at the workplace can help not only identify threats, but also act as a preventive measure.

Systematization (step 2S) can effectively support the determination of CCPs (HACCP Principle 2). Order at the workplace helps eliminate threats resulting from employee errors and facilitates the identification of CCPs in the production process. Applying both principles simultaneously allows you to optimize the number of CCPs.

The principle of systematization (2S principle) does not apply when establishing objectives and critical limits for each control point (HACCP Principle 3). Introducing and maintaining

order in the workplace, as well as eliminating unnecessary elements, can only contribute to a better focus on establishing objectives and tolerance limits for each CCP.

On the other hand, the implementation of step 2S can have a positive impact on the CCP monitoring system (HACCP principle 4). The implementation of step 2S can improve the organization of the workplace, which in turn enables more effective monitoring and control of critical points in the production process. In the event of identified irregularities, 2S supports the identification of areas where potential and actual problems exist. And this in turn can support the determination of corrective actions (HACCP Principle 5). Better organization of the workplace also facilitates the verification and control of compliance with established standards (HACCP Principle 6).

Systematization also has a positive relationship with maintaining documentation and records (HACCP Principle 7), as it contributes to facilitating the management of documentation and records through the establishment of a clear and unambiguous system for storing and preparing documentation.

4.3. SEISO (Cleaning) versus HACCP Principles

Step 3S (seiso – cleaning) involves keeping the workplace tidy and clean. The goal is to maintain the workplace in a condition that allows for quick identification of abnormal conditions that may affect safety and the work process. This is closely related to the HACCP system, especially Good Hygiene Practices (GHP). Regular cleaning is a type of inspection during which tools and equipment are checked, as well as maintaining the personal cleanliness of employees.

The 3S step can be very helpful in identifying and preparing a list of hazards (HACCP Principle 1), and can facilitate the identification of potential hazards related to contamination, non-compliance with hygiene rules, etc. Regular cleaning (3S) also helps to reduce the risk of hazards (HACCP Principle 2). , and thus compliance with the tolerance limits established at CCPs (HACCP Principle 3). The developed system for monitoring critical control point CCPs s (HACCP Principle 4) can also be used to monitor cleanliness in the workplace and, in the event of hazards, determine and implement corrective actions (HACCP Principle 5). As part of the developed procedure for checking the correct functioning of the HACCP system (HACCP Principle 6), it is also possible to verify the effectiveness and efficiency of cleaning and prepare documentation and records confirming the implementation of these activities.

4.4. SEIKETSU (Standardization) versus HACCP Principles

Step 4S (Seiketsu – standardization) is about maintaining order and cleanliness on a daily basis as a standard. It is therefore necessary to develop standards and procedures that help maintain order and regularity in the workplace.

Standardization, thanks to which employees keep their workplaces clean and tidy on a daily basis, contributes to increasing awareness of threats. As a result, when preparing a list of hazards (HACCP Principle 1), some hazards may appear on the list as potential risks, but should not occur because they are eliminated by continuous compliance with order and cleanliness (4S).

Standardization also minimizes the risk of contamination and hazards, which influences the identification and characterization of CCPs (HACCP Principle 2). Some hazards will be listed, but these will be potential hazards but do not have to be critical, so there is no need to set limits for them (HACCP Principle 3). The development of a monitoring system for these 4S activities should be integrated with the HACCP monitoring system (HACCP Principle 4), as well as verification procedures (HACCP Principle 6) and record keeping (HACCP Principle 7). It should be virtually unnecessary to establish and implement corrective actions, but these actions can be extended to HACCP actions (HACCP Principle 5).

4.5. SHITSUKE (Selfdiscipline) versus HACCP Principles

The last step of 5S (self-discipline) involves consistent implementation of the actions implemented in the previous steps. This step is also compatible with the rules of the HACCP system, so it creates a synergy effect between HACCP and 5S.

When preparing a list of hazards (HACCP Principle 1), self-discipline contributes to the elimination of hazards by complying with standards. Learned good habits and applied self-control reduce or eliminate the hazards described in the CCPs (HACCP Principle 2). The developed CCP monitoring system can also be used to monitor and control compliance with standards and check the functioning of self-discipline (HACCP Principle 4). Developing corrective actions (HACCP Principle 5) is a process that should additionally motivate employees to practice self-discipline and implement established standards. Developing and carrying out a verification procedure (HACCP Principle 6) may also serve the purpose of self-assessment and verification of the effectiveness and efficiency of the actions taken. The last step is to prepare documentation and records (HACCP Principle 7) of the activities carried out, also this stage can be carried out simultaneously for HACCP and 5S.

5. Summary: HACCP/5S Matrix

A summary of the analysis performed is presented synthetically in the form of a matrix (Table 1).

Table 1.
HACCP/5S Matrix

5S steps / HACCP principles	1S SEIRI (sorting)	2S SEITON (systematization)	3S SEISO (cleaning)	4S SEIKETSU (standardization)	5S SHITSUKE (selfdiscipline)
1. Conduct hazard analysis	Identification and elimination of unnecessary elements that may cause hazards.	Maintaining order in the workplace can aid in identifying and eliminating potential hazards, thus minimizing the risk of their occurrence	Maintaining order is essential for effectively identifying and addressing potential hazards, thereby reducing the risk of accidents or incidents.	Standardization contributes to increased awareness of hazards and their elimination through the continuous observance and maintenance of order.	Self-discipline contributes to the elimination of hazards through the observance of standards.
2. Identify Critical Control Points (CCP).	Eliminating unnecessary elements in the workplace reduces the risk of hazards occurring.	Order and organization in the workplace contribute to eliminating hazards caused by employee error and optimizing the number of critical control points.	Cleaning and maintaining cleanliness in the workplace contribute to reducing the risk of hazards occurring.	Standardization minimizes the risk of contamination and hazards, influencing the characteristics of critical control points.	Good habits reduce or eliminate hazards.
3. Define critical limits for each CCP.	Not applicable - the order in 5S method either exists or does not; intermediate values or acceptable limits do not apply.	Not applicable - the order in 5S method either exists or does not; intermediate values or acceptable limits do not apply.	Not applicable - the order in 5S method either exists or does not; intermediate values or acceptable limits do not apply.	Not applicable - the order in 5S method either exists or does not; intermediate values or acceptable limits do not apply.	Not applicable - the order in 5S method either exists or does not; intermediate values or acceptable limits do not apply.
4. Establish monitoring procedures	An organized workplace facilitates the monitoring and control of CCPs.	Systematic maintenance of order and organization of the workplace facilitates monitoring and control of CCPs.	The CCPs monitoring system can be used to monitor cleanliness at the workplace.	A common, standardized system for monitoring CCPs and cleanliness and order at the workplace may result in a synergy effect	A common system for monitoring CCPs and enforcing self-discipline can create a synergy effect
5. Define corrective actions	Corrective actions can be identified simultaneously for both methods	Systematization has a positive impact on the ability to precisely define corrective actions	Cleaning has a positive impact on the ability to precisely define corrective actions, and also has a preventive effect	Standardized, common corrective actions for both methods can be defined	The ability to implement corrective actions motivates compliance with standards and self-discipline.
6. Establish verification procedures	Organized workstations facilitate access to documentation and tools needed for verification.	Organizing and logically arranging items ensures a smooth verification process and reduces the risk of overlooking important elements.	The cleanliness of the work environment increases the credibility of verification results.	Establishing standards and procedures for maintaining order and cleanliness supports the consistency and repeatability of verification processes.	Employee engagement in maintaining order and cleanliness facilitates the collection of data and information needed for verification.
7. Establish documentation and record-keeping.	Documentation determines what is necessary and what is unnecessary, sorting supports the transparency of documentation.	Systematization supports documentation management and well-prepared documentation supports systematization in the 5S method.	Cleaning is a common activity of both methods and can be regulated in one, unified documentation	Standards can be developed that integrate and connect the requirements of both the HACCP and 5S approaches.	The documentation may be supplemented with records of self-monitoring of compliance with standards

Source: own study

The comparative analysis of the HACCP principles and 5S steps reveals that these systems have many common points and elements. These include, among others, the elimination and

monitoring of hazards, maintaining order, cleanliness, and hygiene, implementing corrective actions, and maintaining documentation and records.

Consequently, when organizations implement 5S, they discover that HACCP has already established a structured environment, and the 5S principles should be seamlessly integrated and aligned with the existing system. Some components can be implemented without significant changes or with minor extensions, while others require substantial refinement or the introduction of entirely new elements. Activities such as the critical control point monitoring system, documentation and records of the effectiveness and efficiency of actions, as well as the establishment, implementation, and documentation of corrective actions that function in the HACCP system should be expanded to include actions related to the implementation of the 5S principles.

6. Conclusions

HACCP as a mandatory system should be implemented in all organizations operating in the food industry, while food companies often turn to other systems to support quality management or production optimization. However, the primary goal remains ensuring the health safety of products. Therefore, all subsequent solutions, concepts, systems, or methods must be implemented while respecting the principles of HACCP. One concept that is relatively rarely implemented in the food industry, yet can bring many benefits, is Lean Management.

The purpose of this paper is to analyze whether and how Lean Management can support the implementation of HACCP principles. The analysis was carried out using the example of example of the 5S method, one of the fundamental elements of Lean Management. The analysis was conducted from the perspective of an organization that has already implemented the HACCP system, so when implementing 5S, the principles of HACCP must be respected.

Based on the analysis, it can be stated that the 5S method and the HACCP system have many common points and significantly complement each other. The implementation of the 5S method in the functioning HACCP system contributes to optimizing the number of critical control points, and thus to optimizing or reducing costs. In summary, the implementation of 5S in a food company can be even easier and more effective than in non-food industries. It is also noteworthy to emphasize the emergence of a synergistic effect - the implementation of the 5S methodology not only enables the attainment of benefits characteristic of Lean Management, but also effectively support the HACCP system in managing the safety of the produced food.

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FRAUD IN THE TRADE OF HERBS AND SPICES GIVEN RASFF SYSTEM DATA

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Summary: Demand for herbs and spices continues to grow supported by greater consumer interest in healthy lifestyles and nutrition based on natural ingredients. Europe is one of the largest markets for herbs and spices in the world, with about 25% of the global market. These products often pass through a long and complex distribution chain before reaching the final consumer, and this encourages unfair practices and fraud, which are difficult to detect. It can be assumed that the more links in the distribution chain, the greater the likelihood of illegal practices in the marketing of herbs and spices and fraud. This paper aims to identify ways herbs and culinary species are adulterated in the European Union market based on Rapid Alert System for Food and Feed (RASFF) notifications and ways to prevent fraud. The analysis shows that RASFF notifications related to the "herbs and spices" category accounted for 6.4% of total notifications in 2023. Most notifications were for cumin seeds, peppercorns, paprika, oregano, and nutmeg. The largest group of frauds involved the presence of unauthorized dyes.

Keywords: herbs, spices, market, food fraud, RASFF

1. Introduction

Culinary herbs and spices are the edible parts of plants that are traditionally added to foods for their flavor, aroma, and visual properties. Seasoning is a mixture of permitted food ingredients added as needed to achieve the purpose for which it was designed, that is, to improve

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the taste, food quality, and/or functionality of the food. It usually contains one or more herbs and/or spices and other ingredients that enhance or impart flavor (ESA The ESA Definitions for Culinary Herbs and Spices, 2018). Commonly added to flavor dishes and supplement diets, culinary herbs, and spices have many valuable health properties. Demand for them continues to grow, fostered in part by consumers' growing interest in healthy lifestyles and nutrition based on natural ingredients. A similar trend toward more natural products can also be observed in the cosmetic and pharmaceutical sectors, where herbs are an ingredient in many over-the-counter medicines and dietary supplements. Unit package prices for culinary spices are not high, causing them to be overlooked in household budget analyses, but the spice market generates large revenues for its participants (Newerli-Guz, 2017).

Europe is one of the largest markets for herbs and spices in the world. The largest European markets for herbs and spices are Germany, the Netherlands, France, the United Kingdom, Spain and Poland. It is estimated that its global market share is about 25%. Due to climatic conditions, many herbs and spices are imported mainly from East Asia, Africa, Latin America, and the Caribbean (Maquet et al., 2021). These products often pass through a long and complex distribution chain before reaching the final consumer (Everstine et al., 2021). At every stage of production and distribution, and every link in this globalized chain, unfair practices, and fraud can occur, including the use of unauthorized dyes, additives, chemicals, removal of valuable ingredients, or contamination with foreign plant material. Detecting them is difficult because it often requires a lot of expensive analysis using state-of-the-art analytical techniques. It can be assumed with a high degree of certainty that the more links in the distribution chain, the greater the likelihood of illegal herbal and spice trade practices and fraud (Maquet et al., 2021; Everstine et al., 2021). The momentousness of the problem stems from the fact that spices were listed in the European Parliament's resolution of January 14, 2014, on the food crisis, fraud in the food chain, and its control among the commodities that are most vulnerable to fraud (European Parliament Resolution). Earlier, in 2012. GFSI (Global Food Safety Initiative) formally addressed food fraud as a separate food safety issue (Spink, 2023). Food fraud and adulteration are pathological activities associated with dishonest and unethical practices used in various links of the food distribution chain, aimed at economic benefits. These activities affect the quality and, above all, the safety of food for the consumer and are part of the phenomenon called food crime in the literature, i.e. crime against food and the food chain. This is not a new phenomenon, as regulations for such activities were already in place during the Greek and Roman empires, an example of which is the Code of Hammurabi from around 1700 B.C., which stipulated responsibility and penalties for artisans who failed to ensure an adequate level of quality of products (Code of Hammurabi, MMIII).

Food fraud is generally defined as "intentional fraud for economic gain using food" (Spink, 2023). GFSI distinguishes the following types of food fraud: substance adulteration (through

dilution, substitution, and concealment), unapproved enhancements, mislabelling/branding, grey market production/theft/diversion, and IPR counterfeiting (GFSI, 2018). Dilution is mixing a high-value liquid ingredient with a lower-value liquid, substitution is replacing a high-value ingredient or part of a high-value product with another lower-value ingredient or part of a lower-value product, and concealment is hiding low-quality food ingredients or products. Mislabelling involves making false claims on packaging for economic gain, and unapproved enhancement involves adding unknown and undeclared materials to food products to improve their quality characteristics. Counterfeiting should be understood as copying the brand name, packaging concept, recipe, processing method, etc. of food products to obtain economic benefits. Thus, the term food fraud includes the intentional and deliberate substitution, addition, manipulation, or misrepresentation of food, food ingredients, feed, packaging or food labels, product information, or false/misleading product claims to obtain economic benefits that may affect the health of the consumer (FFPA, 2022). Also, an expert panel of the United States Pharmacopeia Convention (USP) defined intentional and economically motivated adulteration of food ingredients as "the fraudulent addition of inauthentic substances or the removal or substitution of authentic substances without the knowledge of the buyer for the economic benefit of the seller," and created a database in 2012 containing information on food ingredient fraud and adulteration for economic reasons (Moore et al., 2012). Food fraud is committed by any entity that intentionally engages in illegal activities for economic gain, thereby causing or facilitating the marketing of illegal food in the supply chain or fraudulently increasing the value of food (Gussow, 2020). In turn, Evestine et al. (2024) distinguish the following types of fraud: dilution or substitution with another ingredient, artificial enhancement, use of undeclared, unapproved, or banned biocides, misrepresentation of nutritional values, false label claims, removal of authentic ingredients, formulation of a false product through the use of multiple adulterations and techniques. Regardless of the distinguished types, food fraud is always intentional and motivated by economic gain, and its effects are misleading and can hurt consumer health.

The purpose of this paper is to identify ways in which herbs and culinary spices are adulterated in the European Union market based on Rapid Alert System for Food and Feed (RASFF) notifications and ways to prevent fraud.

2. Material and Methods

The research material consisted of data on notifications, from official contact points in member states/EEA-EF countries, made in 2023 under the RASFF system on culinary herbs

and spices, published by the European Commission. In total, out of 4892 registered notifications under the RASSF food system, those in the "herbs and spices" category were 312, accounting for 6.4% of the total notifications in 2023. Based on the annual report, the reported notifications to the system were analyzed by type of product and adulteration, country of the notifier, type of notification classification, risk of decision, countries covered by distribution, country of origin of products, and type of fraud. Fraud in the herbs and spices category was divided into the following groups: unauthorized colour, lack of documentation, foreign bodies, and undeclared ingredients.

3. Results and Discussion

Of the total notifications for the "herbs and spices" category, nearly 32% were alert notifications, 45.5% were border rejection notifications, 16% were information notifications for attention and nearly 7% were information notifications for follow-up, Table 1.

Table 1.
Classification of notifications for herbs and spices in 2023 under the RASFF system

Classification of notifications	%
Alert notification	31,7
Border rejection notification	45,5
Information notification for attention	16,0
Information notification for follow-up	6,7

Source: RASFF – Window. European Commission 2023. https://webgate.ec.europa.eu/rasff-window/screen/search

According to a report by the Joint Research Center and reports from French authorities in 2019, spices such as cumin, turmeric, oregano, paprika/chili, bell pepper, and saffron are frequent targets for fraud in the European market (Maquet et al., 2021). This is also confirmed by an analysis of RASFF notifications, which shows that the largest number of notifications were for cumin seeds (*Carum carvi* L.) - 43, accounting for 13.8% of notifications for herbs and spices, and pepper (Pepper L.) - 34, accounting for 10.9% of notifications made in this food category. There was also a relatively high number of notifications concerning paprika (*Capsicum* L.), oregano (*Origanum vulgare* L.), and nutmeg (*Myristica fragrans* Houtt.). More than 64% of the notifications resulted in a decision of serious health risk, and the risk for nearly 15% of the notifications was assessed as potentially serious.

The largest percentage of all notifications came from Germany (25.6%), the Netherlands and France (13.8% each), and Belgium and Italy (6.7% each). Notifications from other countries accounted for less than 4% of notifications each, and RASFF notifications in 2023 were sent from 25 countries. The highest percentage of notifications were for herbs and spices from China (9.1%) and Egypt (7.7%), in addition to Spain (3.8) and Belgium (3.5%). A total of 45 countries were identified from which herbs and spices notified to the RASFF system originated. In notifications for herbs and spices, the most frequently detected were pyrrolizidine alkaloids (in oregano, both dried and organic and powdered, ground licorice root, cumin seeds and powder, borage, ground roman cumin, ground tarragon, paprika powder, herbal infusion, rosemary, chives, lovage leaves), Salmonella spp. (in black pepper, ground coriander, betel leaves, organic lemons, parsley, basil, mint, dried marjoram, paprika powder, bay leaves, thyme), ethylene oxide (in Indian spices, cumin seeds, bay leaves, mixed powdered spices mainly from India and Lebanon, sumac, ashwagandha, pepper, blue fenugreek seeds, turmeric, fennel seeds, cinnamon powder, masala from India), plus mycotoxins like aflatoxin B1 and ochratoxin A (in nutmeg, bell pepper soup spices, turmeric, respectively, and ochratoxin A in cayenne pepper, nutmeg mainly from Indonesia, organic dandelion root, mixed spices). A total of 110 unauthorized substances were detected in herbs and spices in 2023 RASFF notifications, which can adversely affect the health of consumers of these products. The maximum permissible concentration (MRL) for aflatoxins and ochratoxin A in spices is set by Regulation (EC) 1881/2006 and for Sudan dyes by Regulation (EC) 1129/2011. In general, there are no specific regulations in the European Union's regulations on the authenticity and /or purity of culinary herbs and spices, in addition to those general requirements in the Food Law (Regulation 178/2002). There are ISO standards for foreign matter and total ash content in some herbs and spices, e.g., black pepper (ISO 959-1:1998), ground pepper (ISO 7540:2006), dried oregano (ISO 7925:1999), whole or ground turmeric (ISO 5562:1983), or cumin (ISO 6465:2009) (Maquet et al., 2021).

The characteristics of notifications of fraud in the trade of herbs and spices are shown in Table 2. The largest group of frauds involved the presence of unauthorized dyes, including Sudan I, II, and IV in pepper and curry powder, and rhodamine B chili powder. Sudan dyes are added to intensify and maintain the natural red colour of spices. However, Sudan compounds are not allowed as food additives in the European Union due to their carcinogenic properties. This dye, as well as other azo dyes such as para red, were frequently reported to the RASFF as early as 2003-2005 (Everstine et al., 2013). Just as often, fraud was noted due to the presence of undeclared allergenic ingredients such as celery, mustard, peanuts, or other prohibited plant parts. In addition, the presence of foreign bodies such as stones, wax, mouse droppings, or small pieces of glass were often found in questioned batches of herbs and spices. One in five

notifications had to do with a lack of documentation, including proper health certificates, labels, missing allergenic ingredient information, or incorrect identification codes.

Table 2.
RASFF notifications on herbs and spices fraud in 2023

Spices and herbs	Product	Fraud	Notifying Country	Distribution	Origin
Unauthorized color					
Chilli	Chilli powder	Rhodamine B	Belgium	France	Bangladesh
Chilli	Chilli powder	Orange II, Rhodamine B, Sudan I	Belgium	Belgium	Togo
Paprika	Paprika	Sudan III, Sudan IV	Germany	Germany	Turkey
Paprika	Paprika powder	Sudan I, Sudan IV	Germany		Turkey
Paprika	Paprika spice	Sudan IV	Germany	Austria, Czech Republic, France, Germany, Italy, Lithuania, Netherlands, Poland, Spain	Turkey
Curry	Curry powder	Sudan IV	Netherlands	France, Netherlands	Vietnam
Spices	Spices for BBQ and grill	Sudan I (CAS 842-07-9) > 2000 µg/kg	Latvia	Latvia	Uzbekistan
Lack of documentation					
Mustard	Mustard seeds	Without any label	Latvia		Russia
Ginger, Turmeric	Ginger, Turmeric	Absence of health certificate	Poland		India
Curcuma	Curcuma	Lack of documentation	Italy		India
Spices	spices	Unfavorable identity check	Italy		Syria
Coriander	Ground coriander	Non-labelled allergenic ingredient Mustard	Germany	Belgium, Germany, Netherlands	Spain
Turmeric	Turmeric	Incorrect identification code on the packaging	Slovenia	Austria	India
Cardamon	Cardamon	Incorrect identification code on the packaging	Slovenia	Austria	India
Coriander	Coriander seeds	Absence of health certificate(s)	Slovenia	Hungary	India
Coriander	Coriander	Without any label	Latvia		Russia

Foreign bodies					
Rose	Dried rose petals	Foreign bodies	Germany	Belgium, France, Denmark, Spain Germany, Luxembourg, Netherlands,	Jordan
Cloves	Whole cloves	Stones	Germany	Austria, Belgium, Cyprus, Estonia, France, Germany, Greece, Latvia, Luxembourg, Netherlands, Niger, Slovakia, Slovenia, Sweden, Switzerland, United Arab Emirates	Madagascar via France
Condiment	Condiment paste	Waxy	Germany	Germany	India
Clover	Organic red clover tea	Mouse droppings	Denmark	Norway, Sweden	Denmark
Fennel	Fennes seeds	Small glass pieces	Germany	Belgium, Germany, Sweden	Egypt via Germany
Cloves	Whole cloves	Stones	Germany	Germany	Netherlands
Mint	Rubbed mint	Stones and other foreign objects	Germany	Germany, Poland	Egypt
Undeclared ingredients					
Spice	Spice mix	Celery	Czech Republic	Slovakia	Czech Republic
Parsley	Crushed parsley leaves	Celery	Finland	Finland	Hungary
Marjoram	Marjoram spice	Celery	Czech Republic	Czech Republic, France, Poland, Slovakia	Egypt
Spice	Mix spice and raw garlic and parsley	Celery	Spain	Andorra, France, Belgium, Spain, Bulgaria, Costa Rica, Colombia, Germany, Honduras, Mexica, Panama, Netherlands, Portugal, Switzerland, United Kindom	China and Spain
Spice	Spice mix	Mustard	Germany	Austria, Germany	Turkey via Germany
Pepper	Ground chilli pepper	Peanut (> 25 mg/kg – ppm)	European Commission	Austria, Belgium, Cyprus, Czech Republic, Finland, France, Germany, Luxembourg, Netherlands, Northern Ireland, Poland, Romania, Sweden, Switzerland	Nigeria via the Netherlands
Curry	Green curry	Mustard	Switzerland	France, Germany, Switzerland	Cambodia
Tea	Tea	Coix Lacryma-jobi	Belgium	Belgium, China United States	China
Licorice	Licorice powder	Unauthorised Matrine	Denmark	Denmark	Iran

Source: RASFF – Window. European Commission 2023. https://webgate.ec.europa.eu/rasff-window/screen/search

For many of the questioned batches of herbs and spices, the distribution chain involved more than one country, including in several cases 14 to 16 countries. Hence, it seems fair to say that fraud is fostered by multinational, long distribution chains of herbs and spices. The Joint Research Center's report shows that in cumin, bulking agents such as peanut and almond shells are detected, as well as the presence of mahaleb, a species related to almonds and, in addition, food allergens such as white mustard and others; in turmeric, colour is enhanced with azo dyes (such as Sudan I) and yellow chalk and lead chromate; and corn or rice flour is detected, which are used as fillers. In oregano, on the other hand, the herb is partially replaced with olive leaves, sumac, or myrtle, and in pepper/chili, it is illegal to enhance the colour with azo dyes and use tomato peels or other plant species, including carrot, sunflower, tomato or onion, as fillers. Whole or ground peppercorns are replaced with papaya seeds and the volume of ground pepper is increased with fillers such as rice, buckwheat, barley, mustard, or other undeclared spices (Maquet et al., 2021).

There is growing concern about the incidence of food fraud risks. With that said, according to Everstine et al. (2021), public reports of fraud in the food industry likely represent only a fraction of the actual number of fraud cases in the food supply area. It is an ongoing and growing problem in the food industry, and increased efforts are needed to detect it. Worldwide, several organizations have implemented regulatory standards to control the quality and authenticity of herbs and spices and detect possible adulterants. The best-known of these are the American Spice Trade Association (ASTA), the European Spice Association (ESA), the International Organization for Spice Trade (IOSTA), the Board of India, and the All Nippon Spice Trade Association (ANSA). In the European Union, under the rules on official food and feed controls set out in EU Regulation 2017/625, notifications reported to the Rapid Alert System for Food and Feed (RASFF) means "non-compliance relating to any suspected intentional actions by companies or individuals to deceive buyers and obtain undue benefits from them." Herbs and spices, due to their specificity, variety of species and forms of commercial occurrence, characteristics, geographic origin, and long and multinational supply chains, are attractive to adulteration, mislabelling, or counterfeiting. The "think like a criminal" principle helps mitigate food fraud. This draws on the achievements of criminology, as this science studies criminal behavior and decision-making by criminals. This includes fraud, which is an economically motivated crime. These crimes are seen as the result of opportunities, motivations, and lack of means of control. Opportunities and motivations are determined by a company's internal and external environment and are defined as potential fraud risk factors. The potential risk from these two elements can be mitigated by a third element: mitigation measures applied in the food safety management system and/or external controls in the supply chain, industry segment, and/or regulatory framework (SSAFE, 2015). Within the company, formally these issues could be the responsibility of quality and food safety specialists, and at the national level, formal

external supervision could be carried out by inspections overseeing food safety matters. Informally, the company's employees, suppliers, and customers should be involved in supervision to reduce the risk of fraud. Food control authorities and food operators should use all available and reliable knowledge, e.g., the results of authenticity testing of herbs and spices conducted by various governmental and non-governmental organizations, to better target inspection efforts and strengthen preventive measures and activities to combat food fraud. They should assess the food fraud vulnerability of different product groups and conduct assessments not only of food safety (HACCP Hazard Analysis and Critical Control Point Plan), but also of food fraud vulnerability (VACCP Vulnerability Assessment and Critical Control Point Plan) and food defence (TACCP Threat Assessment and Critical Control Point Plan). A useful tool for assessing food fraud vulnerability is the Food Fraud Vulnerability Assessment Tool published in 2016 by the non-profit organization SSAFE (Food Safety Across the Supply Chain), and prepared in collaboration with Wageningen UR and VU University Amsterdam (https://www.ssafe-food.org/tools/food-fraud-vulnerability-assessment-tool).

4. Conclusions

Fraud in the herbs and spices industry remains a difficult problem due to the global nature, multi-stage complexity of the supply network for herbs and spices, difficulties in testing and detection strategies, and the often unconventional nature of fraud-related adulterations. The analysis shows that RASFF notifications related to the "herbs and spices" category accounted for 6.4% of total notifications in 2023. The largest number of notifications nearly 32% were threat and border rejection notifications (45.5%). Most notifications were for cumin seeds, peppercorns, paprika, oregano, and nutmeg. Most notifications were for herbs and spices from China, Egypt, Spain, and Belgium. The largest group of frauds involved the presence of unauthorized dyes, including Sudan I, II, and IV in paprika and curry powder, and rhodamine B chili powder. Frauds related to undeclared plant ingredients often have allergenic properties and are equally common. In addition, foreign bodies were usually found in questioned batches of herbs and spices, and one in five notifications was related to the lack of documentation, labeling, or information about allergenic ingredients, as well as the use of incorrect identification codes. With the growing problem of food fraud risks, various organizations worldwide are implementing regulatory standards to control the quality and authenticity of herbs and spices and detect possible adulterants. In mitigating economically motivated food fraud, it is recommended to follow the "think like a criminal" principle. Potential risks arising from the possibility and motivation for criminal activities can be mitigated by taking

appropriate measures in the company's food safety management system and strengthening external control mechanisms in the supply chain operating within the framework of applicable legal requirements.

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SELECTED FEATURES OF GLASS PRODUCTS IN THE OPINION OF CONSUMERS

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Summary: Throughout history, glass has found a number of uses. As civilization developed, it served various functions. It can be said that glass is an extremely versatile material and such opinions can often be heard about it. However, can we conclude from the versatility of this material that glass products are also practical? The purpose of this paper is to answer the question: what features of table glass products make users perceive these products as practical in everyday use? The research conducted using the survey method allowed for answering the above question. Certain features of glass products important for customers (ex. durable, reusable, dishwasher safe, washable) have been identified and described.

Keywords: glass, versatility, practicality, quality, usefulness

1. Introduction

Throughout history, glass has found a number of uses. As civilization developed, it served various functions. The first glass products appeared already in the Neolithic era, but it was not glass melting similar to what is known today. If sand was accidentally found in the fireplace, the melting of sand lumps could result in the formation of glass balls. These were the creations of the first, primitive art. These items must have been very valuable at that time, because they

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were used to equip the dead in their tombs. They could therefore be related to the beliefs or superstitions of the people of that time. The glass melting technique was known in Egypt over 3000 BC. Each product was decorated individually, most often using a pattern of wide threads and ribbons associated with the rippling waters of the Nile. Glass was extremely valuable in those times, it was a luxury that only the highest dignitaries and priests of the religions of the time could afford to use (Laba, 2007). Most of the products were containers for medicinal ointments or cosmetics. Glass was therefore already used as packaging, which continues to this day (Sacha et al., 2016). In addition to the above-mentioned applications, vases, amphoras, jugs and trays, as well as jewellery were also made.

Glassware quickly took on a decorative function. The era of the Roman Empire was one of the most significant in the history of glass art. When creating their own culture and civilization, the Romans often were inspired by the achievements of other nations. It was then that mosaic glass became popular (Pulido Valente et al., 2021). At that time, the first glass collections appeared. Emperor Nero was its great lover and collector (Laba, 2007).

In the late Middle Ages, with the spread of the Christian religion in Europe, monasteries were established, which over time became centres of culture and centres of the development of crafts, including glass crafts. The monastery glassworks mainly produced window panes, glass tiles for stained glass windows, as well as utility vessels and candlesticks for the Church (Laba, 2007).

Over the course of history, glass began to decorate elegant living rooms, emphasizing the status of its owner and even arousing jealousy among invited guests (Nachyła, 2019).

Additionally, glass is a versatile material that can be used for various home applications, offering unobstructed views and imparting sophistication (Elsayed et al., 2024). Furthermore, glass bottles and storage jars not only serve practical purposes but also add an aesthetic look to the house interior, reflecting the care and attention of the homeowners (Rajak et al., 2021; Furszyfer Del Rio, 2022).

The intensive development of technology meant that many new applications of glass substances were gradually noticed. In the consciousness of modern man, this material is no longer associated with fragility and delicacy. It combines the ability to provide comfort both acoustically and thermally with excellent aesthetic properties (Kosmal et al., 2022). It is therefore not surprising that glass, having good functional and decorative properties, is now widely used in construction and is today of interest not only to glass producers, but also to engineers and architects (Ritchie, 2004; Stankiewicz, 2006).

Glass eventually also became a means of expressing artistic inspirations. Repeating after Filarska (1973): "In the 20th century, a belief was created that glass is such a versatile material that all creative inspirations can be expressed in it:. The widespread use of glass in various forms allows it to be shaped into diverse and visually striking forms (Elsayed et al., 2024).

Nowadays, glass is also used as an artistic material from which sculptures are created. Today, wealthy people treat them as an investment of capital, just like paintings or sculptures made of other materials.

Taking into account the above considerations, it can be concluded that glass is an extremely versatile material and such opinions can be heard about it many times. But does this mean that glassware is also practical? Is it possible to attribute practicality to glass based on its versatility?

It seems that examining the perception of glass products in terms of broadly understood practicality is an interesting topic. It is worth conducting such research, especially in Polish reality. Poland is a country with a rich history in the production of glass products, and this industry has been present in its territory for almost a millennium (Laba, 2007).

The purpose of this paper is to answer the question: what features of table glass products make users perceive these products as practical in everyday use? The second goal was to answer the question: whether respondents value the aesthetic or functional values of table glass. Understanding this issue may contribute to a better understanding of the needs of customers using glass, and may also be of value to producers of various types of tableware.

2. Methods

The study was conducted in November 2023 using the survey method. The survey questionnaire was distributed online to a group of one hundred and fifty respondents – residents of the Podkarpackie Voivodeship. The questionnaire consisted of demographic and social characteristics and essential questions. At the beginning of the questionnaire, respondents were asked a number of questions aimed at determining how much they identified with specific statements (e.g. "what I value in glass products is primarily the functional function, not the decorative one" or "glass products must be, above all, beautiful"). Responses were acquired using a five-point Likert scale. Based on the answers provided, the respondents were divided into three groups:

- aestheticians (who value the aesthetics of vessels more than their functional values),
- undecided (not showing clear preferences),
- pragmatists (valuing the utilitarian value of a vessel more than its aesthetics)

The $\chi 2$ independence test was used to verify the hypothesis about the differentiation of answers to subsequent questions depending on the features contained in the data. The results of the respondents' answers represented a qualitative variable and a nominal scale, which justifies the use of the above test. This measure allows for a synthetic comparison of the distribution of

empirical numbers with the distribution of theoretical numbers. Hypotheses were verified at the significance level $\alpha = 0.05$, based on the test probability value "p". It was assumed that $p \leq 0.05$ indicates significant differences in the statements of both groups of respondents. (Mynarski, 2003) The essence of the differences was interpreted based on the percentage of indications of individual categories of answers to subsequent questions ($\chi 2$ test). The survey results were statistically analyzed using the Statistica 13.3 software.

3. Results

Table 1 lists the characteristics of the studied population, including demographic characteristics, as well as the division of consumers into aestheticians, pragmatists and undecided.

Table 1.
List of characteristics of the studied population

Characteristic	Segment	Quantity
Sex	man	48,7 %
	woman	51,3 %
Age [years]	from 20 to 35	48,0 %
	from 36 to 50	28,0 %
	over 50	24,0 %
Education	higher education	52,0 %
	secondary or primary or basic vocational education	48,0 %
Domicile	village	55,3 %
	city up to 50 thousand inhabitants	30,7 %
	city over 50 thousand inhabitants	14,0 %
Financial situation	very good or good	62,7 %
	mediocre or insufficient	37,3 %
„Pragmatism”	aestheticians	18,0 %
	undecided	64,0 %
	pragmatists	18,0 %

Source: own study

The opinion that glassware is practical because it is durable varies depending on where the respondents live ($p < 0.05$). The highest percentage of people representing this opinion occurs in the group of city inhabitants with a population of up to 50,000. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 2.

Table 2.
Opinion that: "glassware is practical because it is durable" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	26.03%	0.448
	woman	20.78%	
Age [years]	from 20 to 35	25.00%	0.895
	from 36 to 50	21.43%	
	over 50	22.22%	
Education	higher education	21.79%	0.643
	secondary or primary or basic vocational education	25.00%	
Domicile	village	16.87%	0.002
	city up to 50 thousand inhabitants	41.30%	
	city over 50 thousand inhabitants	9.52%	
Financial situation	very good or good	21.28%	0.440
	mediocre or insufficient	26,79%	
„Pragmatism”	aestheticians	18,52%	0.038
	undecided	20,83%	
	pragmatists	37,04%	

Source: own study

The opinion that glassware is practical because it is suitable for many different occasions is not differentiated by any demographic and social characteristics ($p > 0.05$). This opinion accounted for approximately 21% of responses, so it was one of the most popular among respondents. However, there is no group in which this opinion would be significantly more popular. Detailed data is provided in Table 3.

Table 3.
Opinion that: "glassware is practical because it is suitable for many different occasions" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	60,27%	0,273
	woman	68,83%	
Age [years]	from 20 to 35	59,72%	0,164
	from 36 to 50	61,90%	
	over 50	77,78%	
Education	higher education	61,54%	0,404
	secondary or primary or basic vocational education	68,06%	
Domicile	village	68,67%	0,196
	city up to 50 thousand inhabitants	65,22%	
	city over 50 thousand inhabitants	47,62%	
Financial situation	very good or good	67,02%	0,434
	mediocre or insufficient	60,71%	
„Pragmatism”	aestheticians	70,37%	0,790
	undecided	63,54%	
	pragmatists	62,96%	

Source: own study

The opinion that glassware is practical because it does not get damaged when washed in a dishwasher varies by gender and place of residence of respondents ($p < 0.05$). A higher percentage of women express this opinion. A higher percentage of people representing this opinion occurs in the group of city inhabitants with a population up to 50,000, compared to the other two groups. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 4.

Table 4.
Opinion that: "glassware is practical because it does not get damaged when washed in a dishwasher" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	32,88%	0,048
	woman	48,05%	
Age [years]	from 20 to 35	41,67%	0,550
	from 36 to 50	45,24%	
	over 50	33,33%	
Education	higher education	44,87%	0,275
	secondary or primary or basic vocational education	36,11%	
Domicile	village	32,53%	0,028
	city up to 50 thousand inhabitants	56,52%	
	city over 50 thousand inhabitants	38,10%	
Financial situation	very good or good	44,68%	0,195
	mediocre or insufficient	33,93%	
„Pragmatism”	aestheticians	29,63%	0,362
	undecided	41,67%	
	pragmatists	48,15%	

Source: own study

The opinion that glassware is practical because it is suitable for everyday use varies depending on where the respondents live ($p < 0.05$). The highest percentage of people representing this opinion occurs in the group of rural residents, and the lowest – in the group of city inhabitants with a population over 50,000. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 5.

The opinion that glassware is practical because it is cheap varies with the level of education and financial situation of respondents ($p < 0.05$). A higher percentage of people representing this opinion occurs in the group with at most secondary education. A higher percentage of people representing this opinion occurs in the group declaring an average or poor financial situation. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 6.

Table 5.
Opinion that: "glassware is practical because it is suitable for everyday use" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	65,75%	0,951
	woman	66,23%	
Age [years]	from 20 to 35	59,72%	0,254
	from 36 to 50	69,05%	
	over 50	75,00%	
Education	higher education	60,26%	0,122
	secondary or primary or basic vocational education	72,22%	
Domicile	village	77,11%	0,002
	city up to 50 thousand inhabitants	58,70%	
	city over 50 thousand inhabitants	38,10%	
Financial situation	very good or good	65,96%	0,988
	mediocre or insufficient	66,07%	
„Pragmatism”	aestheticians	62,96%	0,934
	undecided	66,67%	
	pragmatists	66,67%	

Source: own study

Table 6.
Opinion that: "glassware is practical because it is cheap" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	13,70%	0,241
	woman	7,79%	
Age [years]	from 20 to 35	9,72%	0,654
	from 36 to 50	14,29%	
	over 50	8,33%	
Education	higher education	6,41%	0,047
	secondary or primary or basic vocational education	15,28%	
Domicile	village	12,05%	0,162
	city up to 50 thousand inhabitants	4,35%	
	city over 50 thousand inhabitants	19,05%	
Financial situation	very good or good	6,38%	0,028
	mediocre or insufficient	17,86%	
„Pragmatism”	aestheticians	14,81%	0,672
	undecided	10,42%	
	pragmatists	7,41%	

Source: own study

The opinion that glassware is practical because it is easy to store is not differentiated by any demographic and social characteristics ($p > 0.05$). This answer was indicated in approximately 7.5% of cases. However, these indications are scattered among all groups of respondents and it is impossible to clearly determine in which group this opinion appears statistically more often. Detailed data is provided in Table 7.

Table 7.
Opinion that: "glassware is practical because it is easy to store" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	21,92%	0,981
	woman	22,08%	
Age [years]	from 20 to 35	22,22%	0,896
	from 36 to 50	23,81%	
	over 50	19,44%	
Education	higher education	26,92%	0,130
	secondary or primary or basic vocational education	16,67%	
Domicile	village	18,07%	0,423
	city up to 50 thousand inhabitants	26,09%	
	city over 50 thousand inhabitants	28,57%	
Financial situation	very good or good	25,53%	0,176
	mediocre or insufficient	16,07%	
„Pragmatism”	aestheticians	14,81%	0,672
	undecided	10,42%	
	pragmatists	7,41%	

Source: own study

The opinion that glassware is practical because it is universal in use varies with the level of education of the respondents ($p < 0.05$). A higher percentage of people representing this opinion occurs in the group with higher education. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 8.

Table 8.
Opinion that: "glassware is practical because it is universal in use" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	27,40%	0,612
	woman	31,17%	
Age [years]	from 20 to 35	29,17%	0,981
	from 36 to 50	28,57%	
	over 50	30,56%	
Education	higher education	35,90%	0,046
	secondary or primary or basic vocational education	22,22%	
Domicile	village	34,94%	0,184
	city up to 50 thousand inhabitants	19,57%	
	city over 50 thousand inhabitants	28,57%	
Financial situation	very good or good	32,98%	0,204
	mediocre or insufficient	23,21%	
„Pragmatism”	aestheticians	33,33%	0,636
	undecided	30,21%	
	pragmatists	22,22%	

Source: own study

The opinion that glassware is practical because it is easy to clean varies with the respondents' financial situation ($p < 0.05$). A higher percentage of people representing this opinion occurs in the group declaring an average or poor financial situation. Other demographic and social characteristics do not differentiate this opinion ($p > 0.05$). Detailed data is provided in Table 9.

Table 9.
Opinion that: "glassware is practical because it is easy to clean" depending on demographic and social characteristics ($\chi 2$ test results)

Characteristic	Segment	Percentage of indications	p
Sex	man	16,44%	0,495
	woman	20,78%	
Age [years]	from 20 to 35	22,22%	0,535
	from 36 to 50	16,67%	
	over 50	13,89%	
Education	higher education	19,23%	0,854
	secondary or primary or basic vocational education	18,06%	
Domicile	village	16,87%	0,453
	city up to 50 thousand inhabitants	17,39%	
	city over 50 thousand inhabitants	28,57%	
Financial situation	very good or good	13,83%	0,048
	mediocre or insufficient	26,79%	
„Pragmatism”	aestheticians	22,22%	0,517
	undecided	19,79%	
	pragmatists	11,11%	

Source: own study

4. Discussion

The three most frequently chosen answers by respondents to the question of „what it means that glass products are practical” were: „they are suitable for everyday use” (22% of responses), „they are suitable for many different occasions” (21% of responses) and „they do not deteriorate when washed in a dishwasher” (14% of responses). Therefore, respondents equate practicality with universality. They want the dishes to be able to be used on many different occasions. Therefore, it seems that the exclusivity of the dishes and their intended use only for specific occasions may make the dishes not be perceived as practical. Moreover, it is very important for respondents that the dishes do not get damaged when washed in the dishwasher. This study result seems to be consistent with intuition. The number of households equipped with dishwashers in society is constantly increasing (Główny Urząd Statystyczny, 2024). Therefore,

suitability for this form of cleaning is very important for a modern consumer. Women and residents of small towns especially pay attention to this.

The research results indicate that there are opinions that are not differentiated by any demographic and social characteristics. They appear in a dispersed form between different groups of respondents and it is impossible to clearly state where a given opinion appears most often. An example is the opinion that: „glassware is practical because it is easy to store". Such functionality seems to be necessary and important regardless of the group of consumers we are dealing with. Glass products are fragile and can be easily damaged. It therefore seems logical that respondents want to store their glass in a way that does not require much effort.

The same applies to the opinion that: „glassware is practical because it is suitable for many different occasions". This opinion seems to be particularly consistent with meanings such as "functionality" and "usability" found in the literature. (Wielki Słownik Języka Polskiego, 2024).

The prevailing opinion among rural residents is that glassware is practical because it is suitable for everyday use and because it is cheap.

The opinion that glassware is practical because it is durable is common in the group of city residents with a population of up to 50,000, but is very rare in the group of city residents with a population of over 50,000.

The price criterion also seems to be important. The opinion that glassware is practical because it is cheap is more common in the group with no more than secondary education and in the group declaring an average or poor financial situation. This group also often believes that glassware is practical because it is easy to clean.

It may also be interesting that the least frequently chosen answer (less than 2% of responses) was the opinion that glassware is universal because it can be used by children. So it seems that in this aspect, glassware is not perceived as practical. The reason for such a low percentage of indications may be the fact that this opinion was formulated somewhat generally in the survey questionnaire. The use of particular types of cookware may depend on the child's age. Younger children do not use glassware on their own or use it under their parents' supervision. However, older children can successfully use glassware just like adults. Differences may result from the child's age. Because it was not specified in the questionnaire, respondents could understand the question about the use of glass by children in different ways.

Moreover, in the literature we can find a lot of concepts of what quality features glassware should have to be positively perceived by customers. Several authors agrees that durability and longevity of glass products along with its resistance to physical and chemical factors, easiness of cleaning, and non-reactivity, make it suitable for various applications, including food, beverage, and pharmaceutical containers (Shakhgildyan et al., 2020), (Elsayed et al., 2024), (Macfarlane & Martin, 2002). Similar results have also been obtained in this paper, as there are some respondents who value this features very much. The literature review illuminated

availability, and affordability of glass as well (Elsayed et al., 2024). This also has been confirmed by conducted research, because there are certain groups of customers, who do care about the price of glass products.

In recent years, environmental concerns have gained more attention from consumers in line with the increasing importance of sustainability. As a result, the demand for eco-friendly products is rising (Chen et al., 2021). There are a lot of products categories that are popularly labelled as eco-friendly. (Maarif et al., 2024) investigated consumer reviews of eco-friendly products made of various materials to uncover valuable sustainability insights that can help to optimize design. Those authors came to a conclusion, that there are a lot of eco-friendly products among „Health & Household" and „Home & Kitchen" categories. Plates, bowls, cups, tumblers and water glasses are very often labelled as eco-friendly. Not every of them are made of glass, but many are.

In this study the respondents weren't directly asked about whether eco-friendly products are perceived as practical. But thanks to literature analysis it has been observed that glassware products have several features that are perceived as practical (durable, reusable, dishwasher safe, washable). And at the same time (Maarif et al., 2024) discovered that exactly the same features are considered as eco-friendly. Furthermore, for instance, the proximity of terms such as "durable", "reusable", and "dishwasher safe" to the "Home and Kitchen" category implies that these are the attributes that consumers predominantly seek or encounter in home-related products. Material such as glass, although not biodegradable, can be repeatedly recycled without a loss of quality, contributing to its popularity in sustainable product categories.

Therefore, from this study it is not possible to draw a firm conclusion that glass products are practical and environmentally friendly, and that one feature is determined by the other, but there is a solid basis that allows us to predict this. It could also be an inspiration for further research to confirm or reject this conclusion.

The Dictionary of the Polish Language defines the word "practical" as, among others, "based on practice" or "intended to be used in practice" and "useful for something." In the context of a person, "practical" means "taking care of one's life affairs" (Słownik Języka Polskiego, 2024). The word "practicality" in the context of things refers to meanings such as "functionality" and "usability" (Wielki Słownik Języka Polskiego, 2024). According (Maarif et al., 2024) the set of terms related to "product usability" includes descriptors such as "reusable" and "durable." These terms address certain facts that consumers have positive affirmation toward products that simplify their lives and save them time. It confirms the conclusion from this study that glassware is practical because it is durable.

Also (Nguyen, 2022) confirms that durability, price-quality ratio, functionality, recyclability are important to customers. He also informs that some customers care about

„practicality" described as „easy to maintain, easy to clean, easy to use and easy to put away" product.

Other researchers have focused on the practical aspects of storing glassware. For certain groups of people it is crucial that kitchen utensils are easy to storage (Li et al., 2023). In societies when kitchen rooms are generally small (ex. China) customers would like to buy glassware designed for easy storage designed for easy storage, e.g. the shape of the glasses should enable stacking. Also the results of this research implies that there are customers who care about this feature.

5. Conclusions

The conducted research may become a contribution to the discussion on positioning on the glass products market. It is worth emphasizing that promoting glassware as practical or as highly decorative requires deeper consideration among people developing marketing strategies. As the research described in this study has shown, the percentage of people who can be described as aestheticians is as significant as the percentage of people who can be described as pragmatists. Yet the needs of these two groups seem to be extremely different. Equally difficult to interpret is the fact that the majority of people in the surveyed population do not have clear preferences for either aesthetic or functional functions. Therefore, it is hard to predict what promotional strategy should be chosen by enterprises that want to reach this particular group of consumers. Perhaps the solution here will be design aimed at "combining" both functions of glass products. On the one hand, they will have to present a satisfactory level of aesthetics, but on the other hand, they will also have to be "practical", which, as shown in this study, also has many meanings. Some customers understand practicality as durability, reusability, dishwasher safety, washability. But there are some, who rather think, that practical products are mostly easy to store and cheap. From literature review it could also be concluded, that practicality could be somehow correlated with eco-friendliness, but this requires further research.

Hence, related to product quality, it is important that product designers consider using durable materials and that adopting robust construction techniques can ensure product longevity. Therefore, the sustainability aspects of products need not compromise on aesthetic factors. (Maarif et al., 2024).

Additionally, it should be noted that the results of consumer preference research, as is often the case in social research, may become outdated. This is due to generational changes, fashion and other factors. It is therefore worth repeating and updating research to gain access to current data. Moreover, research on social preferences repeated from time to time and compiled over

time may become the subject of later meta-analyses, thus revealing results and trends of a timeless nature. The data collected in the research may also prove useful for manufacturing companies, especially in the domestic glass sector. Further research should concentrate into deeper understanding the hierarchy of consumer preferences among the identified characteristics of glass products.

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TECHOLOGIES SUPPORTING THE DEVELOPMENT OF SERVICE 4.0

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Summary: Industry 4.0, also known as the Fourth Industrial Revolution or 4IR, is currently one of the main development trends in manufacturing. Some of the technologies that enabled the transformation towards Industry 4.0 can also be used in the service industry, but this industry seems to be lagging behind in terms of digital transformation. The concept of Service 4.0 is also relatively rarely analyzed in the literature. The objective of this paper is to highlight the impact of Technologies 4.0 on the development of service sector and to identify the technologies that could have the significant impact on their future development. Based on the literature and our own analyses, 7 technologies were identified that seem to have a significant impact on the development of Service 4.0: Big Data Analysis, Cloud Computing, Robotic Process Automation, Bionic and Cognitive Computing, Ubiquitous Connectivity and the Internet of Things, Virtualization and Smart Devices, Augmented Reality

Keywords: Service industry, Technologies 4.0, Service 4.0.

1. Introduction

Industry 4.0, also known as the Fourth Industrial Revolution or 4IR, represents the upcoming stage in the digitalization of the manufacturing industry. It is steered by disruptive shifts such as the surge in data and connectivity, analytics, human-machine interaction, and advancements in robotics (McKinsey & Company, 2022). This era of industrialization is characterized by the convergence of the physical, digital, and biological worlds, leading to the

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creation of smart factories and interconnected systems that optimize production processes and enable mass customization (Rawat, 2024).

The Industry 4.0 technologies (called also Technologies 4.0), influencing the global economy, also present the remarkable opportunity for enhancing customer value in service sector. Technologies 4.0, with their influence on global economy, offer an exceptional opportunity to enhance customer value in the service sector (Belk at al., 2023). A review of scientific publications concerning Service 4.0 reveal that this topic is significantly less discussed than the concept of Industry 4.0. The objective of this paper is to highlight the impact of Technologies 4.0 on the development of service sector and to identify the technologies that what could have the significant influence on this development.

2. Industry 4.0 Technologies in Service Sector

Much of the technology necessary to turn that vision of providing services into reality already exists. There is no uniform classification of Service 4.0 technologies, but some authors have identified technologies that are particularly useful in the transformation of the service industry. There is no uniform classification of Service 4.0 technologies, but some authors have identified technologies that are particularly useful in the transformation of the service industry. Based on publications regarding Service 4.0 (Rehse at al., 2016; Pschou at al., 2018; Aheleroff at al., 2021, Belk at al., 2023), 7 technologies have been identified that may significantly determine the development of the service industry in the near future.

2.1. Big Data and Analytics

The concept of Big Data has become increasingly relevant in recent years, as the volume, velocity, and variety of data available to businesses have grown exponentially (Erevelles et al., 2016; Vassakis et al., 2017). Big Data analytics enables organizations to extract valuable insights from this vast amount of structured and unstructured data, supporting better decision-making and driving innovation (Power, 2014; Vassakis et al., 2017). In the service industry, Big Data and Analytics are being used to personalize customer experiences, optimize service delivery, and predict future demand. For example, airlines can use Big Data to analyze passenger data and optimize flight schedules, while healthcare providers can use it to predict patient needs and improve care coordination.

2.2. Cloud Computing

Cloud computing has become an indispensable technology in both personal and business settings, providing on-demand access to a wide range of computing resources (Paschou et al., 2018; Susnjara & Smalley, 2024). This technology enables ubiquitous access to data and applications, facilitating remote work and seamless omnichannel customer engagement (Paschou et al., 2018; Susnjara & Smalley, 2024). In the service industry, Cloud Computing enables the delivery of software-as-a-service (SaaS) solutions, allowing service providers to offer their services remotely and scale their resources as needed. For instance, customer relationship management (CRM) software, often delivered as a cloud-based service, allows sales and customer service teams to access customer data and manage interactions from anywhere.

2.3. Robotic Process Automation

Robotic Process Automation (RPA) aims to automate repetitive, simple tasks by using software robots or AI workers to perform them accurately and efficiently (Ribeiro et al., 2021; Van der Aalast et al., 2024). This technology can significantly reduce the burden on employees, allowing them to focus on more complex and strategic tasks (Ribeiro et al., 2021; Van der Aalast et al., 2024). In the service industry, RPA is being used to automate tasks such as data entry, invoice processing, and customer onboarding, freeing up employees to provide higher-value services to customers.

2.4. Bionic Computing and Cognitive Computing

Bionic Computing and Cognitive Computing are fields that seek to mimic human cognitive abilities and physical characteristics, with the goal of creating more intuitive and natural interactions between humans and machines (Banash, 2024; Fazelli et al., 2019; Sharma, 2024). These technologies have the potential to revolutionize various industries by enhancing human-machine collaboration (Banash, 2024; Fazelli et al., 2019; Sharma, 2024). In the service industry, Bionic Computing and Cognitive Computing can be used to develop intelligent virtual assistants that can understand and respond to customer queries more effectively, or to create augmented reality-based training systems for service technicians.

2.5. Ubiquitous Connectivity and the Internet of Things

The Internet of Things (IoT) has become an increasingly prevalent concept, enabling the interconnection of a wide range of devices and objects, allowing for improved monitoring, control, and automation (Radenkovic & Kocovic, 2020; Rose et al., 2015; Silverio-Fernández

et al., 2018). This ubiquitous connectivity supports various applications, from asset tracking to smart city development (Radenkovic & Kocovic, 2020). In the service industry, IoT can be used to monitor the performance of equipment, predict maintenance needs, and automatically dispatch service technicians when issues arise. For example, a smart elevator system can continuously monitor its own condition and automatically schedule maintenance, ensuring reliable service for building tenants.

2.6. Virtualization and Smart Devices

Virtualization technology allows for the creation of simulated computer environments, providing greater flexibility, adaptability, and robustness (Kelley, 2023; Rehse at al. Hoffman, 2016; "What is..."). Smart devices, ranging from sensor nodes to smartphones, are integral components of this virtualized ecosystem, enabling advanced applications and cloud-based services (Rehse & al., 2016; Silverio-Fernández et al., 2018). In the service industry, Virtualization can be used to create virtual call centers, where customer service representatives can access customer information and applications from any location, while Smart Devices can be used to provide self-service options and remote monitoring of service delivery.

2.7. Augmented Reality

Augmented Reality (AR) technology integrates digital elements with the physical world, allowing for enhanced visualizations and interactions (Paschou et al., 2018; Schmalstieg & Hollerer, 2017). This technology can provide operators with a better understanding of ongoing activities and facilitate collaboration between physical and virtual environments (Paschou et al., 2018; Schmalstieg & Hollerer, 2017). In the service industry, AR can be used to provide remote assistance to field technicians, allowing experts to guide them through complex repairs by overlaying instructions and diagrams on the technician's view. AR can also be used to create interactive product demonstrations and visualizations for customers, enhancing the service experience.

3. The Impact of Artificial Intelligence on 4.0 Technologies

Artificial Intelligence (AI) is rapidly entering every sphere of human activity. By 2030, the value of the global AI market is expected to reach $1.35 trillion, and the development of AI technology could contribute to a $15.7 trillion growth in the global economy (Keary, 2024).

AI is defined as the ability of a machine to perform cognitive functions that we associate with human minds, such as perceiving, reasoning, learning, interacting with the environment, problem solving, decision-making, and even demonstrating creativity (Rai at al., 2019). Due to its analytical capabilities, AI makes decisions by relying on large amounts of data (Big Data), data that humans are unable to handle or analyse. To improve the performance and accessibility of interconnected AI to this information (e.g. digital records), cloud computing is often employed as the online system to store these huge amounts of data (Belk at al., 2023). In the service industry, AI-powered Cloud Computing solutions are being used to deliver personalized recommendations, automate customer service interactions, and optimize resource allocation.

AI also affects all other technologies supporting the development of Service 4.0, by strengthening them, as well as generating new possibilities. AI has also advanced Robotic Process Automation, allowing for more intelligent automation, natural language processing, and cognitive decision-making capabilities in the service industry. Additionally, the rapid advancements in AI have significantly boosted the capabilities of Bionic Computing and Cognitive Computing, enabling the development of more intelligent and adaptive systems that can learn and evolve over time. These AI-powered technologies are being used in the service industry to create virtual assistants and augmented reality-based training systems that can provide personalized guidance and support. AI-powered Virtualization can be used to create virtual call centers with intelligent customer routing and sentiment analysis, while AI-powered Smart Devices can provide personalized self-service options and remote monitoring of service delivery.

In conclusion, it can be stated that AI and technologies 4.0 have the potential to generate significant changes in the service industry. As Belk et al. (2023) assert, technologies 4.0 should no longer be perceived merely as another technology implemented by companies, as AI, VR, and service robots are actively reshaping business operations, employees' roles, and customers' positions in service interactions.

4. Service 4.0 in Practice – Examples

There are numerous examples of practical implementation of 4.0 technologies in various service industries. Netflix, for example, revolutionized media consumption by providing highly accurate recommendations to its subscribers on the basis of ongoing analyses of user preferences and behavior. Amazon has used the capability of ubiquitous connectivity and the IoT to integrate live support with its Kindle tablets, thus eliminating the traditional barrier

between the service provider and the user. In this connected setup, the user has interactive consultant support (Rehse & Hoffman, 2016).

In the Hospitality sector, solutions like Robotic Process Automation (RPA) are utilized. Humanoid robots, such as Kime, are employed in Spain to pour and serve customer drinks and snacks at self-contained kiosks (Biba, 2024). Robot Peppers serve as tour guides in museums (Misaros et al., 2023). In Taiwan, the Chase Walker Hotel operates as a fully robotic service hotel where guests primarily interact with robots for services like automatic check-in (Chiang & Trimi, 2020).In Healthcare, humanoid robots play crucial roles in communicating patient information and measuring vital signs (Biba, 2024). Among the commonly used robots in Healthcare are those assisting in surgeries, such as the da Vinci robot by Intuitive Surgical (Sostero, 2020). Other technologies employed in this industry include IoT-based applications for health monitoring, covering aspects like physical activity monitoring, patient safety, and vital sign tracking (Witkowski, 2017), as well as providing tele-health services (Radenkovic & Kocovic, 2020). Smart IoT-based applications like wearable devices, electronic medical report (EMR) generators, and smart mobile phone healthcare systems are increasingly utilized (Khan et al., 2014). Big data analysis is considered particularly promising (Belle et al., 2015, Khan & Alotaibi, 2020). This is an industry where the amount of data is growing exceptionally dynamically, and the ability to multidimensionally analyze large data sets enables better diagnostics and the creation of more effective solutions.

In the Retail Sector, Industry 4.0 technologies are extensively used, ranging from replacing human tasks (e.g., Walmart) to creating more attractive and interactive offerings for customers (e.g., Prada). Walmart employs the Auto-C robot for floor cleaning in its stores, operated either autonomously or by a human operator (Sostero, 2020). Prada, on the other hand, utilizes IoT by tagging chips to their clothing and accessories, activating a flat panel TV in the dressing room to display models wearing selected clothing when clients hang products they wish to buy (Xu, 2012).

These examples showcase the integration of Service 4.0 concepts across various service industries. Despite the focus on these technologies mainly from an industrial perspective in literature, it is evident that the Service 4.0 concept is evolving parallel to the Industry 4.0 concept, not only utilizing but also enhancing these technologies.

5. Summary

The technologies presented in the article seem particularly important in the context of Service 4.0. Big Data and Analytics, for instance, rely on Cloud Computing to store and process vast amounts of data, while Robotic Process Automation leverages these analytical capabilities to automate repetitive tasks (Vassakis et al., 2017; Susnjara & Smalley, 2024; Ribeiro et al., 2021). Bionic Computing and Cognitive Computing can harness the capabilities of Smart Devices and the Internet of Things to enhance human-machine interactions (Fazelli et al., 2019; Radenkovic & Kocovic, 2020). Virtualization and Augmented Reality further integrate these technologies, creating a more seamless and adaptable service environment (Kelley, 2023; Paschou et al., 2018).

However, the selection of these 7 technologies is subjective and may be incomplete, so the presented considerations should be treated as a voice in the discussion regarding the directions of development of the Service 4.0 concept. The digital transformation of the service industry is still ongoing, and technologies 4.0 are constantly developing. Therefore, further research and analysis are necessary to identify directions for the development of Service 4.0.

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QUALITY AND CONSUMER SATISFACTION ASSESSMENT ANALYSIS FOR LITHIUM-ION BATTERIES IN POLAND

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Summary: The present paper defines the features of selected batteries that are the most important for users and these are dimensions. They determine the suitability of the purchased rechargeable battery for use in the target device. The article presents an analysis of the dimensions of the three most popular types of batteries distributed on the domestic market. These are 18650, 26650, and 14500 batteries available on several popular auction sites. The batteries from two groups were tested: those that have protective electronics against overcharging and excessive discharging, and those that do not. Built-in protections affect the dimensions of the batteries due to the implemented electronics. Empirical tests involving measurements of battery sizes were carried out, the dimensional tolerance provisions in the standards were analysed and the results of the empirical measurements were compared with the values declared by the battery manufacturers. The results of the measurements are presented in the graphs included in the article, where the dimensions relating to the sockets installed in the devices powered by the batteries under test are marked as a reference point.

Keywords: batteries, product quality, quality, consumer satisfaction

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1. Introduction

Quality is a comprehensive concept involving various practices, methodologies, and philosophies aimed at ensuring products and services meet or exceed customer expectations. It requires a continuous effort from all parts of an organization and an unwavering focus on improvement and customer satisfaction. Quality is a multifaceted idea that plays a critical role in various domains, including manufacturing, services, product development, and more. The different ways of defining quality are influenced, among other things, by the fact that quality assessment depends on experience, knowledge, demand for the product, the level of awareness of employees and superiors and the degree to which quality concepts are implemented in the company. Furthermore, the concept of quality is subject to change as a result of human development and ongoing technological change.

In the early 20th Century Frederick Winslow Taylor (Taylor, 1911) began to use scientific management principles emphasized efficiency and the use of systematic methods to improve production and quality. In the 1920s, Walter A. Shewhart (Shewhart, 1931) developed statistical process control (SPC) techniques, introducing the use of control charts to monitor and control manufacturing processes. In Japan after the Second World War W. Edwards Deming and Joseph Juran (Deming, 1982; Juran & Godrey, 1993) introduced the principles of quality management. Deming's teachings on statistical quality control and Juran's focus on quality management and human factors significantly influenced Japanese manufacturing, leading to the rise of companies like Toyota. In the 1950s to 1980s, the idea of Total Quality Management (TQM) developed (Anastasiadou, 2015). Initially, quality circles – small groups of employees who identify and solve quality problems – became popular in Japan. At the time Kaoru Ishikawa (Union of Japanese Scientists and Engineers 2015) developed tools such as the fishbone diagram (Ishikawa diagram) for root cause analysis and promoted the concept of company-wide quality control (CWQC). Philip Crosby also introduced the concept of 'Zero Defects' and emphasized the importance of quality being 'free', stressing that the cost of poor quality far outweighs the investment in good quality practices (Crosby, 1979). At the end of the 1980s. the International Organization for Standardization (ISO) introduced the ISO 9000 series of quality management standards (International Organization for Standardization, 1987), providing a globally recognized framework for quality management systems. The global crisis of the 1980s and 1990s caused most businesses to experience a decline in sales and profits. Shrinking markets and increased competition led to a shift in the relationship between companies and customers. The customer became the main point of reference, and all organizational activities were directed towards meeting their needs. This shift in thinking resulted in the growing popularity of the TQM concept (Hamrol & Mantura 2020), where

quality is treated comprehensively and multidimensionally, but most importantly, from the customer's perspective (Dziadkowiec 2017).

There are numerous definitions of quality, reflecting various perspectives and emphases within the field (e.g. ISO, ASQ, TQM, Juran's Definition, Deming's Definition, Crosby's Definition, Ishikawa's Definition) (Crosby, 1979; Deming, 1982; Juran & Godrey 1993; Anastasiadou 2015; Union of Japanese Scientists and Engineers 2015; asq.org). Quality can be defined as 'fitness for use', 'customer satisfaction', 'doing things right the first time', or 'zero defects'. Webster's dictionary defines quality as 'a degree of excellence' and 'superiority in kind'. Based on ISO quality is defined as 'inherent characteristic of a product, process, or system related to a requirement' (International Organization for Standardization, 2015).

Improving the quality of a product or service should be based on the specific expectations of the customer. Focusing on the customer is currently one of the fundamental principles of quality management. It is the customer who sets the direction of the improvement process, and the organization should strive to meet their needs. To achieve this goal, it is necessary first to correctly identify the customers, then to recognize their needs and measure their satisfaction with the products or services provided.

The present paper defines first the features of selected batteries that are the most important for users and these are dimensions. They determine the suitability of the purchased rechargeable battery for use in the target device. In identifying customer needs and measuring satisfaction, this study uses a method of analyzing customer opinions posted on one of the popular auction portals.

2. Quality of Dry Cell Batteries

Standards for dry cell batteries have been developed by American National Standards Institute (American Standard Association, 1930), Japanese Industrial Standards (Japanese Standards Association 2007, 2015), British Standards and others. There are civilian, commercial, government and military standards. Two of the most widely used standards today are developed by the International Electrotechnical Commission (IEC) and the American National Standards Institute (ANSI) and there are: the IEC 62133 (International Electrotechnical Commission, 2017a) and the ANSI C18.2M (American National Standards Institute, 2021), both of which provide dimensions, standard performance characteristics and safety information. IEC 61960-3:2017 (International Electrotechnical Commission, 2017b) defines performance tests for secondary single lithium cells and batteries for portable applications and describes designations, markings, dimensions and other requirements. The

purpose of this standard is to provide purchasers and users of secondary lithium cells and batteries with a set of criteria against which to evaluate the performance of secondary lithium cells and batteries offered by various manufacturers. Portable applications include handheld equipment, portable equipment and mobile equipment. According to the recommendations of the Polish Committee for Standardization, the PN-EN 61960-3:2017-08 standard (Polish Committee for Standardization, 2017), which is based on the IEC 61960 standard (International Electrotechnical Commission, 2017), should be used in Poland.

Cylindrical lithium-ion batteries distributed in the Polish market are available in various variants; they differ in both diameter and length. Along with the external dimensions of the battery, there are also differences in nominal voltage and capacity (Beard, 2019; Czerwiński 2012). Larger batteries usually have a higher capacity, but there are manufacturers on the market who significantly overstate the declared capacities. Examples of the most popular lithium-ion rechargeable batteries on the Polish market are: 10440, 14500, 14650, 16340, 17335, 17500, 17670, 18350, 18490, 18500, 18650, 18700, 21700, 22650, 25500, 26650, 32650. According to the PN-EN 61960-3 standard (Polish Committee for Standardization, 2017) these markings suggest the dimensions of the links: the first two digits indicate the diameter, expressed in mm, and the next two indicate the length of the link, also expressed in mm. However, in this standard we can find this sentence referring to the dimensions of the batteries: ‘the dimensions of the cell or battery shall not exceed the manufacturer's' specified values. Elsewhere in the standard we can only read about parameter measurement tolerances: ‘The overall accuracy of controlled or measured values, relative to the specified or actual values, shall be within the following tolerances (...) ± 0.1 mm for dimensions. This is the reason for the incompatibility of the batteries with the sockets placed in the equipment and the size discrepancies between batteries of the same type from different manufacturers.

3. Examination the Batteries’ Quality

The article presents an analysis of the dimensions of the three most popular types of batteries distributed on the domestic market. These are 18650, 26650, and 14500 batteries available on several popular auction sites. Commercial batteries’ sizes are still referred to by old standard or manufacturer designations, and some non-systematic designations have been included in current international standards due to wide use. The batteries can also be divided into two groups: those that have protective electronics against overcharging and excessive discharging, and those that do not. These with protection are used as interchangeable elements in flashlights, toys, or other devices. Protected batteries differ from unprotected ones by having a protruding

positive electrode. Unprotected batteries are used to create so-called packs, and the role of protection is taken over by the electronics protecting the entire pack. Packs are used in laptops, electric scooters, power tools, and even in electric cars. There are unprotected batteries with a protruding positive electrode on the domestic market. Discharging such a battery below the nominal voltage or overcharging it causes irreversible changes in its chemical structure, rendering it suitable only for recycling.

Below are presented the results of tests that allow confronting the guidelines presented in the standards with manufacturers' declarations and empirical measurements. Characteristics 1-6 show the main dimensions of batteries as declared by manufacturers. The length and outer diameter of each battery are shown.

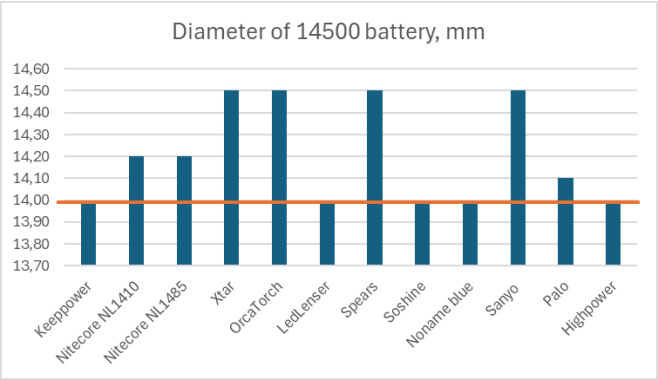

Figure 1. Declared diameter of 14500 battery

Source: own study

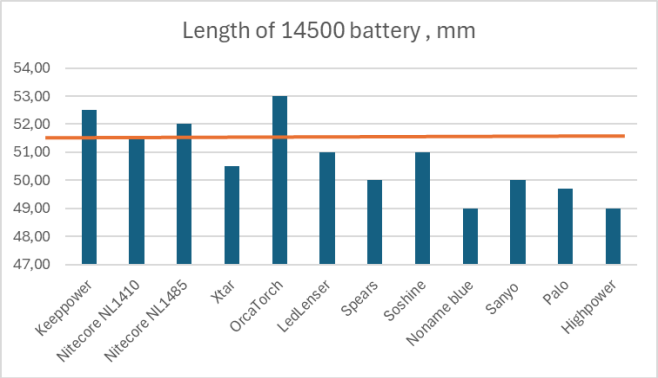

Figure 2. Declared length of 14500 battery

Source: own study

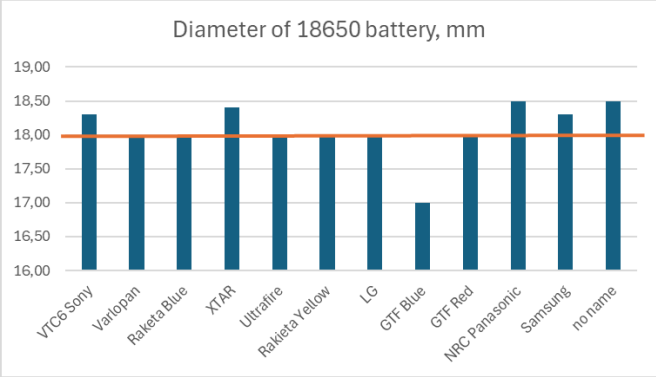

Figure 3. Declared diameter of 18650 battery

Source: own study

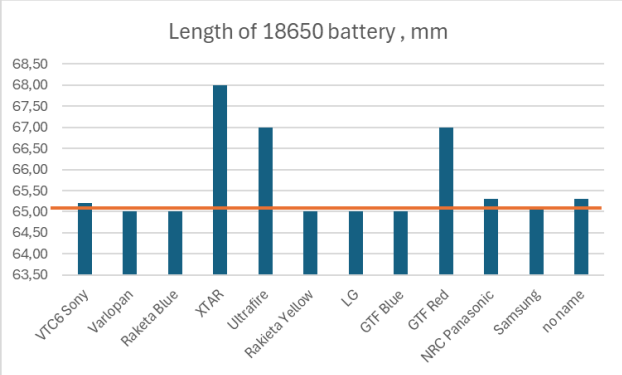

Figure 4. Declared length of 18650 battery

Source: own study

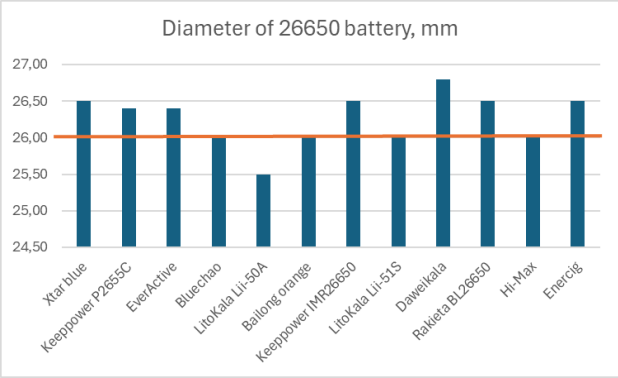

Figure 5. Declared diameter of 26650 battery

Source: own study

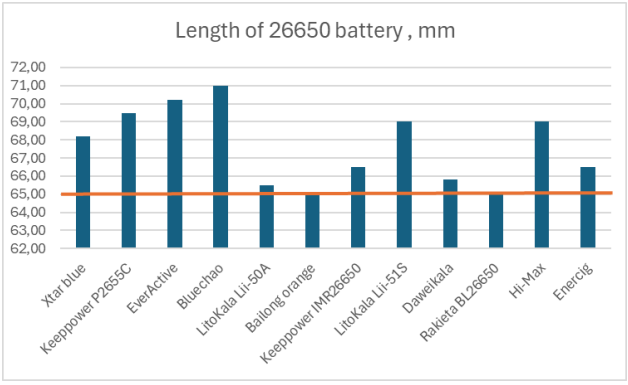

Figure 6. Declared length of 26650 battery

Source: own study

As can be seen in the figures 1-6, almost all batteries differ in their external dimensions from those coded in their names.

One type of battery (18650) was selected as an example, and measurements of its dimensions were taken. Characteristics 7-8 show the results of measurements that allow comparison of the manufacturer's declarations with the actual dimensions of the battery.

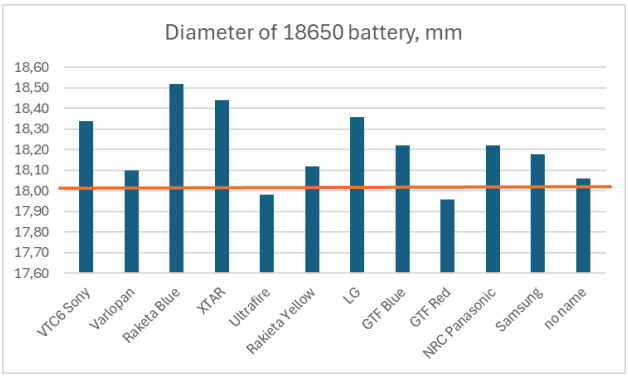

Figure 7. Measured diameter of 18650 battery

Source: own study

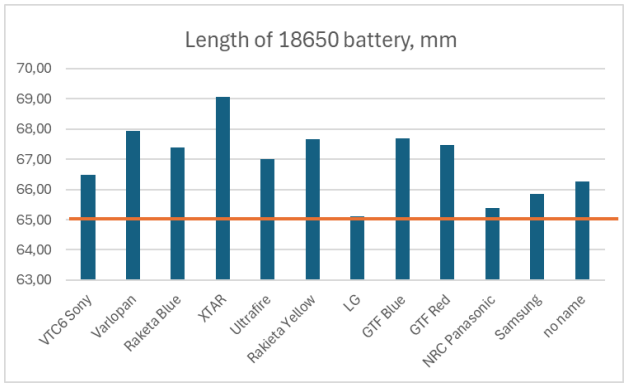

Figure 8. Measured length of 18650 battery

Source: own study

The measurements demonstrate that there are differences even between the values declared by the manufacturer and the actual values.

The average consumer, faced with choosing the right product that meets the parameters required by the device, must first consult the data sheet for the electrical specifications of the battery. This situation results from the lack of the right legal regulations concerning such products. For consumers, the another problem they face is choosing batteries with the most favourable price-to-capacity ratio (Czerniak, Gacek and Szopa 2021, 2023a, 2023b) but above all those that will fit standard sockets. It is particularly noteworthy that no standards have been issued to standardize the external dimensions of cylindrical batteries. The lack of such regulations allows manufacturers great freedom in producing such products. An analysis of feedback from a popular auction site revealed many negative evaluations and comments, in which, in addition to discrepancies in declared capacities, irregularities involving non-standard product dimensions were raised in second place. The emerging feedback clearly indicates a problem with the dimensions of the battery, for example: 'the battery is of good quality but does not fit the torch socket'. The battery purchased by the consumer is not compatible with the dimensions of the sockets used in this type of device. In another case, the battery's dimensions were smaller than the socket, and the consumer had to insert a coin to achieve the proper electrical connection. It is worth noting that such sockets have size tolerances due to their construction, yet the battery dimensions did not allow for proper mounting.

4. Conclusions

Referring to ISO standards, which is currently the most popular quality management system (Hamrol, 2017), one can cite the provision from ISO 9001 on non-conforming products (International Organization for Standardization, 2015). A non-conforming product is defined as any product that deviates from the drawing requirements or technical specifications. Simply, it is any product that does not meet the standards. It is also worthwhile to include all suspect products as non-conforming. The procedures for dealing with such products are strictly defined in the standard. However, how should products be controlled for which strict standards have not been established, and which reach the end customer in virtually any form?

The authors, prioritizing the customer's best interest, believe that the organizations should establish quality objectives for small-sized batteries. Quality objectives are discussed in section 6.2.1 of the ISO 9001 standard (International Organization for Standardization, 2015). The organization shall establish quality objectives at relevant functions, levels, and processes needed for the quality management system. Further analysis of the standard reveals that quality

objectives should, among other things, be measurable, take applicable requirements into account, relate to the conformity of products and services, and most importantly aim to increase customer satisfaction.

On the other hand, customer orientation is also one of the basic principles of TQM. This is the most important principle of quality management. The improvement of the quality of a product or service should be based on the specific expectations of the customer, because it is the customer who sets the direction of the improvement process. The organization should strive to meet his or her needs. In order to achieve this goal, it is necessary first to correctly identify the customer, then to identify his needs and to measure his satisfaction with the products or services provided. The process of researching customer needs and satisfaction should be continuous. The organization must take into account changing needs and be able to respond to them in a timely manner.

There is a need for appropriate legal regulations concerning batteries. These regulations would protect consumers from incurring financial losses resulting from the purchase of undersized batteries. These regulations would also have an environmental effect, as improperly protected batteries wear out more quickly, exposing the environment to a greater burden due to the need for frequent replacement and thus more frequent recycling processes.

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CRISIS ON THE SEMICONDUCTOR MARKET: CAUSES, EFFECTS, AND COUNTERMEASURE ACTIVITIES

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Summary: The study identifies the conditions and proposes actions to counteract crisis phenomena on the semiconductor market. The paper focuses on the analysis of the crisis on the global semiconductor market. This crisis is the result of global geopolitical tensions, the effects of the COVID-19 pandemic, restrictions in the supply of raw materials and challenges resulting from dynamic technological progress. The study shows the economic consequences for the world economy related to the crisis on the semiconductor market. An analysis of the adaptation of companies' activities in the face of limitations in the supply of semiconductors was also carried out, the importance of new technologies in the process of rebuilding the semiconductor market and the role of politics and regulations on crisis management were shown. The study also proposes undertakings and actions to minimize the impact of crisis phenomena on the semiconductor sector and other related sectors.

Keywords: semiconductor market, crises, countermeasure activities.

1. Introduction

Modern processes of production of goods and services are conditioned by several factors, including technological innovations, development of the digital economy, changes in the global

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division of labour (including offshoring), changes in the way companies and market institutions are organized, demographic shifts and transformations in consumption patterns (OECD, 2017). However, the key determinant of changes in the business environment is technological progress, which influences: socioeconomic processes (Avant, 2014), the development of knowledge-based industries (Godin, 2006), product and process innovation, but also business processes and models (Blaschke et al., 2017) and business structures (Snow et al., 2017). Contemporary advances in technologies for producing goods and services but also for communication are associated with the advent of a new era, referred to in the literature as: the second machine age (Brynjollfsson & McAfee, 2014), the third industrial revolution (Rifkin, 2011), Industry 4.0 (Schwab, 2017), or Industry 5.0 (Breque et al., 2021). Regardless of the terms applied to modern technological changes, it should be assumed that it is modern technologies that are currently the foundation of modern socio-economic processes at the level of the individual, institution, economy. Consequently, semiconductors, as the raw material of modern technologies, are becoming crucial to the continuity of business processes, but also to the modern economy. This was particularly noticeable in the face of the crisis in the semiconductor market, or more precisely, the limitations in their supply to most industries of modern economies. Decrease in supply of semiconductors caused an increase in their prices, as well as of products whose components use semiconductor-based technologies. Ultimately, this has caused inflationary pressures on a global scale, halting the production processes of many industries, upsetting global supply chains, negatively affecting the GDP of many countries. A review of the relevant literature indicates that there are few studies that analyse the crisis on the semiconductor market and identify possible actions to counteract this type of crisis in the future.

The purpose of the paper is to identify the determinants and undertakings for counteracting crisis phenomena in the semiconductor market. Within the framework of the so defined intention, the importance of semiconductors in the modern economy was shown, the determinants and consequences of the crisis in this market were identified. The culminating thread of the study is the identification of actions to counteract crisis situations in the semiconductor market.

2. The Importance of Semiconductors in the Modern Economy

The semiconductor industry is an essential component of the global economy, with wide applications in fields such as integrated circuits, optoelectronic devices, power semiconductor devices, consumer electronics, sensors, automotive, solar cells, healthcare, and communications (Yu et.al., 2024). A distinctive feature of the progress being made in production technologies

is the increasing automation and robotization of work processes, while in social life there is the widespread occurrence of devices based on microcomputers, and integrated circuits, such as smartphones and personal computers. Therefore, all artefacts of modern technological development have one aspect in common - semiconductors are required for their production. They are usually represented by solid elements or chemical compounds that conduct electricity only under certain conditions. This makes them an ideal medium for controlling electricity and everyday electrical devices. The integrated circuits, commonly known as chips, are made of millions or even billions of transistors, which can be compared to microscopic electrical switches. As a result, microchips can transform abstract numbers into real phenomena such as sounds, images and radio waves (Miller, 2023).

Integrated circuits, based on semiconductors, are key elements of all electronic devices. It should also be noted that the production of semiconductors is extremely complex and requires advanced technologies. Miniaturization and the development of new generations of components pose a huge technological and financial challenge. Achieving ever-smaller semiconductor sizes while maintaining performance and reliability is a key goal for manufacturers.

Semiconductor market situation is highly unstable. Since the outbreak of the COVID-19 pandemic, when there were massive shortages in the semiconductor market, companies around the world have been forced to deal with unique challenges. The pandemic introduced disruptions in the supply chain, leading to limitations in semiconductor production and availability. In a political context, the global semiconductor market is currently affected by tensions stemming from the technology war between two powers - China and the US. The dispute between the two countries is over control of technology, protection of their competitive edge and national security issues. A particularly endangered country is Taiwan, about which the two powers have their own plans, and where the TSMC factory - home of the world's highest-quality chip company - is located. The entire supply chain depends on several companies located in different parts of the world, so only through their cooperation and synchronization can the production of the highest quality products and uninterrupted supply continuity be ensured.

Moreover, the semiconductor industry faces several significant challenges in sustainable development, primarily driven by the complex global supply chain (Chang et al., 2022). In particular, semiconductor industry's major challenges include energy and resource consumption, addressing risks and resilience issues, ensuring sustainable resource management (Wang et al., 2023), and corporate social responsibility, etc. additional factor which greatly affects the semiconductor industry is geopolitical tensions, regulatory changes (Yu et al., 2024).

3. Causes and Effects of the Semiconductor Market Crisis

The dynamic development of the semiconductor market has been hit by a crisis in recent years due to the overlap of many factors. Thus, growing demand from the economy especially for advanced semiconductors will exceed their supply. Perturbations have also occurred in terms of global supply chains. The complexity of the semiconductor manufacturing process requires multiple steps and advanced technologies, and shortages in the supply of raw materials, components, and advanced equipment can lead to delays and cost increases.

Crisis phenomena in the semiconductor market were also triggered by geopolitical factors, i.e. trade conflicts, sanctions, and export restrictions. Such international tensions have impacted on impediments to the exchange of technology, raw materials, and finished products. In addition, the COVID-19 pandemic brought the entire world to a standstill within months. All international transportation came to a halt, and electronics and automobile manufacturers, under pressure from workers, authorities or as a precautionary measure, imposed restrictions or completely halted production at their plants. The shortage of components forced manufacturers to use stockpiles, which quickly ran out, resulting in global production suspensions in mid-2021 (Forsal, 2021), and the pervasive lockdown and restrictions on the ability to meet with other people quickly drove up demand for hardware and electronic devices.

Another reason is the trade war between China and the US, which has been going on since the 1970s, when the Americans began opening their first chip factories in Asia. In 2020, the U.S. government sanctioned Semiconductor Manufacturing International Corporation (SMIC), China's largest chipmaker, and Huawei, an electronics company. Moreover, U.S. companies were banned from exporting products or technology licenses to China (IT Hardware, 2020). The reason was the risk of US military technology being seized by the People's Republic of China's military. This was a serious blow to China's economic plan, which for more than three decades has aimed to ensure self-sufficiency in the technology industry. According to official data released by the China Customs Administration, the first two months of 2023 saw a sharp 26.5% drop in semiconductor component imports. The total value of imports also fell 30.5% to $47.8 billion, compared to $68.8 billion last year (South China Morning Post, 2023).

This is not the only conflict that has affected the semiconductor industry. Russia's attack on Ukraine also had its effects. In addition to the closure of airspace over the conflict areas, which significantly delayed deliveries, there were also disruptions in the production of key materials. Ukraine as a key producer of rare gases such as neon and krypton, which are essential for semiconductor production. Ukraine accounts for 50% of the world's production of both gases, so when Russia invaded Crimea in 2014, prices for these elements rose by 600% (Financial Times, 2023).

Another threat that experts say could have even more drastic consequences for the semiconductor market is the climate crisis. Taiwan - which accounts for more than half of the world's chip production - is facing its worst drought in more than 50 years as of 2021. The Taiwan Semiconductor Manufacturing Company (TSMC) has stated that it uses 156,000 tons of water per day to manufacture its chips, the equivalent of about 60 Olympic-sized swimming pools (CNN, 2021). This is not the only natural hazard Taiwanese are concerned about. In 1999, the island was hit by a 7.3 magnitude earthquake that knocked out power to most of the country, including two nuclear power plants. All it takes is one massive earthquake for an entire plant to lie in ruins, and with it 60% of the world's chip production.

An analysis of the factors contributing to the semiconductor market crisis reveals the complex mosaic of challenges the industry has faced. All these factors added up to a crisis that requires a unified response from the industry and long-term solutions to minimize risks. According to a study by Goldman Sachs, the semiconductor crisis severely affected nearly 169 industries (Goldman Sachs, 2021). Starting with steel products, concrete and ending with companies that produce beer or soap. It should be noted that chips are not only important in final products, but also in the management of the machinery needed to produce final goods, which affects all global production.

The automotive industry was one of the industries hit hard by the crisis. At the beginning of the pandemic, many car companies cut back on chip orders, expecting a drop in vehicle sales due to the lockdown. However, when demand for autos increased rapidly, it became apparent that chipmakers were using their production capacity for customers in other industries, particularly focusing on the IT market.

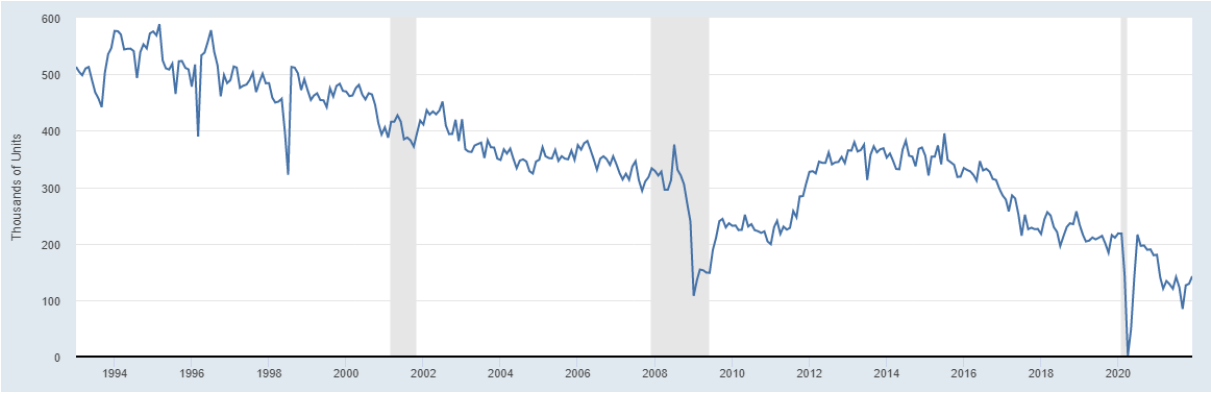

Figure 1. Automobile production in the United States from 1993 to 2021

Source: FRED Economic data, 2023

Automobiles account for about 15% of global chip consumption, while personal electronics account for about 50%, so semiconductor manufacturers value orders from sectors other than automotive much more (Miller, 2023). According to the American Automotive Council there

may be between 1,500 and 3,000 chips in each latest production model. If even one is missing, the car cannot be produced and delivered to the customer. It is estimated that in 2021, due to chip shortages, 7.7 million fewer cars were produced than production capacity and orders from the market would have allowed, resulting in a reduction in revenue of about $210 million (Figure 1).

Many companies have faced the huge impact of material shortages. Ford, for example, did not stop producing trucks. They were produced and then parked while waiting for the necessary chips (The Drive, 2021). Toyota in September 2021 decided to cut vehicle production worldwide by 40%, while General Motors announced it would halt production of almost all cars at its North American plants for a week or two at a time. Opel has closed its Eisenach production plant until 2022 due to a shortage, resulting in the temporary layoff of 1,300 workers. Ford, meanwhile, has decided to lay off 3,200 workers in Europe alone (Times Now News, 2023). It is another serious result of the crisis - not only can manufacturers not meet consumer demand, but they can't afford to keep employees who lack the materials to work.

As millions of people moved to remote work and upgraded their computers in 2020, the PC and board market faced a huge challenge. Demand for server-supported data centres also increased as more and more aspects of daily life moved online. The global chip shortage had a huge impact on the availability of virtually all components required to build a desktop computer. The two major manufacturers of CPU (Central Processing Unit) chips, AMD and Intel, struggled to keep up with the growing demand for their products as a result of the global pandemic.

4. Activities to Prevent Another Crisis in the Semiconductor Market

The general conclusion that is derived from analysis of semiconductor crises and which is addressed to global supply chains management is a transition from a more centralized distribution of resource power among core countries (or regions) towards a more decentralized arrangement (Yu et.al., 2024). Crisis mitigation actions' goal is not only to minimize the negative effects of such crises, but also to maintain the stability of supply, production, and the ability to innovate in the technology industry. Therefore, policy recommendations seems to be a predominant factors enhancing the resilience of the global semiconductor materials supply chain. The mitigation undertakings consist of a series of measures that can also counteract future crisis phenomena in the semiconductor market while safeguarding the economy from further losses.

The first recommended action in this regard is to diversify suppliers so that companies reduce their dependence on single semiconductor manufacturers. Developing multiple sources of supply helps avoid the disruption that can occur if one supplier fails. The challenge, however, is the semiconductor product itself. Keep in mind that it is one of the most complex and costly technological processes in the world, and a factory cannot be opened overnight anywhere in the world. The main factors that limit the development of more semiconductor factories are:

- investment costs - requires huge investments in infrastructure, advanced equipment, and highly skilled labour; high investment costs can deter investors, especially when returns on investment may not be immediate;
- demanding technologies - semiconductor manufacturing is a very complex and demanding process, as factories must be equipped with state-of-the-art equipment, technologies, and know-how;
- regulatory and environmental requirements - opening semiconductor factories involve compliance with strict environmental and safety regulations;
- access to raw materials and advanced technologies - semiconductor manufacturing requires access to rare raw materials and advanced technologies that can be controlled by a small number of suppliers worldwide.

While it is challenging to open semiconductor factories in other regions, this does not mean that such investment is impossible. Many countries and regions are making efforts to encourage such investment by offering tax incentives, regulatory relief and supporting scientific and technological research. However, achieving competitiveness in this market requires a long-term strategy, innovation and cooperation between the private and government sectors. In 2021, the European Union Commission presented a chip act that could enhance security of supply and ensure the Union's resilience to future crises. The European Act would provide the right tools, skills and technological capabilities to make the European Union a leader in the design, production and distribution of integrated circuits. The act consists of 3 main elements (European Commission, 2021):

- "Chips for Europe" initiative - its goal would be to combine the resources of the Union, member states, and associated countries with existing Union programs and the private sector;
- new security of supply – the main task of this component would be to increase production capacity and attract investors; the fund would also make it easier for fledgling projects to access financing;
- coordination mechanism between member states and the Commission – by gathering key information from companies, the Union could map weaknesses and bottlenecks in the semiconductor value chain.

While it is clear that the entire initiative is a long-term process, it is important to start as early as possible to see its effects sooner. Investing in developing production capacity in a country or region can help minimize the impact of the crisis on the supply chain. Local production can be more flexible and adaptable to changing conditions. By partnering with universities, research institutes, and startups, innovative solutions can be created that drive the country's technological and economic development.

The current crisis has demonstrated the weaknesses of the just-in-time management method, which is used by most companies in the automotive industry. Managers should analyse the situation and create a preventive actions. Creating reserves of semiconductor raw materials is an important part of the crisis mitigation activities. It is to minimize the risk of component shortages and sudden price increases, which can significantly affect semiconductor production and the technology industry as a whole.

Research into new semiconductor materials or advanced materials in manufacturing processes could lead to better semiconductor properties, improved performance, or reduced dependence on scarce raw materials. With the emergence of cheaper and more common alternatives to silicon, it is speculated that semiconductors could be created much more efficiently, regardless of the part of the world.

5. Discussion and Summary

The time has come when impossible things become possible. No one predicted that one day a pandemic would paralyze the entire world, just as no one could have predicted even 50 years ago that humanity would be able to produce billions of transistors in a single microchip. And because the world is so unpredictable, all the more reason for companies to have a plan to prevent supply chain crises.

The paper analyses the determinants of the semiconductor market crisis. It also attempts to identify the key challenges facing global industries, and sectors that produce and use semiconductors in the production of goods and services. The analysis of the semiconductor crisis shows that the advanced technology in particular is vulnerable to disruptions that can lead to complex global consequences. COVID-19, geopolitics, and shortages in the semiconductor market have significantly affected companies, forcing them to adapt to the changing business environment, flexibly adjust to new conditions, and maintain operational continuity. At the same time, however, semiconductor shortages have pointed to these challenges, particularly in the automotive, telecommunications, and electronics industries, where these components are essential to production. Companies continue to confront the consequences, and managing these

problems is becoming a key aspect of business strategies. In this situation, the role of adaptation, innovation, and cross-sector cooperation is being emphasized. Companies that successfully integrate these elements are more capable of countering the current uncertainty, which can contribute to building a more resilient and sustainable industry. Ultimate success in this area will depend on the ability of companies to respond quickly to changing conditions and prepare for possible future challenges.

Actions that companies can use to limit the negative effects of crises on the semiconductor market can be a starting point for formulating business strategies. Individual companies can also apply in this respect traditional strategies, which are a combination of emergent and rational strategies, i.e. planned, entrepreneurial, ideological, umbrella, process, disconnected, consensus or imposed (Quinn et al., 1988). It is important that company decision-makers are focused on modifying their strategies in response to changes and tensions in global supply chains. Therefore, strategic planning in particular companies should, in addition to shaping strategies, also include supporting the emergence of strategic actions from within the company. Because only in this way, it is possible to formulate creative strategies based on human capital, intangibles and learning (Hatch 2018). This approach assumes a relatively new orientation, so that instead of focusing primarily on the effects, causes and measures ensuring the development of the company's strategy, hidden assets, including human capital, should be identified and shaped, and strategies should be selected based on the company's strengths. Only then the activities presented in the study for preventing future crises in the semiconductor industry might be seen as issues which enable industries to become more resilient to future market perturbations. In a year of further research, it will become possible to verify their effectiveness, including in the context of the postulated cooperation of government institutions at the level of individual countries and groups of countries with manufacturers at various levels of global supply chains.

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THE QUALITY OF DERMOCOSMETICS IN BRAND MARKETING COMMUNICATIONS ON SOCIAL MEDIA

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Summary: The aim of this paper was to assess the communication activity of nine leading dermocosmetic brands on their company profiles on Facebook. The study used the analysis of the content of messages provided on brands profiles on Facebook in the form of posts and reels in the 1st quarter of 2024. The analysis showed diversity regarding the frequency of publication of posts and reels as well as the rate of interaction and engagement of the consumers. Despite the varying levels of activity of the brands, the strategy of post and reel publication was similar. The function of the post was, first and foremost, to advertise the products and present new dermocosmetics. The brands paid great attention to the content and form of the messages, publishing cosmetic advice and statements by experts and consumers. The company profile on Facebook functioned as an expert platform that was an important source of knowledge about the qualitative properties of dermocosmetics. The brands primarily communicated the features of their products that differentiated from the competition – their skincare properties and effectiveness of action as well as their active ingredients. The content of the messages was designed to build confidence in the quality of the product, including reliable information about the brand and the product. The messages were often very specific to emphasise the importance of correctly selected dermocosmetics in the care of a particular problem.

Keywords: quality, dermocosmetics, communication, social media.

1. Introduction

Dermocosmetics play an important role in problem skincare and are primarily distributed in pharmacies and selected drugstore chains (Dreno et al., 2014). Research (TNS OBOP, 2012;

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IQS, 2018; Malinowska, 2020) indicates that dermocosmetics are perceived differently from other cosmetics and are bought by persons with skin problems. Consumers who choose dermocosmetics are usually convinced of their increased effectiveness in skincare, higher quality, lower content of potential allergens, higher content of advanced active ingredients in their formulas and the lack of allergic reactions after their use (Malinowska, 2020). According to the consumers, the most important features determining the dermocosmetics quality cover the lack of adverse skin reactions after product application, effectiveness in problem skincare, safety for health, lack of potential allergens, the content of highly advanced active ingredients and skincare properties of dermocosmetics (Malinowska, 2020). Dermocosmetic brands put a lot of effort into preparing appropriate communication regarding safety, effectiveness, care properties, advanced active ingredients and formulas of the products they offer.

Marketing communication is an important instrument in the marketing strategy of enterprises, included dermocosmetics companies. Its objective is to provide information about the enterprise, its products, their properties, prices and place of purchase and to shape the needs, attitudes and behaviours of the customers and stimulate demand. Marketing communication is considered to have an informational, persuasive and reminding function, reducing the barriers of access to the offering, building buyer experience with the product, driving buyer engagement and improving the competitive position of the enterprise (Taranko, 2015; Wiktor, 2013).

In the case of dermocosmetic brands, the most important aspect is the personal communication of the enterprises with the specialists, particularly dermatologists, cosmetologists and pharmacists. Enterprises that offer dermocosmetics focus on meetings of specialists with medical representatives, organisation of presentations, fairs and training programmes and personal sales in pharmacies or wholesale stores. Recent years have seen increased use of dermocosmetic communication tools such as advertising, sales promotion, public relations efforts, sponsorship and image advertising. Dermocosmetic brands use the Internet, offering consumers access to company profiles on social media and extensive educational websites, as well as the services of popular blogger testers (Malinowska, 2020).

The analysis of the content of the websites of dermocosmetic brands conducted by author (Malinowska, 2020) points to an important role of the qualitative aspects of the offered products in the marketing communication of enterprises. The word “quality” appearing in such messages as: “high-quality dermocosmetic brand” (Bioderma), “product quality control” (Dermedic) or “the highest quality of ingredients” (Pharmaceris) is the leading tagline of dermocosmetic brands. The high quality of the offered products is also commonly communicated in the philosophy and mission of the brands and in such attributes as the French origin of the products, being friendly to the environment, ethical and responsible approach, developed quality management systems or high sterility of production processes. All this suggests that enterprises

incorporate quality in their strategy, and the high quality of dermocosmetics can be understood as guaranteeing the satisfaction of the consumers by resolving their skin issues.

This paper focuses on an analysis of the marketing communications of dermocosmetic brands in social media. The marketing message (communication) is a piece or collection of information communicated by the enterprise to existing or potential customers. It may include a description of the product, unique characteristics, use instructions, benefits for the customer, information about the brand and a call to action. The content and form of the message depend on the objective, target group and communication channel. A well-prepared message is attractive, understandable, original, relevant, tailored to the audience and compliant with the law and good practices. Such a message improves brand awareness, builds a positive brand image, promotes new products, increases sales and effectively communicates the values and quality of the products.

Brand communication via social media platforms is becoming particularly important. Social media are regarded as a very effective marketing tool (Neti, 2011), an effective marketing communication channel used as an advertising and informational medium (Ab Hamid et al., 2013). As emphasised by Kotler and Keller (2013), social media, which are used for contact and content sharing between users, are used by enterprises not only to communicate content but also to build strong relations with consumers. Social media also play a special role in the so-called content marketing, i.e., the promotion, creation and distribution of content interesting and useful to the target audience (Kotler et al., 2017). Suitable use of content is also an important part of the communication strategy of enterprises in social media. If the consumers can find high-quality content on the social media profile of the brand, it is more likely that new buyers will be attracted to the brand and that positive relations will be established with potential customers (Strzębicki, 2018). In the case with dermocosmetics, which are addressed to specific target groups, the enterprises can undertake tailored marketing measures, not just in the form of advertising or promotion but also communication of professionally prepared content on the company profile.

The aim of this paper was to assess the communication activity of nine leading dermocosmetic brands on their company profiles on Facebook in the 1st quarter of 2024.

2. Methods

The study used the analysis of the content of messages provided on brands profiles on Facebook in the form of posts and reels. The analysed brands include: Eau Thermale Avène, Bioderma, Bioliq, CeraVe, Cetaphil, Dermedic, La Roche-Posay, Pharmaceris and Vichy.

In the analysis, the author paid particular attention to the main published topics and the messages concerning the qualitative features of dermocosmetics. The assessment concerned the features identified by Malinowska (2020) that, according to the consumers, determine the quality of dermocosmetics, such as the absence of adverse skin reactions after using the products, effectiveness in problem skincare, safety for health, absence of potential allergens, e.g., fragrances or alcohol, content of highly advanced active ingredients, skincare properties of dermocosmetics consistent with those declared on the packaging by the manufacturer and the content of natural ingredients.

The analysis has also enabled the gathering of quantitative data, such as the number of posts and reels published in the analysed period, the number of likes, the number of comments, the number of shares and the number of views of the reels and videos. The three indicators of the engagement of Internet users in the interaction with the brand that indicate their actual interest in the particular post are the like, comment and share. Engaging the users of social media is needed for the success of the brand (Chen et al., 2015; Alves et al., 2016).

Thus, the analysis has enabled an assessment of the marketing activities of the brands not just in terms of how they address the quality of the offered products but also as an estimate of the engagement of the audience of the messages.

3. Results and Discussion

Results of the observations of the communication activity of the top nine dermocosmetic brands: Eau Thermale Avène, Bioderma, Bioliq, CeraVe, Cetaphil, Dermedic, La Roche-Posay, Pharmaceris and Vichy and the engagement of Internet users on the Facebook platform in the 1st quarter of 2024 are shown in Table 1.

There is a high disproportion between the overall number of followers of the profiles of international brands and the number of followers of Polish brand profiles. The international brands Vichy and La Roche-Posay, both owned by the L'Oreal corporation, had the highest number of followers and, consequently, the highest number of likes of their company profile, and the Polish brands Bioliq and Dermedic had the least followers. The biggest profile, belonging to Vichy, with 8.9 million followers, had from several dozen to several thousand times more fans than the profiles of Pharmaceris, Dermedic or Bioliq.

Table 1.
Communication activity of dermocosmetic brands and Internet user engagement on their company profiles in the 1st quarter of 2024.

Brand	Number of followers of the company profile of the brand	Number of posts and reels on the company profile of the brand	Number of likes of posts and reels	Number of comments with replies	Number of shares	Number of reel views
EAU THERMALE AVÈNE	4,000,000	14	2,106	107	74	29,837
BIODERMA	5,300,000	28	4,469	584	181	206,999
BIOLIQ	1,100	33	134	54	17	105
CERAVE	1,300,000	23	3,112	959	182	117,318
CETAPHIL	3,800,000	41	1,669	36	24	235,500
DERMEDIC	45,000	29	1,537	38	68	105,240
LA ROCHE-POSAY	8,000,000	32	4,353	794	292	31,462
PHARMACERIS	170,000	34	5,071	721	234	63,064
VICHY	8,900,000	32	2,883	86	265	8,500

Source: own study

In the 1st quarter of 2024, the activity of the brands varied in terms of the publication of posts and reels. It ranged from 14 posts/reels on the profile of the least active brand, Eau Thermale Avène, to 41 posts/reels on the profile of the most active brand, Cetaphil. Most of the remaining brands oscillated around the average of approximately 30 posts in 3 months, posting them at intervals of 3 days on average. Overall, Pharmaceris had the highest number of interactions, and Bioliq – the lowest. The highest number of likes was received by Pharmaceris, the highest number of comments – by CeraVe – and the highest number of shares – by La Roche-Posay. The level of fan interaction did not increase due to the publication of a higher number of posts and reels. Cetaphil, with 3.8 million followers of its profile, publishing the highest number of posts and reels (41), did not even reach the same overall number of fan interactions (1,729) as Eau Thermale Avène (2,287), which published only 14. The highest level of fan engagement was recorded by Bioderma, which published 28 posts, with 187 interactions per post on average (160 likes, 21 comments and 6 shares), and CeraVe, which published 23 posts, with 185 interactions per post on average (135 likes, 42 comments and 8 shares). In addition to the attractiveness of the posts themselves, the higher level of interactions might also be caused by the higher number of fans of the page than in the case of the remaining brands. In this study, the profile of Vichy, with the highest number of followers, had only 101 interactions per 1 post, i.e., the engagement rate was much lower than for Bioderma (187 interactions), CeraVe (185 interactions), Pharmaceris (177 interactions), La Roche-Posay (170

interactions) and Eau Thermale Avène (163 interactions). Brands with a relatively low engagement rate included Dermedic (57 interactions) and Cetaphil (42 interactions), and the lowest rate was recorded by Bioliq, which published 33 posts, with just 6 interactions per post on average.

Gregor and Kubiak (2014) emphasise that the frequency of publication of messages has a big impact on the strength of brand-consumer interaction. More frequent messages encourage the follower to engage in a "dialogue" with the brand and enter a deeper interaction. Profiles with rarely published entries are often ignored and forgotten. In the case of the analysed dermocosmetic brands, the engagement of the fans might indeed be higher when the published posts concern competitions and special offers the fans can take part in, but this does not significantly increase the overall number of interactions in the tested period. Likewise, the study of dermocosmetic brands did not support the theory that a higher number of followers of the brand profile could translate into a higher number of fans engaged in interactions with the brand.

The general topics discussed in the posts and reels on the dermocosmetic brands profiles are given in Table 2.

Table 2.
Topics of the messages provided in the form of posts and reels on the dermocosmetic brands profiles in the 1st quarter of 2024.

Brand	Topics of posts and reels on the company profile of the brand
EAU THERMALE AVÈNE	Dermocosmetic advertisement; Presentation of new products; Cosmetic advice; Competition; Women's Day wishes; Questions to engage the fans
BIODERMA	Dermocosmetic advertisement; Presentation of new products; Promotion of product sales; Cosmetic advice; Expert statement/advice; Competition; Presentation of the consumers' opinion about the products; Questions to engage the fans
BIOLIQ	Dermocosmetic advertisement; New Year wishes; Valentine's Day wishes; Presentation of new products; Cosmetic advice; Questions to engage the fans; Competition
CERAVE	Dermocosmetic advertisement; Questions to engage the fans; Competition; Cosmetic advice; Promotion of product sales; Easter wishes
CETAPHIL	Dermocosmetic advertisement; Brand participation in an event (Fashion Week in New York); Questions to engage the fans; Cosmetic advice; Recommendation of a dermocosmetic by an ambassador of the brand, model or influencer; Invitation to a meeting with an expert; Competition
DERMEDIC	Dermocosmetic advertisement; Brand participation in a dermatological conference; Women's Day wishes; Easter wishes; Expert statement; Cosmetic advice; Presentation of new products
LA ROCHE-POSAY	Dermocosmetic advertisement; Questions to engage the fans; Recommendation of a dermocosmetic by consumers; Skin Life-Changers programme; Cosmetic advice; Presentation of new products; Information about an event; Brand mission; Competition; Statements of experts; Women's Day wishes
PHARMACERIS	Dermocosmetic advertisement; Questions to engage the fans; Cosmetic advice; Presentation of new products; Recommendation of a dermocosmetic by consumers; Competition; Women's Day wishes; Easter wishes
VICHY	Dermocosmetic advertisement; Competition; Cosmetic advice; Presentation of new products; Presentation of brand ambassadors; Recommendation of a dermocosmetic by an influencer; Grandma's Day wishes

Source: own study

Another type of dermocosmetic advertisements published in posts were the statements and advice of experts, usually dermatologists, opinions given by consumers and recommendations of the brand by a model or influencer. Brands also published posts with cosmetic advice that included expert knowledge concerning skin care and hair care or posts informing about the participation of the brand in industry events, such as dermatological conferences. To drive fan interactions, the posts included questions to the fans designed to engage them and initiate dialogue. Sometimes, they involved a competition or a special offer to promote product sales. The brands also published posts referring to specific holidays, in the analysed period, these included the following: Grandma's Day, Grandpa's Day, Valentine's Day, Women's Day, Man's Day and Easter.

When analysing the content of the messages, the author also focused on messages concerning the qualitative features of dermocosmetics, such as the absence of adverse skin reactions after using the products, effectiveness in problem skincare, safety for health, absence of potential allergens, the content of highly advanced active ingredients, skincare properties of dermocosmetics and the content of natural ingredients. The results of the analysis are given in Table 3.

Table 3.
Features determining the quality of dermocosmetics in the messages published in the form of posts and reels on the dermocosmetic brands profiles in the 1st quarter of 2024

Brand	Features determining the quality of dermocosmetics
EAU THERMALE AVÈNE	– skincare properties of dermocosmetics – effectiveness in problem skincare (mature skin, acne skin, skin with blemishes, dry skin, atopic skin, irritated skin) – content of highly advanced active ingredients – safety for health (connected with the correct use of the product, being intended for babies from the 1st day of life, UV protection of skin in the winter and early spring) – content of natural ingredients
BIODERMA	– skincare properties of dermocosmetics – effectiveness in problem skincare (sensitive skin, irritated skin, mature skin, acne skin, skin with blemishes, dry skin) – content of highly advanced active ingredients – safety for health (for very sensitive skin, connected with the correct use of the product, UV protection of skin in the winter) – no adverse skin reactions after using the product
BIOLIQ	– skincare properties of dermocosmetics – effectiveness in problem skincare (atopic skin, irritated skin, vascular skin, mature skin, acne skin, skin with blemishes, dry skin) – content of highly advanced active ingredients – safety for health (connected with the correct use of the product, UV protection of skin in the winter and when using products with retinol) – no adverse skin reactions after using the product
CERAVE	– skincare properties of dermocosmetics – effectiveness in problem skincare (greasy skin with a tendency for dryness, dry skin) – safety for health (being intended for babies starting from the 2nd month of life)

	– no adverse skin reactions after using the product
CETAPHIL	– skincare properties of dermocosmetics – effectiveness in problem skincare (sensitive skin, atopic skin, acne skin, dry skin) – content of highly advanced active ingredients – no adverse skin reactions after using the product
DERMEDIC	– skincare properties of dermocosmetics – effectiveness in problem skincare (sensitive skin, mature skin, dry skin, itchy skin, hair loss, dandruff) – content of highly advanced active ingredients – safety for health (UV protection of skin in the winter) – no adverse skin reactions after using the product
LA ROCHE-POSAY	– skincare properties of dermocosmetics – effectiveness in problem skincare (sensitive skin, irritated skin, mature skin, atopic skin, itchy skin, skin with blemishes, acne skin) – content of highly advanced active ingredients – safety for health (connected with the product being intended for babies from the 1st day of life, UV protection of skin in the winter, skin care during oncology treatment)
PHARMACERIS	– skincare properties of dermocosmetics – effectiveness in problem skincare (vascular skin, mature skin, dry skin, atopic skin, sensitive skin, allergic skin, skin with psoriasis, skin with rosacea, greasy hair, hair loss, seborrheic dermatitis, damaged hair) – content of highly advanced active ingredients – safety for health (connected with the product being intended for babies from the 1st day of life, UV protection of skin in the winter)
VICHY	– skincare properties of dermocosmetics – effectiveness in problem skincare (mature skin, skin with blemishes, acne skin, dry skin, dandruff, greasy hair) – content of highly advanced active ingredients – absence of potential allergens, e.g., fragrances

Source: own study

The analysis showed that four out of seven most important features determining the quality of dermocosmetics, such as skincare properties of the dermocosmetic, effectiveness in problem skincare, the content of highly advanced active ingredients and safety for health, appear very often in the content of posts and reels on the profiles of dermocosmetic brands. In their communications, each brand emphasised the unique skincare properties of the offered products and their effectiveness in the resolution of specific skin problems. The portfolio of most brands includes products for the care of the most common skin problems (such as ageing, acne, atopy and allergies) and hair problems (such as dandruff and hair loss), but during the period covered by this analysis, the brands did not publish content concerning all of their offered lines and their properties or effectiveness. The profile of Pharmaceris posted the highest number of messages connected with many different skin problems, such as vascular skin, mature skin, dry skin, atopic skin, sensitive skin, allergic skin, mature skin, skin with psoriasis, skin with rosacea, seborrheic dermatitis, greasy hair, hair loss and damaged hair. All brands except CeraVe highlighted the presence of advanced active ingredients in their formulas to a smaller or bigger extent and described their properties. Also, the content of the posts of most brands, except for

Cetaphil and Vichy, included messages concerning the safety of dermocosmetics, such as, for instance, the correct use of products with retinol, UV protection of the skin in the winter and during treatments with retinol, intended use of the products for babies and very sensitive skin or, as in the case of La Roche-Posay – safety of the products for skin care during oncology therapy.

The features determining the quality of dermocosmetics, such as the absence of adverse skin reactions after the use of the products or the absence of potential allergens, were less often mentioned in the posts and reels. Both these features are connected with the aspect of safety for health, and they are relevant to consumers who expect effectiveness in problem skincare without the risk of irritation of their sensitive skin (Malinowska, 2020). According to Regulation No. 1223/2009/EC, every cosmetic product made available on the market shall be safe for human health when used under normal or reasonably foreseeable conditions of use, but the consumers perceive safety as a feature connected with a smaller risk of adverse skin reactions (Malinowska, 2020). This fact is used in the communications of dermocosmetic brands, even though, according to Commission Regulation (EU) No 655/2013, the declaration: "free from allergens or allergenic substances" is not permitted because it is not possible to guarantee a complete absence of the risk of allergic reactions, and the product should not give the impression that it gives such a guarantee (Cosmetics Europe, 2017). Although, as shown by Malinowska (2020), the quality of dermocosmetics for consumers mainly comes down to the guarantee of the absence of potential allergens, i.e., a lower risk of adverse skin reactions after using the product, the manufacturers of dermocosmetics should avoid the communication of such statements. This analysis has shown that only Bioderma, Cetaphil and Dermedic directly mentioned the absence of irritation after the use of specific products in individual communications, e.g., "does not irritate even severely scaly or dry skin" (Bioderma), "do not irritate" (Cetaphil) or "comfortable cleansing without irritation" (Dermedic). Less direct communications concerning the absence of irritation after using the product could be found in the posts of Eau Thermale Avène, Bioderma, Bioliq, CeraVe and Dermedic, e.g., "will be suitable for even the most sensitive skin" (Eau Thermale Avène), "super-safe for sensitive skin" (Bioderma), "perfect even for sensitive skin" (Bioliq), "to preserve the protective barrier of the skin and reduce irritation, complement your skincare routine with lipid-rich products" (CeraVe) or "will be perfect even for very dry and sensitive skin" (Dermedic). Only Vichy communicated that "the product is also available in an unfragranced version for sensitive skin", emphasising that a product without a fragrance may reduce the risk of adverse reactions of sensitive skin.
The last dermocosmetics' quality feature important to the consumers – the content of natural ingredients – appeared only in the communications of Eau Thermale Avène.

The content published by the brands on their company profiles also included messages concerning the latest trends in dermatology and cosmetology, such as the moisture sandwich

technique, massaging the skin with ice or skin streaming, which involves the use of a small number of effective high-quality cosmetics with a chemical composition carefully tailored to the needs of specific skin. It was observed that in the investigated period, which included winter and early spring, the brands reminded about sun protection on the ski slopes, the correct use of products based on retinol, removal of blemishes during the times of the smallest sun exposure and selection of suitable serums.

4. Conclusions

Effective marketing communication of the brand in social media mainly consists of the creation and communication of valuable content and engagement of Internet users to share the content with their friends. The analysis of the communication activity of dermocosmetic brands on their company profiles on Facebook showed diversity regarding the frequency of publication of posts and reels as well as the rate of interaction and engagement of the consumers. Despite the varying levels of activity of the brands, the strategy of post and reel publication was similar. The function of the post was, first and foremost, to advertise the products and present new dermocosmetics. The brands paid great attention to the content and form of the messages, publishing cosmetic advice and statements by experts and users/consumers. It seems interesting that the strategy for the publication of posts and reels was associated with the calendar. The topics of the posts referred to holidays, special days in the calendar or times of the year. As a result, a consumer browsing through the profiles of most brands may get the impression that the offered products are the perfect solution to their skin problem in the particular period and that the cosmetic advice or expert statement is precisely the content they were waiting for. The analysis also showed that in the case of dermocosmetic brands, the company profile on Facebook functioned as an expert platform that was an important source of knowledge about the qualitative properties of dermocosmetics. The brands primarily communicated the features of their products that differentiated from the competition – their skincare properties and effectiveness of action as well as their active ingredients. Particular attention was paid to the right diagnosis and selection of products to match the needs of skin of the consumers who suffer from a skin problem and would like to resolve it. The content of the messages was designed to build confidence in the quality of the product, including reliable information about the brand and the product. The messages were often very specific to emphasise the importance of correctly selected dermocosmetics in the care of a particular problem.

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EMOTIONAL INTELLIGENCE OF THE LEADER AND ITS ROLE IN BUILDING ENGAGEMENT OF VIRTUAL TEAMS

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Summary: Today's professional environment is characterized by the need for team collaboration, rapid communication, intense competition and dynamic innovation, where traditional cognitive intelligence is insufficient. Success in the new business environment requires employees to go beyond conventional intelligence and use emotion-based skills, especially in an increasingly complex work environment. Emotional intelligence, especially in teams, is crucial because interactions between team members take place on multiple levels, and emotional abilities are among the most sought-after skills in the job market today. Research indicates that most leaders achieve their positions through emotional intelligence rather than cognitive skills. The evolution of virtual communication, especially in the face of a global pandemic, requires leaders in virtual environments to have a unique management approach based on empathy and understanding. The article explores the essence of the importance of leaders' emotional intelligence in building commitment among employees in virtual teams, using two research tools: PKIE Emotional Intelligence Questionnaire and the Work Engagement Scale (UWES). The results indicate that leaders' emotional intelligence has a significant impact on employee engagement, which can be translated into improved organizational performance. In light of these results, it seems crucial to develop the ability to understand and interpret emotions in virtual communication, which has a significant impact on the effectiveness of teamwork, can significantly contribute to the success of the organization and improve the quality of its functioning in a dynamically changing business environment.

Keywords: emotional intelligence, leader, virtual teams, PKIE, UWES scale.

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1. Introduction

Today's trade life is characterized by an increasing need for teamwork, faster communication, increased competition and speed of innovation. Achieving success in this new business environment is no longer possible with general intelligence alone. Today, an employee must go beyond traditional cognitive intelligence and use emotion-based skills to cope with an increasingly complex social work environment. Importantly, team emotional intelligence is a more complex construct than individual emotional intelligence because of the type and multiple levels of interaction. It is difficult to overestimate the importance of emotional intelligence in the workplace, and it is undeniable that a team made up of emotionally intelligent people is distinguished by higher productivity, increased motivation or unusually high levels of empathy and satisfaction, which marks its great importance in the workplace. Psychological discourse identifies it as a predictor of success in the workplace and one of the most sought-after abilities marking its superiority over general intelligence or technical skills. Going by the future thought that robotics, along with artificial intelligence, follows to automate many industries that do not require too much human interaction, it can be concluded that its popularity and need will grow.

Most modern leaders have achieved their positions through emotional intelligence, not cognitive intelligence. They work well in teams and empower team members, are characterized by having a vision, being able to communicate it and implement it, delegating tasks and rewarding their followers. Effective team leaders are those who can deliver results, provide leadership, communicate with team members regarding their vision, motivate members and influence the team (Korcz, 2016).

Maintaining work-life balance and advances in technology are imposing innovative changes in the ways businesses communicate virtually. Remote work, which entered a higher level of popularity during the pandemic, is one of those changes that has made the use of digital platforms a part of work . Since this is a relatively new way of working and communicating for many companies, leaders in virtual environments have faced many organizational challenges in managing employees due to their unpredictability. In order for teams communicating virtually to be successful, an understanding and empathetic approach must be developed to maintain employee morale and motivation, while keeping their mental health in mind (Delfino & Van Der Kolk, 2021).

Looking through the prism of intensive work changes that have taken place in organizations, the article decided to assess the relational impact of the leader's emotional intelligence on the work commitment of members of the virtually collaborative team, using two research methods - the PKIE Emotional Intelligence Questionnaire and the work commitment survey using the UWES Questionnaire. The research problem is an attempt to answer the question: does an

emotionally intelligent leader have an impact on the level of commitment of members of a virtually collaborative team, which can influence the improvement of the quality of organizational functioning?

2. The Role of Emotional Intelligence

The premise of every organization is to succeed and produce the best results, but for this goal to become realistic they need leaders behind the scenes who can visualize the future, motivate and inspire others, and adapt to ever-changing needs. Competencies such as recognizing, managing and harnessing one's own and others' emotions are very often critical to leadership effectiveness (Blanchard & Bekier, 2007). As the potential of an emotionally intelligent leader develops, his profile becomes desirable throughout the organization influencing increased productivity and efficiency. Based on the 1990 definition by psychologists Salovey and Mayer, emotional intelligence is defined as a set of personal competencies that serve a complementary function to intellectual abilities. They divided emotional intelligence into four broad categories: perception, emotional facilitation of thinking, deliberation of emotions, and management of emotions. Goleman, on the other hand argues that emotions have a positive impact on daily life, at work and in various relationships. According to him, emotions enable individuals to achieve goals, create workflow, persuade others and give the impression of empathy and understanding. Goleman defines emotional intelligence as a combination of the ability to understand emotions and the ability to recognize one's own and others' feelings, motivate and manage emotions. It is based on five traits: self-awareness, self-regulation, motivation, empathy and social skills. Empathy and social skills were later called social awareness and relationship management (Sadowska & Brachowicz, 2008).

The benefits of high emotional intelligence can be seen in many professions across industries. For example, at a technology company, programmers demonstrating the top 10% of emotional intelligence levels developed software three times faster than other programmers in the company (Nithya, 2015). The use of emotional intelligence has also been shown to reduce employee turnover costs. A Fortune 500 company in Texas switched from personality assessments to emotional intelligence and saw a 67% increase in employee retention in just the first year. This helped reduce employee turnover costs, saving $32 million (Minikin, 2012). While these examples clearly illuminate the benefits of emotional intelligence in the workplace, using it in work teams is even more pressing. Moreover, when groups are used effectively, they make smarter decisions than individuals, giving companies that rely heavily on teamwork a sizable advantage.

Research on teams has shown that trust between members, a sense of group identity and group effectiveness are three conditions that are essential for group success (Pyszka, 2015). The literature shows that people with higher levels of emotional intelligence are able to work more effectively because they are more effective at communicating and empathizing with team members.

With the development of work organizations, emotional intelligence seems to play an important role in determining interpersonal communication, especially between employees in their work environment. Since today's global environment is multifaceted, it has become necessary to link emotional intelligence to employee performance on a global scale. Emotional intelligence is therefore crucial to the presentation and development of an organization, since its achievement of goals depends mainly on its employees (Goleman, 2016). Emotional intelligence therefore plays an important role in helping employees cope with these dynamic changes in the business environment.

3. The Idea of a Virtual Team

Although the purpose and nature of teams have changed over the years, one constant factor that has characterized almost all teams has been the need for personal, face-to-face information exchange to achieve team goals. Research confirms that virtual teams have become an integral part of many organizations due to the increase in corporate restructuring, changing team conditions, increasing competition or limited access to specialists. A virtual team is one that crosses organizational and cultural boundaries" (Ferazzi, 2014). Virtual teams are geographically and organizationally dispersed teams that function across time zones. Due to physical distance, face-to-face contact in virtual teams is limited. Teamwork supported by electronic means brings its own opportunities and challenges. The use of virtual teams can be evaluated at the individual and organizational levels. At the individual level, virtual teams can allow members greater flexibility, more control over time and higher levels of responsibility. At the organizational level, some of the benefits of virtuality include working around the clock, speed and flexibility to meet market needs, less expense in travel and office space, and the ability to hire teams based on expertise rather than geographic preference. Like emotional intelligence, virtual teams can also have a major impact on a company's bottom line. Recently, there has been a growing interest in virtuality as information and communication technologies have increased exponentially (Meluso et al., 2020). Virtual teams are an increasingly common work structure in today's organizations. Through computer mediated communications and advanced technologies, organizations are able to connect human talent separated by time zones

and geographic distance. A collection of talent from all over the world, the ability to develop business in other markets, and cost reductions are only partial benefits of having a virtual team (Kobis, 2019).

Virtualization of work has become an important aspect in the organizational structure, on many market levels. Despite the informational and digital transformation of society over the past quarter century, the rapid development of technology and the drive to increase employee productivity, there is much debate about the effectiveness of virtual teams (Mitchell, 2021). Concepts examining the level of effectiveness of virtual teams and teams working in the normal mode, suggest an advantage for the former, provided that they are properly managed. Undoubtedly, the scale of the growth of work virtualization poses challenges within leadership activities in the context of the leader as a universal connecting unit. The key to success is the selection of a leader who is characterized by the ability to differentiate organizational culture while pushing out maximum positive emotions (Zając & Prokopowicz, 2022).

A combination of areas such as leadership, emotional intelligence and commitment to teamwork has the potential to increase the effectiveness of virtual environments and, in turn, the quality of work performed.

4. Purpose, Methodology and Results of the Study

Most studies indicate a positive effect and relationship between Emotional Intelligence, leadership and team success. Emotional Intelligence is an important skill in dealing with the negative effects of various types of anxiety at work and helps increase employee motivation, productivity and creativity. Therefore, the study focused on analyzing the relational relationship between the level of work engagement and a leader's emotional intelligence, using the PKIE Popular Emotional Intelligence Questionnaire and the Utrecht UWES Work Engagement Scale.

The Emotional Intelligence Questionnaire is a test that was developed in Poland based on tests created by qualified psychologists of research institutions on the basis of Mayer and Salovey's EI skills model, referring to four components of emotional intelligence: AKC (accepting, expressing and using emotions in action); EMP (empathy expressed through understanding and recognizing the emotions of others); KON (control of one's own emotions); ROZ (self-awareness of one's own emotions). It consists of 94 self-descriptive questions rated on a 5-point scale. Results are presented in an overall calculation and individually for each of the 4 factor scales (Jaworowska & Matczak, 2005). The UWES questionnaire, the second research item, consists of 17 statements with a 7-point scale from 0 ("never") to 6 ("always/every day"). The survey scores overall and on three subscales: vigor, dedication and

absorption (Shaufeli at al., 2011). A medium-sized, geographically dispersed organization was selected as the research sample, focusing on remote teams. 100 people (34 managers and 66 employees managed by them) were invited to participate in the survey, of which 68% of leaders (N=23) and 82% of employees (N=54) participated. The survey was anonymous, but all respondents were required to provide demographic information in the survey in order to classify the basic elements of the population, such as gender, age, position/department and seniority. The average age of respondents among leaders was 43, while among employees it was 36. The seniority variable oscillated between 6 and 9 years for all respondents. Results for the parameters of emotional intelligence, including scores on factor scales and total emotional intelligence scores were provided via a report for each participant. Data were collected through secured questionnaires in an online format ensuring confidentiality and security. Statistical analysis was performed using IBM SPSS Statistics. Regression analysis, r- Pearson correlation coefficient test and reliability tests were conducted to verify the research hypotheses.

Based on the raw PKIE results, an analysis of quantitative variables was carried out by calculating the minimum, maximum, mean, standard deviation, skewness and kurtosis coefficients to illustrate the shape and asymmetry of the analyzed distribution (Table 1).

Table 1.
Descriptive statistics of PKIE - raw results

(N=23)	Min	Max	Average	SD	Skewness	Kurtosis	*A*
PKIE general	378	424	406,43	17,648	-0,187	-0,881	0,99
area of experiential EI	137	152	143,74	4,361	-0,026	-0,778	0,87
strategic EI area	68	96	87,43	10,565	-1,148	-0,460	0,87
AKC	65	72	68,35	2,080	0,418	0,717	0,94
EMP	71	80	75,39	2,966	-0,224	-1,011	0,96
KON	31	51	44,61	7,260	-1,128	-0,428	0,89
ROZ	37	46	42,83	3,380	0,158	0,602	0,97

Source: own study

Based on the obtained results of the skewness values and kurtosis values, it can be concluded that the distribution is platykurtic and adopts a left skewness, nevertheless the values are between -2 and 2 therefore the distribution is close to a normal distribution (Tab.1). The total emotional intelligence score, after being converted into standardized units, was subjected to interpretation according to the characteristics of the standardized sten scale (Tab.2). It indicates a very high level of emotional intelligence, which indicates the ability to accept emotions, the ability to perceive them and use them to support the thinking and acting process. Analyzing the rest of the data (Tab.2), it was noted that the EMP scale had the lowest score, but fell within the lowest spectrum of high level. . Interpretation concludes that the respondents have self-awareness of their own emotions nevertheless probably cannot completely determine their causality.

Table 2.
PKIE sten scale - level of emotional intelligence

	Low score (1-4 stens)	Average score (5-6 stens)	High score (7-10 stens)	Medium stens
PKIE general	0	0	23 (100%)	9,47
AKC	0	0	23 (100%)	8,58
EMP	0	6 (26%)	17 (74%)	7,01
KON	0	4 (17%)	19 (83%)	8,99
ROZ	0	0	23 (100%)	8,78

Source: own study

The UWES questionnaire, is a research tool used to determine the strength of work engagement, which is defined as a positive, rewarding and work-related state of mind distinguished by three factors: vigour, dedication to work and absorption in work. When testing the UWES tool with the sample data, the total UWES score and the three dimensions of vigor, dedication and absorption were correlated at a high level and obtained a high reliability of Cronbach's alpha > 0.8. An analysis of quantitative variables was carried out on the basis of which the average total UWES score for all team members was obtained at 4.02 (Tab.3), no statistically significant differences were noted, placing the level of work engagement at a similar level.

Table 3.
UWES descriptive statistics

(N=23)	Min	Max	Average	SD	Skewness	Kurtosis	α
UWES Total	2	6	4,02	0,826	-0,845	0,932	0,913
Vigor	3	6	3,97	0,799	-0,762	0,932	0,904
Dedication	2	5	4,14	0,784	-0,877	1,368	0,904
Absorption	3	6	3,84	0,643	-0,921	1,730	0,897

Source: own study

The overarching goal of the study was to analyze the phenomenon of leader's emotional intelligence and its impact on building commitment among virtual team members. An important point was to conduct an analysis of correlations, measured by the *r-Pearson* coefficient, between the variables studied.

Both the results at the individual level and the data at the aggregate level were exploited, which allowed to obtain a relevant relationship between the overall PKIE score and the result of work engagement.. The results shown in Table 4 indicate a significant relationship between two factors: dedication to work/sacrifice and vigour.

Table 4.
Correlation of the relationship between the studied variables

(N=23)	UWES Total	Vigor	Dedication	Absorption
PKIE general	0,7252	0,6836	0,7824	0,4077
EI experience area	0,05925	0,5478	0,6544	0,3294
EI strategic area	0,7148	0,6960	0,7334	0,4207
AKC	0,4588	0,4414	0,4865	0,2543
EMP	0,5495	0,4959	0,6211	0,3059
KON	0,6937	0,6788	0,7117	0,4016
ROZ	0,7443	0,7176	0,7637	0,4526
Size of the team	0,071	0,085	0,059	0,060
seniority (n=54)	0,031	0,114	0,051	0,041

Source: own study

In view of the stated purpose of the study, which was to analyze the relationship between two variables: leader emotional intelligence and engagements of virtual teams, hypotheses were established to match the two research questions.

Question 1: Does a virtual leader's emotional intelligence score affect the work engagement score of his/her virtual employees as measured by PKIE and UWES survey tools?

H_1 : A leader's high level of emotional intelligence significantly affects engagement with virtual teams.

A first-class analysis was performed to investigate the relationship between the overall PKIE score and work engagement, without taking into account other parameters. The combined results showed a significant relationship at the correlation coefficient level of n (23) = 0.7252 (p = 0.7252), which indicates the validity of the hypothesis and supports its assumption.

Question 2: Is there a notch of correlation between the emotional intelligence of virtual team leaders and the individual work engagement elements of their employees as measured by the UWES tool?

H_2 : A leader's high level of emotional intelligence significantly correlates with the vigor of employees in virtual teams.

It was found that the leader's level of emotional intelligence extracted a significant correlation with the vigor of employees of virtual teams at the level of n (23) = 0,6836 (p=0,028). Accordingly, hypothesis two was also supported.

H_3 : A leader's high level of emotional intelligence significantly correlates with employees' dedication to virtual teams.

The dimension of devotion obtained a correlation of n (23) = 0,7824 (p=0,088) which indicates the most significant relationship with the leader's emotional intelligence. The hypothesis was also confirmed.

H4: A leader's high level of emotional intelligence significantly correlates with the uptake of employees in virtual teams.

The absorption dimension received the lowest correlation value at n (23) = 0,477(p=0,006) indicating a moderate degree of correlation. Nevertheless, this hypothesis was also supported. All results showed a positive correlation which makes it plausible that as the level of leader's emotional intelligence increases, the commitment to virtual team members will increase.

The final analysis was conducted to test the significance of the relationship between the four branches of emotional intelligence (acceptance, empathy, control, and understanding) and work engagement in virtual teams. Among the abilities of emotional intelligence Understanding, as a component of the strategic ability of emotional intelligence showed the strongest correlation with the dimension of dedication to work engagement (n (23) = 0,763, p = 0,006), an equally strong relationship existed with the overall score n (23) = 0,744 and the dimension of vigor n (23) = 0,717. The obtained data of the correlation coefficient of the other three areas of emotional intelligence showed a high correlation. The lowest correlation value was found by examining the correlation of the acceptance element with the absorption element n (23) = 0,2543 (p=0,007) considering it insignificant.

Some studies assume that demographic attributes such as age or length of service can affect correlation results, so a relative impact analysis was conducted using as the dependent variable the area of dedication as the highest correlated element. No significant correlation was shown between the extracted data. However, it was noted that the strategic area of emotional intelligence remained highly correlated with the UWES dedication dimension after controlling for the age attribute β = 0,9778. An illustration was made (Fig.1) the correlation of the factors affecting the emotional intelligence of virtual leaders and the work attributes of virtual team members considering scores of >/= 6. It shows a significant correlation of strategic emotional intelligence with all three areas of work engagement. This is mainly due to the ability to understand, to recognize within emotional intelligence, while no highly strong correlations were found with the ability to accept and the area of experiencing.

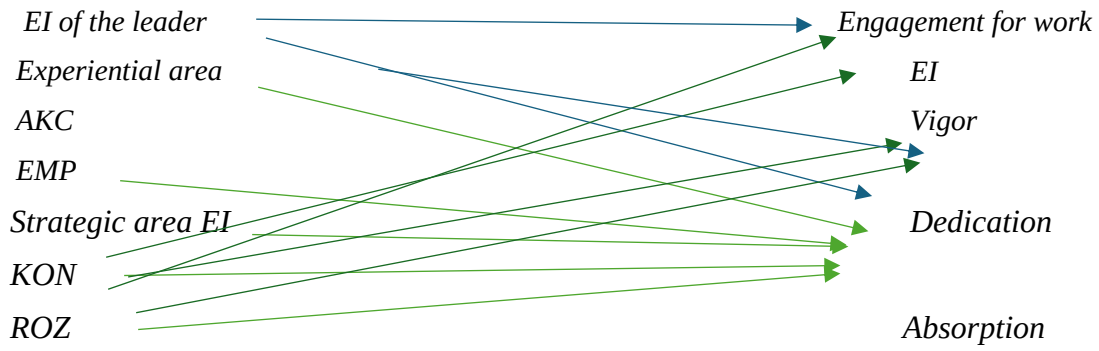

Figure 1. Correlation relationships between attributes of emotional intelligence of virtual team leaders

Source: own study

5. Conclusions and Recommendations

The basis of the current theory of emotional intelligence is the ability to observe one's own emotions and the emotions of others, distinguish between them and use the "emotional message" to improve thinking and guide behavior. Emotional intelligence is a psychological construct, a tool to help understand the behavior of others. Although today's progressive technology predestines videoconferencing, enabling communication on a visual level, the organization surveyed did not take full advantage of this technological potential, using mostly basic communicators such as email and instant messaging to transmit information. Discussing the results with the leaders, plotted during the survey testing the level of emotional intelligence, a significant number of them articulated the neglect of the issue of communication activities. While the need for increased personal communication with team members was vaguely expressed, the benefits of conference calls or video conferencing were not considered important enough to implement this available technology into daily means of communication. The focus was on coaching emotional intelligence and targeting personal development.

The analysis showed that the strategic area of emotional intelligence, specifically the ability to control and understand one's own emotions, proved to be the highest correlated skill, presumably indicating that emotional self-knowledge and the ability to interpret one's own emotions is more important in a virtual environment.

Based on the results obtained, it can be concluded that the leader's emotional intelligence plays a significant role in building commitment to work in a virtual environment. However, it should be taken into account that the virtual environment uses the potential of emotional intelligence quite differently than the stationary work environment. The analysis predicts strategic emotional intelligence as the more significant one, while the experiential side of emotional intelligence is not excluded either. Correlation results oscillated between 0,4 and 0,65, which indicates a moderate degree of correlation, but nevertheless does not exclude it. Probably, this is due to the inability to make emotional analysis expressed through body language, micro expression, and tone of voice or choice of words, which are less discernible in the virtual structure. It is likely that conducting additional research aimed at understanding how to assess and develop this skill could contribute to improving the results of the study conducted. Moreover, the ability to build and maintain relationships and understand emotional paradigms plays a significant role in engaging virtual team members. It can be theorized that this highly perceptual emotional intelligence skill has a key impact on the virtual ecosystem environment. Although this theory would require further research to determine what specific actions leaders perform to demonstrate this ability affects work engagement.

The study conducted only attempts to fill the gap regarding the role of an emotionally intelligent leader in building engagement in a virtual environment, and indicate the need for further exploration of their attributes, but nevertheless support the relevance and authoritativeness of the emotional intelligence of a virtual team leader. Given the proliferation of remote work, the yearly increase in interest in this mode, and the growing demand for geographically dispersed talent, it becomes critical to capture the key attributes needed to lead a unified communicative, empathetic, effective and engaged virtual workforce.

The results of a number of studies generally support the premise that Emotional Intelligence is an important skill in dealing with the negative effects of certain types of anxiety at work and helps to increase employee motivation, productivity and creativity. The results of this study may provide a basis for undertaking research into the effectiveness of Emotional Intelligence in order to facilitate the development of training programs to increase its level in organizations working in a virtual environment. Over time, researchers have agreed that emotional intelligence can be applied to many areas of everyday life, such as education and business. The large amount of information that needs to be processed, a highly competitive environment, and collaboration across the globe - these are huge differences in the workplace that employees face on a daily basis. Individuals who do not exhibit an adequate level of emotional intelligence do not have the competence to respond to these unforeseen changes. The impact of emotional intelligence is said to apply to a wide range of work characteristics, such as customer quality and loyalty, creativity, employee engagement, talent development, and teamwork. At this point it should be mentioned that emotional intelligence is not an attribute of only managers and CEOs, but of all employees especially in a virtual environment. The prevailing aspect in modern management is that all projects marked with the highest priority, requiring cooperation in a calm environment, also require emotionally intelligent people to cope with them. Experts suggest that any employee who wants to achieve satisfactory results must develop his emotional intelligence.

Proper leadership characterized by emotional intelligence is the key to the smooth and effective functioning of a team in a virtual environment. D. Goleman et al. demonstrate that the difference between an ineffective and effective manager lies in emotional intelligence. The task of any emotionally intelligent leader is to build an organization that is understood by people, and at the same time understood by them (Stańczyk & Gajdziszewska-Dudek, 2015).

6. Completion

It is known that emotional intelligence in itself as well as all its components are not the most important factors in building relationships in the work environment. Nevertheless, a vast amount of research, articles or messages have shown a strong correlation with performance when it comes to building engagement at work. People with high intelligence perform better at work, strengthen their personal relationships and increase efficiency. Leaders with high emotional intelligence are likely to communicate their intentions, goals and views in an exciting and proactive way so that people feel they are the best fit for the work environment. At the same time, people with high intelligence are better able to understand their followers. Employees in virtual teams communicate non-verbally - intelligent leaders understand words that are not spoken. Moreover, emotional intelligence is more important than ever due to globalization, especially when teams are multicultural or virtual, as emotional interactions and emotional expression are much more complex.

Global competition and technological advances are leading to the expansion of virtual teams to implement business strategies. The discovery of the unique characteristics of virtual teams has shown that they require different types of leadership than traditional face-to-face teams. The research enriched knowledge on the subject by further exploring and refining key skills, enablers and inhibitors of success in managing virtual teams. Some of these factors were known, but their relative importance was not clearly understood. By understanding the relative importance of key skills, enablers and inhibitors, virtual managers will be able to demonstrate the various leadership qualities and practices required to successfully manage virtual teams. The study found that at the core of effective leadership of virtual teams is the manager's ability to demonstrate social-emotional skills. As virtual work teams grow in popularity, there will be a growing need to simulate the emotional bond experienced in a face- to-face environment. Regardless of the reasons why companies opt for geographically dispersed teams, remote work has become virtually ubiquitous. Technological advances have made it easier to organize and manage distributed groups of people. Competitive pressures and the needs of today's global economy have made virtual teams a necessity, or even the only possible form of operation for many organizations.

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SOCIAL SUSTAINABILITY AND GENDER DISPARITY IN THE FINANCIAL BEHAVIOURAL

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Summary: Currently, the concept of sustainability has evolved as a primary ethical value, encompassing social challenges in significant political deliberations, such as the conditions for achieving an economic growth model that is socially inclusive. Gender inequalities still persist today in various sectors of the market, particularly in the financial field and within the professional category of financial advisors who engage in planning and monitoring financial investments. The objective of this research is to highlight the current critical issues in the world in terms of gender disparities, and then to understand the measures to be taken and the commitments to be made, both at the governmental level and by companies, to ensure the fundamental rights of men and women in the near future, thereby definitively eliminating any form of gender-based discrimination. In order to achieve this objective, a case study was conducted on the financial behaviour and investment choices of men and women to highlight gender differences in individuals' attitudes toward savings management. The instrument used was an anonymous questionnaire developed and administered to a reference sample. From the results, it is evident that the perception of gender inequalities in work and family financial management has weakened among both young students and adults, including various financial consultants. However, there still exist differences in knowledge of investments and financial behaviours between men and women, mainly due to the ongoing lack of adequate financial education. Nevertheless, the case study demonstrates significant improvements towards women's empowerment compared to previous literature and research studies.

Key words: Gender gap, Inclusion, Sustainability, Development, Behavioural finance, Survey

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1. Introduction

Numerous reports from the World Economic Forum and the Organisation for Economic Co-operation and Development (OECD, 2017) find that gender equality is a key element for economic progress and sustainable development. Investing in gender equality promotes women's economic participation, increases productivity, reduces poverty, stimulates innovation, and improves consumption and investment capacity (Morsy, 2020). Gender equity is not just a social objective, but also a determining factor for a prosperous and inclusive economy (Amaliah et al., 2024).

In this regard, 193 member countries of the United Nations have endorsed an action plan, the 2030 Agenda, which includes 17 Sustainable Development Goals to be achieved for the sustainable development of the planet, including gender equality. In the Agenda, apart from dedicating an entire Goal with its respective sub-goals to gender equity, there are continuous references to the topic in all the remaining goals, as gender equality is considered a cross-cutting priority in all the issues addressed and of fundamental importance.

In particular, the EU-SILC surveys (EUROSTAT, 2018) highlight significant gender divergence in income contribution within couples in some European Union countries. To study the differences between men and women in terms of economic aspects, the difference in financial behavior between the two genders is analyzed. We have structured and developed a questionnaire that has allowed us to update data on gender disparities in Italy and provide informative material on savings management dynamics in Sicily. The advantages of conducting such a survey are primarily of a social and economic nature.

From the results of the questionnaire conducted in this study, it is evident that the perception of gender inequalities in work and family financial management has weakened among both young students and adults, including various financial consultants. However, there still exist differences in knowledge of investments and financial behaviours between men and women, mainly due to the ongoing lack of adequate financial education.

Nevertheless, the case study demonstrates significant improvements towards women's empowerment compared to previous literature and research studies.

This study consists of 4 sections: the first section, "Agenda 2030: Goals and tools for achieving gender equality," provides a comprehensive overview of the objectives and action plan that the governments of the 193 UN member countries intend to pursue; the second section, "Evidence of gender inequality: education and economic availability," analyzes one of the most relevant gender disparities, namely the contribution to family income; the third section, "The financial advisory market in Sicily," introduces the study by explaining the target market in terms of product and geography; the last section presents a specifically designed questionnaire on financial behaviours, focusing on the differences between men and women, and showcases the results obtained with final comments and suggestions for improvement.

2. Agenda 2030: Objectives and Tools for Achieving Gender Equality

The Agenda 2030 for Sustainable Development is an action plan adopted in September 2015 by the governments of the 193 member countries of the United Nations (Organizzazione delle Nazioni Unite, 2015). It includes 17 Sustainable Development Goals (SDGs) to be achieved for the sustainable development of the planet, further elaborated into 169 sub-goals and over 240 indicators that serve as a guide for achieving the goals (Moallemi et al., 2019). The Agenda is the result of over two years of public consultation and continuous collaboration among all member countries, which formed the Open Working Group on Sustainable Development Goals of the General Assembly and the United Nations. The SDGs encompass economic, environmental, social, and institutional objectives; they are designed to be adaptable and applicable in a global context, taking into account the socio-cultural situations, policies, and priorities of each nation (Annesi, 2021).

Regarding SDG 5 "Gender equality - Achieve gender equality and empower all women and girls.", equality is established in the EU's political and legal framework since the beginning of European integration, and new policies are being developed to address persistent gender inequalities (Commisione Europea, 2016).

Goal 5 is composed of several sub-goals, also known as targets, which highlight gender inequalities in various areas and sectors of social life and propose actionable solutions at the global, national, and regional levels.

5.1. End all forms of discrimination against women and girls everywhere.

5.2. Eliminate all forms of violence against women and girls, including trafficking and sexual exploitation, and eliminate harmful practices such as forced marriages, child marriages, and female genital mutilation.

5.3. Recognize and value unpaid care and domestic work by providing public services, infrastructure, and social protection policies and promoting shared responsibilities within families, in accordance with national standards.

5.4. Ensure full and effective participation of women and equal opportunities for leadership at all levels of decision-making in political, economic, and public life.

5.5. Ensure universal access to sexual and reproductive health and rights, as agreed in the International Conference on Population and Development Programme of Action, the Beijing Platform for Action, and subsequent documents.

5.a. Undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance, and natural resources, in accordance with national laws.

5.b. Enhance the use of enabling technologies, particularly information and communications technologies, to promote women's empowerment.

5.6. Adopt and strengthen sound policies and enforceable legislation for gender equality and the empowerment of all women and girls at all levels (ASVIS, 2015).

The Agenda is structured around four guiding principles: integration, universality, inclusiveness, and transformation, placing value on individuals and recognizing well-being in

a sustainable environment, within a context of peace and harmony. Women experience limited access to paid work and wage parity, and they have extremely limited opportunities for accessing credit due to their lack of collateral to offer the financial system (Boccia, 2013).

To concretize the implementation of the Agenda, it is crucial that all mechanisms available to governments are activated and that all resources are harnessed and financed (Lenzi et al., 2015). One of the most significant milestones in the process towards gender equality in Italy is represented by the adoption of the 'Code of Equal Opportunities between Men and Women'.

In particular, the 'Code' reproduces the provisions already contained in laws No. 903 of 1977 ('Equality of treatment between men and women in employment'), No. 125 of 1991 ('Positive actions for achieving gender equality in employment'), and No. 215 of 1992 ('Positive actions for female entrepreneurship').

The most significant achievements, aimed at harmonizing national legislation with European legislation on equal opportunities, include Directive 2004/113/EC on equal treatment between men and women in the access to and supply of goods and services.

The policy on female employment also involves an investment of 11 billion euros between 2017 and 2022. These ideas have been materialized in the proposal for the Strategy and consequently need to be implemented in local contexts and communities.

In terms of work-life balance, FoPaC, a tool proposed by the Forum of Family Associations to support the reconciliation of care tasks and professional growth, achieves a mediation based on two pillars: The first relates to contractual schemes that involve hourly or performance modulations linked to income support justified by family care responsibilities. The second translates into contractual welfare forms that provide the provision of vouchers aimed at supporting workers benefiting from the system (Faioli & Rebuzzini, 2010).

The issue at hand assumes importance in terms of diversifying the workforce, expanding needs, and fostering coexistence between genders, leading to a change in the modes of work delivery (Ruiz-Mallen & Heras, 2020).

3. The Financial Consulting Market in Sicily

To study the differences between men and women in terms of the economic aspect, the financial behaviour between the two genders is analysed. For this purpose, the financial consulting market in Sicily is introduced, which helps us understand and explain some dynamics in financial choices in general before delving into the study conducted on gender differences.

The Italian market for financial consulting, and investments more broadly, is currently characterized by an asymmetry between supply and demand, with supply surpassing demand. Moreover, the best and most efficient financial products and instruments are not necessarily the most purchased by investors.

However, as individuals' financial education grows, their inclination to make independent decisions, that is, to deviate from the recommendations of intermediaries or even not rely on professional figures, increases. This is because their trust in their own abilities simultaneously increases (Oriani & Zanaboni, 2011). Same reasoning can be applied to the demand for consultancy services, which is closely related to factors such as the level of financial education, trust in one's consultant, and the level of satisfaction with the service received. Higher levels of these factors are associated with a greater propensity to hold risky instruments and to invest with the support of an intermediary (Linciano, 2012).

In Sicily, the productive fabric expanded and grew, contributing to income growth and employment development, albeit with significant contradictions and the persistence of some structural problems (Banca d'Italia, 2020). Statistical records indicate that households in Sicily are approximately 10% less likely to hold mutual funds or individual asset management compared to households in the central-northern regions. These trends were confirmed and even intensified in the first quarter of 2020, reflecting reduced consumption and the need for liquidity accumulation by businesses. By the end of March, deposit growth rate reached 5.9%.

Reference should also be made to the process of reorganizing the territorial network and distribution channels of financial products and services. The number of bank branches has decreased to 1,297 units (Banca d'Italia, 2021).

The regional banking system has undergone several reorganization processes in order to operate with 23 banks headquartered in Sicily and a total of 286 branches as of December 2018. The other banks present in the region but with legal headquarters outside its territory operated with 1,011 branches.

The accumulation of liquidity by households intensified, with deposits growing by 7.6% in December (compared to 4.0% in 2019). This growth can be attributed to a decline in consumption and precautionary motivations. The growth of deposits by businesses was particularly robust, with liquidity held in checking accounts increasing by over one-third compared to the previous twelve months.

Figure 1. Bank Deposits of Consumer Households and Sicilian Businesses, from 2010 to 2021 (Monthly data; percentage changes over 12 months)

Source: Supervisory reports, Bank of Italy, Regional Economies - The Economy of Sicily, page 45.

The overall value of custody securities held by banks for Sicilian households and businesses remained largely stable in 2020. The significant contraction experienced in the early months of the year, due to financial market tensions triggered by the spread of the pandemic, was subsequently absorbed. It should be noted that interest rates in the region are also higher compared to those recorded for the sub-group of Southern Italy. The decline in bond holdings was offset by an increase in government securities, while the value of stocks slightly grew. The value of open-end investment fund units remained stable after a significant expansion in 2019 (Bank of Italy, 2021). Consistent with the data presented in the chapter, investors rely more on advice when they do not perceive a conflict of interest and when they have a lower opinion of their own expertise and a higher opinion of their advisors' competence (Elsas et al., 2010).

All these observations allow us to reflect on the role of financial advisors and the importance, for this professional figure, of providing personalized services, constantly informing the client, and involving them in their investment and portfolio management choices. These topics are often overlooked among the interests of the parties involved but are crucial to make the investment decision-making and application process effective and efficient for all parties involved.

4. Differences in Financial Behaviour: A Questionnaire

The questionnaire developed aims to analyse the financial behaviour of men and women to highlight any differences in 2023.

The questionnaire is structured into three sections. The first section serves as an introduction, containing questions about the participants' personal information, as well as their family, social, and economic background. The second section aims to assess the respondents' knowledge of financial education, investment products, and tools, while also determining their genuine interest in financial management.

The third and final section goes into more detail, analysing the participants' portfolio management choices, preferences for purchasing financial products and services, and practical behavior regarding financial administration. Once the questionnaire was formulated, it was administered to a sample of 202 individuals, with 104 males and the remaining participants being females.

The sample analyzed comprises individuals of various age groups, with a rough distribution across four categories: 18-29 years (22% of respondents), 30-49 years (24%), 50-59 years (31%), and 60 years and above (23%). Although we include all ages within our sample, we attached a greater weight to the range 50-59 because during those years people have typically more saves. Within each age range, moreover, people are randomly selected.

The respondents who completed the questionnaire primarily reside in the province of Catania, with smaller representation from other locations such as Agrigento, Alessandria, Bari,

Biella, Bologna, Catanzaro, Como, Enna, Fermo, Genova, Lecce, Mantova, Messina, Milano, Monza, Palermo, Ragusa, Roma, Siracusa, and Torino.

The initial questions in the questionnaire are general in nature and reveal the following findings:

The majority of the respondents are married (92 individuals) with families averaging around 3 members and the singles (64 individuals).

The respondents have a medium to high level of education. Out of the total sample, 137 individuals (81 women and 56 men) have obtained a higher education degree, including a bachelor's, postgraduate degree, or a doctoral degree, indicating the educational attainment of women surpassing that of men. The primary source of income for most respondents (146 individuals) is from employment. They are predominantly employed as office workers, students, or self-employed professionals. Interestingly, among the few respondents who identified themselves as entrepreneurs, none of them are women. These initial findings provide a glimpse into the demographic characteristics of the respondents, including their marital status, family composition, educational background, and sources of income.

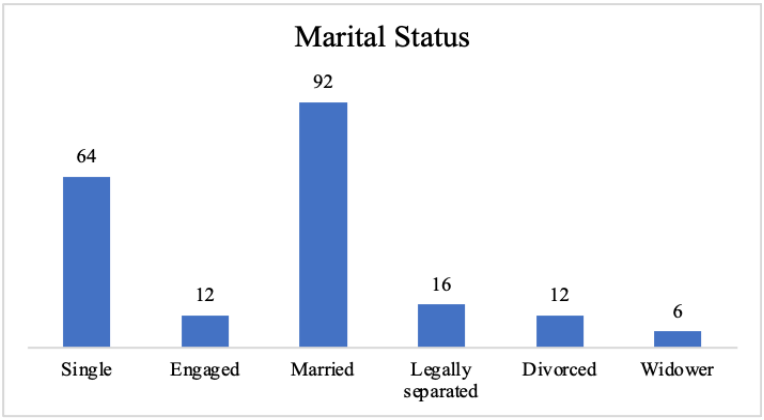

Figure 2. Marital Status of the Respondents

Source: anonymous questionnaire, 2023

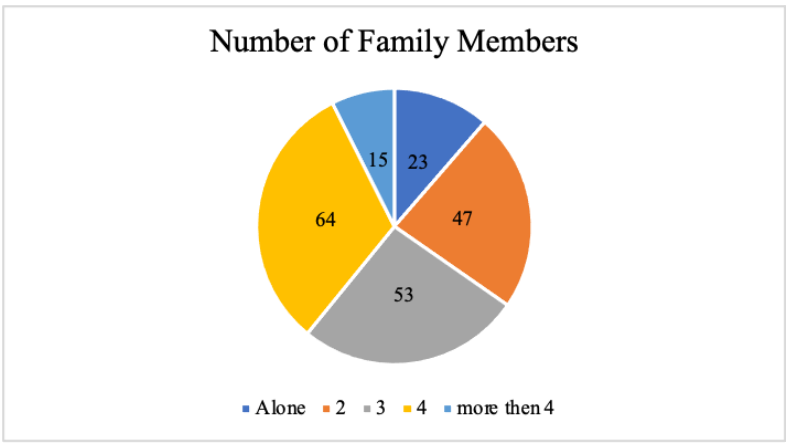

Figure 3. Number of Family Members of the Respondents

Source: anonymous questionnaire, 2023

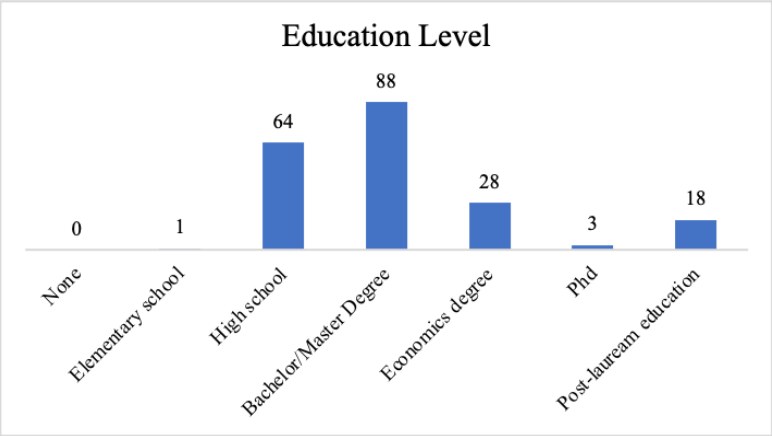

Figure 4. Educational Qualifications of the Respondents

Source: anonymous questionnaire, 2023

Regarding the economic and financial condition of the respondents, it is observed that the majority have a low to medium income level (83% have an income ranging from 0 to 75,000 euros). The assets are evenly divided between real estate and financial assets, and individuals prefer to avoid joint ownership of assets between spouses (76% against 24% of subjects with shared assets).

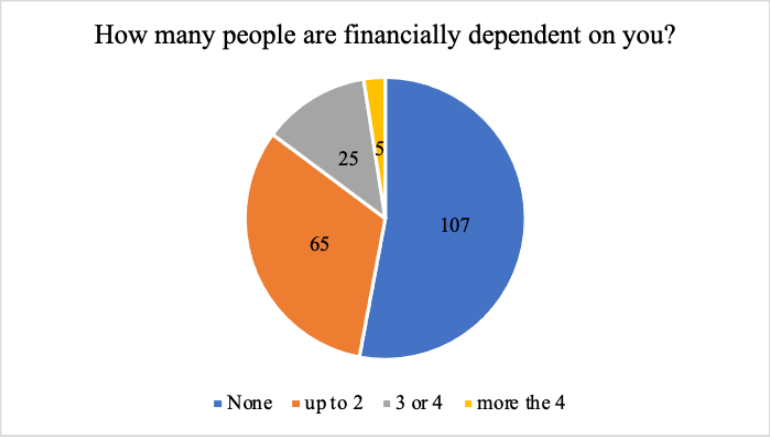

Figure 5. Economic Dependency Ratios of the Respondents

Source: anonymous questionnaire, 2023

Subsequently, questions were administered regarding knowledge of investments and financial management in general, with a particular focus on the role of financial advisors. It was found that most respondents, both women and men, manage their own assets independently (132 individuals). 34 individuals manage their finances together with their spouse or partner, and only a very small portion, mostly women, entrust their savings to their partner or consult with them before making financial decisions (Igamo et al., 2024).

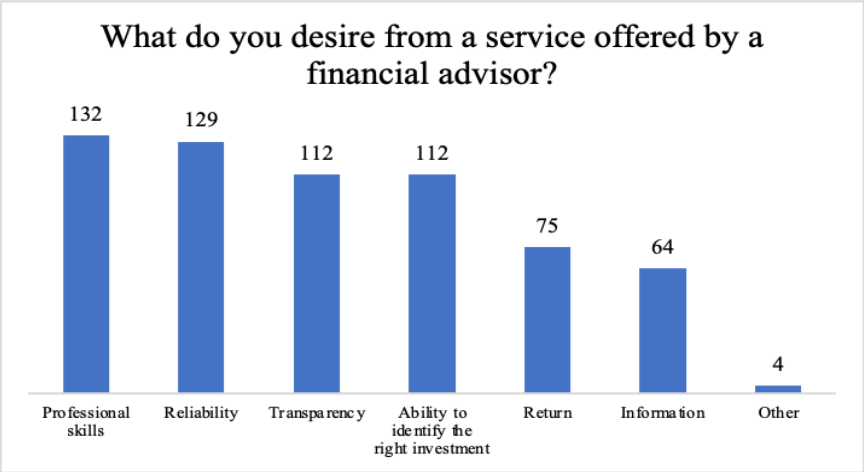

Figure 6. Requests of the interviewed subjects regarding advisory services

Source: anonymous questionnaire, 2023

Regarding the profession of financial advisors, there is a contrast between the high level of awareness of the subject (90% claim to know who a financial advisor is) and the lack of trust placed in them, as 36% of the respondents would not entrust their financial resources to a financial advisor. Therefore, when asked "What do you desire from a potential service offered by a financial advisor?" the most widely shared response is reliability, in addition to competence (134 individuals selected it among the options), leaving behind the request for high returns, which is not among the top choices.

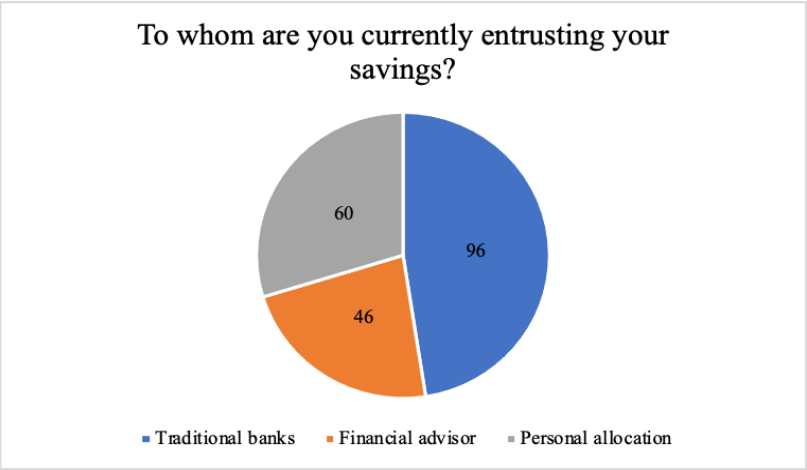

Figure 7. Management of savings by the interviewees

Source: anonymous questionnaire, 2023

The third section of the questionnaire addresses the financial behaviour of the interviewed subjects, 90% of whom declare planning their short-term, medium-term, and long-term needs. They prefer entrusting their savings to a traditional bank (47%) rather than a financial advisor, further emphasizing the general lack of trust the public has in this professional figure.

In addition, when faced with risk, which is still perceived as a negative connotation of the possibility of losing invested capital, individuals prefer to accept a moderate to low variability

in value and/or returns for moderate, limited, or no capital growth. Furthermore, gender differences are observed in financial decision-making based on individual needs (Sundarasen et al., 2023) .

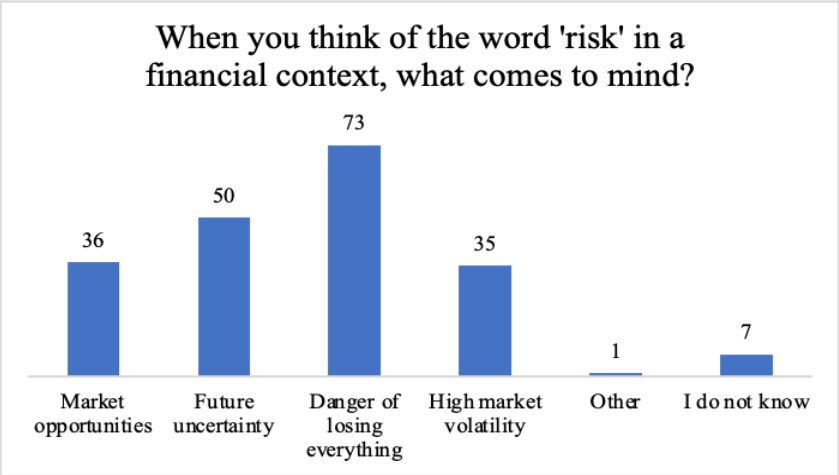

Figure 8. Perception of Financial Risk

Source: anonymous questionnaire, 2023

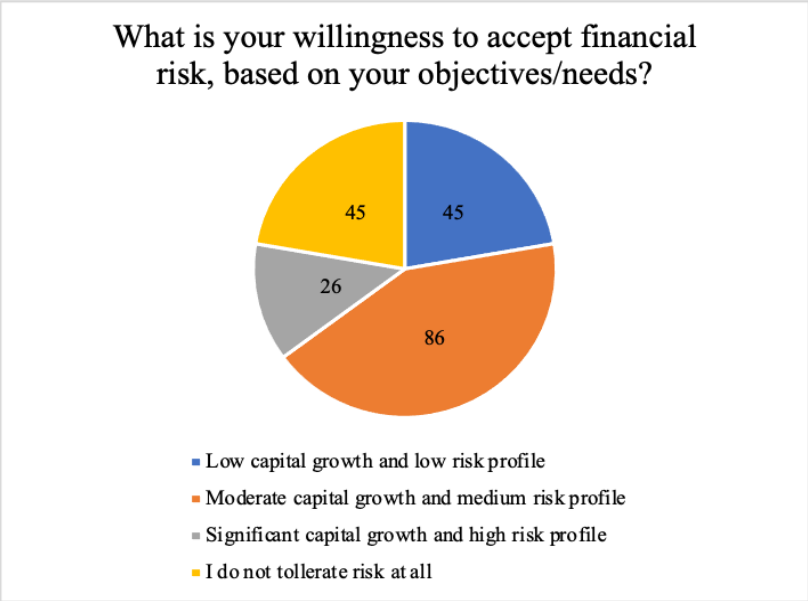

Figure 9. Acceptance of Financial Risk

Source: anonymous questionnaire, 2023

Women often seek security, reliability, and protection in an investment, possibly driven by a family-oriented perspective. On the other hand, men prefer one investment over another to increase returns and achieve substantial capital growth.

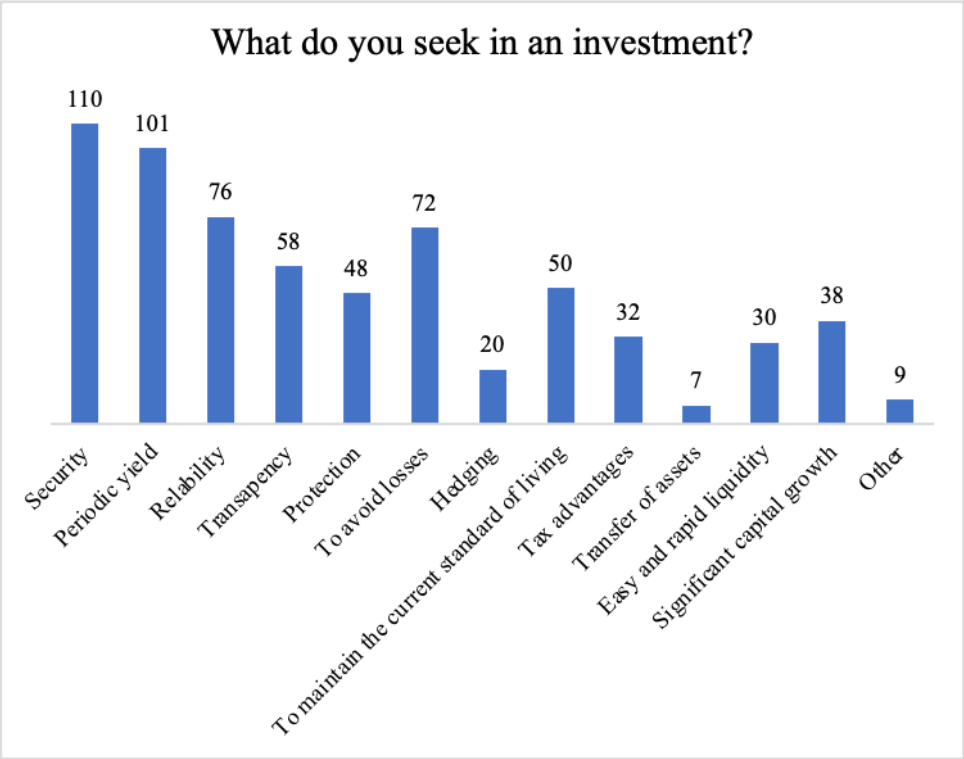

Figure 10. Needs Influencing Investment Choices

Source: anonymous questionnaire, 2023

Some questions were only addressed to the financial consultants among the interviewees. From an internal perspective of the industry, there is criticism of the clients' lack of knowledge and inadequate recognition of the profession, and improvements are proposed, such as paying more attention to the needs of women, especially in managerial careers. However, only 18% of the consultants notice gender disparities in professional opportunities, and almost none have experienced specific gender-related issues in their client relationships. They all believe that work organization can be reconciled with family activities.

Another set of questions was administered only to students enrolled in the three-year Economics program and the master's program in Corporate Finance at the University of Catania, in order to analyse the issue from a different perspective. The students' disinterest in the profession is greater than the interest (58% versus 42% of those interested).

The main strengths that students perceive include the continuous growth of the profession facilitated by the evolution of financial markets, the opportunity to provide added value to clients, and the chance to interact with a public of savers and investors. On the other hand, students suggest that there should be improvements in how potential investors are reached, through comprehensive, transparent, and more detailed exchange of information.

Contrary to those who work in this profession, students believe that gender equality is not guaranteed in the industry.

The developed questionnaire allowed for updating data on gender disparities in Italy and providing informative material on savings management dynamics in Sicily. The advantages of conducting such a survey are primarily of a social nature, as it serves as a tool to highlight the

priority areas for intervention in Italy and Southern Italy in terms of social sustainability towards achieving financial literacy for families and individuals, regardless of gender. Furthermore, there are economic benefits as companies, in particular, can understand their current positioning on sustainability issues and commit to making improvements through communication and awareness initiatives on social responsibility, investments to ensure full and effective participation and equal leadership opportunities at all levels, and actions aimed at training personnel and harnessing the great economic potential of female employees and stakeholders.

This study can be considered a database to develop targeted actions and policies to ensure gender equality in all sectors where occupational segregation persists, through literacy and education processes, the attainment of voting rights in all Countries, the signing of international treaties, punishment for aggression and violence against women by men, the re-evaluation of established mental models, and the orientation towards new models of thinking and organization in order to enhance female participation in political, economic, and technical decision-making bodies, and progress in safeguarding the rights and freedom of women, and the liberation of those considered the true victims of the current war.

5. Conclusions

As explained, gender equality is a key element for economic progress and sustainable development. It promotes women's economic participation, increases productivity, reduces poverty, stimulates innovation, and improves consumption and investment capacity (Andoriolo & Perosino, 2017). Thanks to the evolving social responsibility within companies and the progress in global and national regulations, in line with the objectives of the 2030 Agenda, trends showing significant disparities between women and men are changing. From the results of the questionnaire conducted in this study, it is evident that the perception of gender inequalities in work and family financial management has weakened among both young students and adults, including various financial consultants. However, there still exist differences in knowledge of investments and financial behaviours between men and women, mainly due to the ongoing lack of adequate financial education.

Nevertheless, the case study demonstrates significant improvements towards women's empowerment compared to previous literature and research studies. It also establishes the opportunity for the referenced company to apply the data resulting from this survey to address any existing gender gaps or disparities in its business dynamics. This can be achieved through the establishment of new regulations that ensure equal career opportunities for both male and female employees, initiatives promoting work-life balance, investments in training and financial education for their clients and the public of savers, to actively involve women in financial decision-making in their family or personal lives (Lodigiani, 2020). Furthermore, socially responsible investment proposals (financial products and services) related, for

example, to women-led companies, can be introduced to enhance and encourage female entrepreneurship. All these actions can help overcome the obstacles that still hinder the achievement of equal living conditions, particularly regarding attitudes towards savings (Small & Ven Der Meulen, 2016).

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June 5-6, 2024
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AVOIDING WINE COUNTERFEITING USING BLOCKCHAIN TECHNOLOGY: A PROPOSAL FOR APPLICATION

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Summary: This paper delves into the pervasive challenges of food fraud, counterfeiting, and authenticity within global food supply chains, with a particular focus on the wine sector. It examines the economic and health risks posed by deceptive practices and highlights the critical need for enhanced traceability and integrity measures. The study underscores the potential of blockchain technology as a transformative tool in addressing these challenges, offering unparalleled security and transparency throughout the supply chain. By leveraging blockchain, stakeholders can create an immutable digital record of product provenance, enabling consumers to make informed decisions and fostering trust in food and wine authenticity. By exemplifying an application of blockchain to the Consortium for the protection of Etna DOC wines, the paper illustrates how this technology can revolutionize traceability efforts and combat counterfeiting in the wine industry. Moreover, it explores the implications of blockchain for market players, regulators, and consumers, emphasizing the importance of collaborative efforts in realizing its full potential. Ultimately, the integration of blockchain technology promises to reshape the food and wine sectors, safeguarding public health, promoting economic integrity, and empowering consumers with greater transparency and trust.

Keywords: agriculture 4.0, wine sector, blockchain, counterfeiting methods, sustainability

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1. Introduction

Food fraud, counterfeiting, and the issue of food authenticity pose significant challenges within the global food supply chains. The intricate web of our interconnected food systems, coupled with economic incentives to reduce costs, has facilitated the widespread occurrence of food fraud, with an estimated annual cost of approximately EUR 30 billion to the global food industry. Moreover, such fraudulent practices not only disrupt the proper functioning of the internal market, but also pose risks to public health (The EU Food Fraud Network… 2018). From mislabelling to international fraud, deceptive practices pervade various sectors of the global food industry, encompassing products such as olive oil, fish, honey, dairy, meat, grains, fruit juices, wine, and alcoholic beverages, among others (Johnson, 2014; Europol, 2021).

In particular, alcoholic beverages, including wine, stand out as a significant area of concern due to their high threat level to consumer health and state revenue, with Italy, a major producer and exporter, being notably affected (Europol, 2021). The Italian wine industry, a cornerstone of the renowned "Made in Italy" brand, faces substantial risks from counterfeiting and fraud, with a market value estimated at EUR 83 million (Romano et al., 2021). Counterfeit practices in the wine sector result in substantial economic losses, tax evasion, and job displacement, further exacerbated by deceptive labelling and the sale of inferior or adulterated products (Tirrò, 2020).

Blockchain, renowned for its immutable and decentralized ledger system, has gained traction in various industries, including agriculture and food markets, with an estimated market value projected to reach $430 million by 2023 (Kaszuba, 2018). In the context of food supply chains, blockchain offers the potential to revolutionize traceability efforts by creating a secure and transparent digital record of each product's journey from farm to fork.

The application of blockchain in the wine sector holds particular promise, given the sector's vulnerability to counterfeiting and fraud. It is exemplified the application of blockchain to the Consortium for the protection of Etna DOC wines to enhance traceability and authenticity in wine production. By leveraging blockchain, the Consortium might create an immutable digital record of Etna wines' journey, ensuring transparency and authenticity from vineyard to consumer. Moreover, blockchain technology facilitates consumer engagement and empowerment by providing access to comprehensive information about the wine's origin, production process, and sustainability impact.

By enhancing traceability, transparency, and consumer trust, blockchain has the potential to revolutionize the way we produce, distribute, and consume food and wine, safeguarding both public health and economic interests. However, the widespread adoption of blockchain requires

cooperation and concerted efforts from industry stakeholders, policymakers, and regulatory bodies to realize its full potential in creating a more resilient and trustworthy food supply chain.

2. Food Fraud, Counterfeiting and Food Authenticity Problem

The complex nature of our globalized food supply chains and the economic motivation to provide cheaper food products have contributed to the prevalence of food fraud. The cost for the global food industry has been estimated at around EUR 30 billion every year, thereby hindering the proper functioning of the internal market. Fraudulent practices in the food sector may also lead to public health risks (The EU Food Fraud Network, 2018). Any instance of fraud within the food sector can have catastrophic consequences. The simple, misleading mislabelling of products and international fraud are common throughout the global food industry. Overall, foods and food ingredients commonly associated with food fraud include olive oil, fish, honey, milk and dairy products, meat products, grain-based foods, fruit juices, wine and alcoholic beverages, organic foods, spices, coffee, and tea, and some highly processed foods. As Europol reported, in terms of public health and revenue for state budgets, the threat level related to illicit products in alcoholic beverages category continues to be high, making alcoholic beverages one of the most significant threats to the life and health of consumers worldwide, state income and IPR (Johnson, 2014; Europol, 2021).

In Italy the wine sector is the third most important agri-food sector after dairy and meat in terms of production with an industrial turnover exceeding 13.2 billion euro and more than 13 thousand employees in the wine industry (Gulisano, 2012). But anyway, it is the most important agri-food exporting sector accounting for 6.2 billion euro in 2018, i.e., 14.8% of total agri-food export, mostly represented by high-quality wines with geographical indication. In fact, Italy ranks first at world level in terms of number of geographically denominated wines, with 408 Protected Designation of Origin (DOP) and 118 Protected Geographical Indications (IGP) wines, accounting for 58.2% of wine production and for an astonishing 88.2% of wine export in 2018 (Romano, et al. 2021; Decreto Ministeriale n.54182). Reported in 589 cases during OPSON IX, alcohol was the second most seized commodity, totalling about 1,613 tonnes of products seized. From an operational perspective, it represents a significant quantity. Of the total seized, almost 1,300 tonnes were wine, and Italy was one of the countries who reported by Europol notable seizures in this regard with more than 45,000 litres of wine (Europol, 2021).

In Italy, the food fraud market is worth about EUR 83 million. It is estimated that counterfeiting steals EUR 6.1 billion per year to the wine and liquor sector in the European Union. In particular, the “EUIPO”, the EU Intellectual Property Protection Office, in its last

report (2019) estimated that the sector lost, on average, every year between 2012 and 2016, EUR 2.4 billion in direct sales due to forgeries. This circumstance had a significant cost in terms of work with 38.885 jobs loss due to the fake industry and EUR 2.1 billion in unpaid taxes. In addition, according to EU data in 2017, 10% of European consumers, about 43 million, was led by deception to buy a fake product with serious repercussions for the Italian wine sector. Counterfeiting occurs mostly in non-EU countries where, according to Euipo data, by 2022, one in two consumers the risk to buy a falsified product. Specifically, the countries where the most counterfeit products are produced in the wine sector are: China, India, Thailand, Turkey, Malaysia and Pakistan. In the category of food fraud, we find sophistication, adulteration, alteration, and counterfeiting.

The main fraud in wine is the use of sugars other than those coming from grapes and vinous by-products, such as anomalous, ultra-pressed wines, lees and additives for oenological use not permitted (Tirrò, 2020).

Food fraud can be of a commercial or health nature; the former consists of selling food of lower commercial value than the real one, while the second relates to the use of microbial contaminants and exogenous chemicals potentially harmful to health (Lambiase, 2017). In particular, the sophistication of wine is mainly achieved through the addition of methanol, also known as methyl alcohol or wood spirit; other less dangerous sophistications are: use of table grapes unsuitable for vinification for the production of wine then passed off as IGT, DOC or DOCG (Spadaro at al., 2020).

The use of methyl alcohol increases the alcohol content of wine; however, all this entails not only commercial damage but also nutritional hygienic damage to our health (Matarazzo, 2019).

One of the main methods of counterfeiting is to market common sparkling wine for champagne (Colangelo & Colluci, 2020) by watering wine. In particular, the analysis of the isotopic ratios of water naturally present in the wine and comparison of the value obtained with the reference values in the European databases determines the illegal addition of spring water to wine (Perini, 2018).

A particular episode of counterfeiting involved a prestigious Tuscan DOC, in fact in October 2020 an organization that falsified Tuscan wines DOC Bolgheri Sassicaia was discovered. This crooked game was based on a business of around 400.000 Euros per month, with a production of about 700 cases of wine per month for a total of 4200 bottles.

As we have seen blockchain technology has become a widely used tool in the wine sector and the growing demand of the market for guarantees of safety, transparency and traceability can be well satisfied with the adoption of it both in national and international scene.

The complexity of food supply chains – spread across a wide variety of territories – raises myriad questions about traceability. Do we really know what is going into our products if

someone in our supply chain is determined to deceive us? How can we ensure integrity throughout the supply chain? However, as food fraud is an international phenomenon that crosses borders, a truly global solution is required (Chauhan, 2019; Elahi et al., 2018).

3. Blockchain - a Tool to Prevent Food Counterfeiting

Blockchain is a technological solution that is able to prevent food fraud and can provide a much better level of cyber-security in the distribution of goods and increase efficiency, but it can also provide customers with all the information they need (Di Pierro, 2017). According to the report "Blockchain in Agriculture Market: Global Industry Analysis, Size, Share, Growth, Trends, and Forecast, 2018-2026." blockchain in the agriculture sector and food market will worth $430 million by the end of 2023. An example of the use of blockchain technology in food supply chains is the 'Food trust' platform. After 18 months of testing, US technology giant IBM has launched its Food Trust food supply chain tracking ecosystem. One of its first users is Carrefour. The French retailer has begun testing the system in its own shops and plans to roll out blockchain technology to its entire global network. This is a concrete initiative under the Act for Food program. IBM blockchain solution establishes a trusted and permissioned environment for food transactions, where all participants can collaborate in a secure and purposeful way (Kaszuba, 2018).

Figure 1. Blockchain network actors in food chains

Source: Szymczak J. & Sadowski A., 2019

The diagram shown in Figure 2, illustrates the potential application of blockchain technology in the food supply chain. It includes four components interconnected by a distributed network, which is what blockchain technology creates.

First, the firm provides the data that are stored in the cloud and then pass on to the processor, where also the parameters for the product enter. The next link in the chain is the distributor, whose responsibility it would be to share information on the transport of goods (Malorgio et al,, 2011). The final chain is the customer, who, thanks to modern technology, can check the food product' parameters and the exact route the good has taken. Feedback about the data entered to the network is also important. This means that none of the recorded information can be concealed at any stage of the food supply. If, at any point, a failure in procedures or some other shortcoming is observed, the information can be immediately passed on to the rest of the chain, so that a batch of defective product can be immediately withdrawn from all chains (Szymczak & Sadowski, 2019).

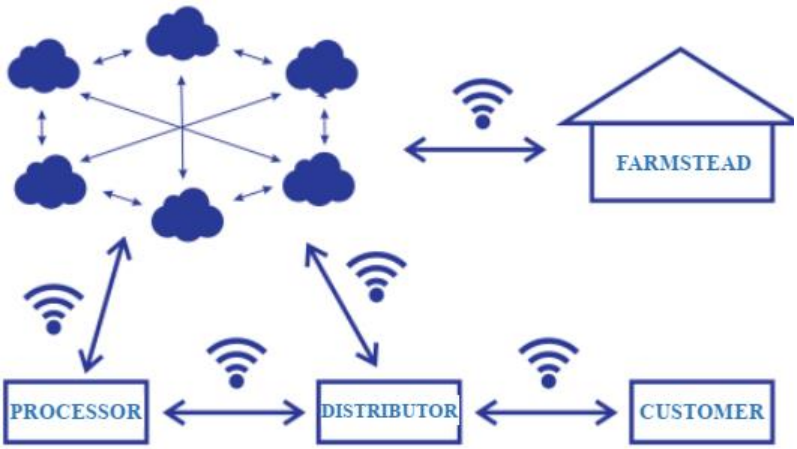

Figure 2. Graphical representation of blockchain technology within the food supply chain
Source: Szymczak J. & Sadowski A., 2019

All this, after the coronavirus emergency, risks to give the final blow to the exports of Italian wine bottles to China. There, indeed, after years of constant growth, markets are practically halved in 2020 with a 44% drop, witnessed at the same time by the continuous growth of the business of the fake Made in Italy that in the world and especially in China is worth over 100 billion Euros. Specifically, such illegal practices are so habitual in China that can be prepared by importers, distributors or sub-distributors, whose objective is to reduce the purchase price of wine by fictitiously pumping the volume of trademarks, and also avoiding customs duties and taxes. In addition, according to many experts it is still impossible to quantify the size of the fake wine trade in China. At this point, the possible use of blockchain technology may become essential to ensure safety as regards the traceability of the product and therefore the originality of the product itself to the importer and the final distributor (Crew, 2019). In this context, blockchain technology could be an effective tool in ensuring the safety and value of the product.

4. Exemplification of Blockchain Application on Wine Sector

4.1. The Consortium Etna DOC

The Consortium for the protection of Etna DOC wines is dedicated to both enhancing and promoting the Etna region and its wines. Established in 1994, its primary goal is safeguarding the production and the entire wine industry associated with Etna wines. The Etna DOC appellation, the first of its kind in Sicily and among the earliest in Italy, was established in 1968. In February 2018 (D.M., 2014). The Consortium received "erga omnes" recognition through a ministerial decree, enabling it to undertake promotional activities for Etna wines. Its key objectives include bolstering the visibility of the Etna DOC brand as an emblem of Italian craftsmanship while fostering stronger connections between producers and the market (www.consortioetnadoc.it).

There are a total of 136 producers of Etna DOC wines, collectively producing 4.5 million bottles. The controlled designation of origin "ETNA" is specifically designated for the following types of wines: Etna bianco, Etna bianco superiore (only for wines made from grapes in the municipality of Milo), Etna rosso, Etna rosso riserva, Etna rosato, and Etna spumante. The province of Catania stands out as the primary region for grape cultivation suitable for producing Etna DOC wines.

Figure 3. The logo of the Etna Doc Consortium

Source: www.consortioetnadoc.it

The unique diversity of soils in the Etna region is a direct result of its volcanic origins. Etna, which emerged approximately 600,000 years ago from underwater volcanic activity, has steadily grown to a towering height of 3,220 meters above sea level. Situated on Sicily's eastern coast, Mount Etna is renowned as one of the most active and extensively studied volcanoes globally, holding significant scientific and cultural importance in the fields of volcanology and geophysics. The climate of the Etna area is typically Mediterranean, characterized by temperate clime conditions (La Malfa, 2006). Annual rainfall peaks during autumn and reaches its lowest levels in summer. This climate, coupled with the unique soil and climatic conditions,

distinguishes the Etna region from the rest of Sicily, earning it the moniker "an island within an island". The landscape predominantly consists of lava, but human intervention has transformed it into one of the most agriculturally productive areas on the island. The tradition of cultivating and tending to wines in this region dates back centuries, as documented in "Storia dei vini d'Italia" published in 1596, which mentions wines from the hills surrounding Catania. These wines were praised for their quality, attributed to the volcanic ash from Mount Etna.

The minimum natural alcoholic content of the grapes must meet the following requirements: Etna bianco 11.00% vol, Etna bianco superiore 11.50% vol, Etna rosso 12.00% vol, Etna rosso riserva 12.50% vol, Etna rosato 12.00% vol, Etna spumante 10.00% vol.

Regarding vinification, sparkling wine production, mandatory aging, bottling, and bottle aging, these processes must take place within the defined production area outlined in Article 3 of Etna DOC protocol. However, they are also permitted throughout the municipalities' territories. The maximum permitted grape yield for wine production across all types must not exceed 70%. Grapes exceeding 75% of the yield are not eligible for registered designation of origin. Specifically addressing Etna DOC sparkling wines, there was a notable increase in production in 2020, with over 30% growth compared to the previous year, resulting in more than 160 thousand bottles produced. To further strengthen the connection between this type of wine and one of the resgion's most renowned and widely cultivated grape varieties, Nerello Mascalese, the consortium approved an increase from 60% to 80% of its utilization in the sparkling wine production process (Frigerio, 2020).

Table 1.
The Ampelographic Composition of Etna Wines Cycle

WINES	AMPELOGRAPHIC COMPOSITION
Etna Bianco	- Carricante at least 60% - Common or glossy white Catarratto from 0 to 40%
Etna Bianco Superiore	- Carricante at least 80%
Etna Rosso	- Nerello Mascalese at least 80% - Nerello Cappuccio from 0 to 20%
Etna Sparkling	- Nerello Mascalese at least 60-80%

Note: List of wine varieties included in the Etna Doc protocol.

Source: www.consortioetnadoc.it

4.2. Blockchain for Wine Supply Chain Tracing

In the light of the severe measures dictated by protocols of regulated certifications (Bio, PDO, PGI, STG, SQNPI) and, in particular, the ones applicable to Etna Doc, the risk of counterfeiting along the supply chain become a crucial problem by definition (The EU Food Fraud Network, 2018).

This research highlights blockchain as a potent technology capable of enhancing data transparency and accountability concerning the sustainability impact of supply chains.

To this purpose, the present study proposes a tangible application of blockchain for the Consortium Etna Doc, favouring the following aspects:

- **Traceability:** blockchain creates an immutable digital record that tracks the journey of wine from the vineyard to the consumer, ensuring transparency and security.
- **Authenticity:** wine information is certified in a public digital register that offers greater guarantees on origin and quality, combating counterfeiting.
- **Value:** blockchain allows for the creation of new marketing experiences for consumers, who can access exclusive information about the wine and its story.

The implementation of blockchain is supposed to trigger a virtuous circle among the market players towards a higher degree of sustainability (i.e., advanced tracking systems can show the environmental impact of winemaking, encouraging sustainable practices), improved market trust (i.e., blockchain certification gives consumers greater confidence in the accuracy of the information), and accessibility (i.e., thanks to user-friendly applications, verifying information and ensuring its authenticity becomes effortless for everyone) (Kosior 2018).

On top of that, an application of blockchain on the wine market is a win-win solution providing producers with an innovative tool for production efficiency and quality protection, and consumers with an instrument that guarantees transparency and knowledge enabling conscious and sustainable choices (Acciarini et al., 2023).

Since Etna Doc is a structured consortium, the entire supply chain, excluding the distribution stage, is located within the same geographic area and follow a specific cycle. This makes the implementation of the tracing technology apparently simpler and feasible (Matarazzo et al, 2021). Firstly, some data is registered into the blockchain during the primary phase regarding the cultivation and harvest (vineyard stage). Then other data is required throughout the secondary phase related to the transformation (vinification stage). Ultimately, the final product presents some characteristics (reported on the Etna doc protocol) which must be correctly preserved before the distribution (storage stage).

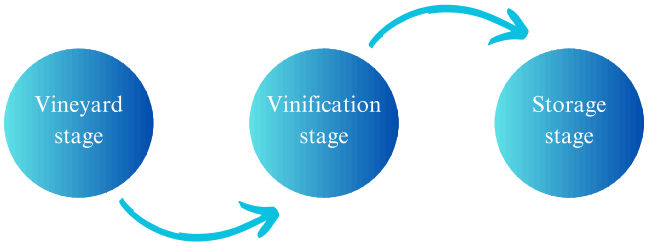

Figure 4. Supply chain stages included in the blockchain application

Source: authors' elaboration

The structure of the platform focuses on three different parts:

1. Vineyard: an agricultural establishment or plantation where grapevines are cultivated for the purpose of wine production.
2. Winemaking: also known as vinification, is the process of producing wine from grapes or other fruits.
3. Lot: refers to a specific quantity of wine that is typically identified by a unique batch number or code.

Each of the three parts of the platform considers two dimensions, consisting in camps and life cycles which require the insertion of different data input.

Table 2.
The input variables for the blockchain technology

Vineyard		Wine making		Lot	
Camps	**Life cycle**	**Camps**	**Life cycle**	**Camps**	**Life cycle**
ID	pruning	ID	destemming and crushing	ID	bottling
name	treatments	name	direct pressing	name	bottle ageing
category	weather effects	category	maceration	category	
location	grape harvest	location	alcoholic fermentation	type	
size		containers	pressing	number of bottles	
altitude		cellar temperature	blending	cork	
soil type		moisture	maturation/refining	visual appearance	
grape variety			sulphiting	smell	
form of farming			clarification	taste	
vineyard age			filtration	food pairing	
				serving temperature	
				alcoholic strenght	
				website	

Note: List of variables for each stage of the supply chain under consideration

Source: authors' elaboration

Finally, all this information is available and immutable to whoever needs to consult it, from a certification agency to the final consumer by scanning a QR code aimed at telling the story of

a wine. This can provide a rich and interactive knowledge and experience that goes beyond what is possible on a traditional wine label.

The immutable nature of the data contained in the platform may be visualized through the blockchain explorer, a web tool or application that allows users to view and interact with data on a blockchain network, providing transparency and visibility into the decentralized ledger system. Indeed, it is possible to view transaction details openly, assess block information and interpret network statistics.

5. Limits, Further Technologies, and Future Studies

While blockchain technology holds significant promise in mitigating food fraud and enhancing supply chain transparency, it is not without limitations. Understanding these limitations is crucial for developing realistic expectations and implementing complementary measures to address existing gaps.

One major limitation is the reliance on data accuracy and integrity. While blockchain provides immutable records of transactions, the veracity of data input remains dependent on the honesty and accuracy of participants. Inaccurate or fraudulent data entry at any point in the supply chain can compromise the integrity of the entire blockchain network, rendering it vulnerable to manipulation and exploitation. Moreover, blockchain technology does not inherently address physical tampering or contamination of food products. While it can trace the digital footprint of products, it cannot detect instances of adulteration or contamination that occur offline (Raithatha, 2018). Therefore, blockchain should be viewed as a complementary tool, rather than a standalone solution for ensuring food safety and authenticity.

Another challenge is scalability and interoperability. As the volume of transactions increases within a blockchain network, scalability issues may arise, leading to slower processing times and higher transaction costs. Additionally, interoperability between different blockchain platforms and existing legacy systems presents a significant hurdle for widespread adoption and seamless integration across the food industry.

Furthermore, blockchain technology requires significant investment in infrastructure, resources, and expertise for implementation and maintenance. Small-scale producers and stakeholders with limited technical capabilities may face barriers to entry, exacerbating existing inequalities within the food supply chain. In addition to the cost for developing technological blockchain platforms, depending whether the development experts are internal or external and, on the quantity/quality of work, there are some other costs connected to the use of blockchain infrastructures. Typically, those additional costs are computed per each single transaction (i.e.,

every time data is uploaded into the blockchain) and are often indexed to cryptocurrencies market price. An example of a blockchain infrastructure applying fixed transaction costs is Algorand that asks 0.001 ALGO (its own cryptocurrency) and one ALGO currently is worth €0.185. Then there are other blockchains which may be significantly more expensive and volatile like Ethereum.

In the light of those limitations, other technologies to integrate blockchain in the scope of authenticity of Etna Doc Consortium or more in general the wine sector are the following: Internet of Things (IoT), Artificial Intelligence (AI) and Machine Learning (ML), biometric authentication and DNA Barcoding and Chemical Fingerprinting.

By integrating blockchain with these complementary technologies, stakeholders can create an efficient and comprehensive ecosystem for combating food fraud, enhancing supply chain transparency, and ensuring the integrity of food products from farm to fork.

Future scientific studies and contributions in the field of combating food fraud and enhancing supply chain integrity could explore several promising avenues. One such direction involves delving into the development of blockchain-based authentication systems tailored specifically for the food industry, refining cryptographic techniques and consensus mechanisms to bolster security and reliability. Additionally, researchers could investigate the integration of emerging technologies like artificial intelligence, Internet of Things, and advanced analytics with blockchain to create intelligent solutions for real-time fraud detection. Research efforts could also extend to developing regulatory frameworks and policy recommendations to govern the implementation of blockchain technology, as well as fostering cross-sector collaborations to drive innovation and knowledge exchange in the field. Through these avenues, future studies can contribute significantly to fortifying the safety, authenticity, and sustainability of our food supply.

6. Conclusions

The pervasive issue of food fraud, fuelled by the complexity of globalized food supply chains and economic incentives for cost reduction, presents significant challenges to the integrity of the internal market and public health. With an estimated annual cost to the global food industry of around EUR 30 billion, food fraud remains a pressing concern that threatens consumer trust and safety. From mislabelling to sophisticated international schemes, fraudulent practices span various food categories, with the wine sector particularly vulnerable. Italy's wine industry, a cornerstone of the "Made in Italy" brand, faces substantial risks from counterfeiting, highlighting the need for robust measures to safeguard authenticity and protect consumers.

Blockchain technology emerges as a promising tool to combat food counterfeiting by enhancing security, transparency, and traceability in supply chains. Although not a panacea, blockchain offers significant potential to strengthen safeguards related to food authenticity and integrity. By establishing a trusted and permissioned environment for food transactions, blockchain can facilitate collaboration among stakeholders, and provide consumers with vital information about product origin and quality (Pakseresht, 2023). . The implementation of blockchain in the wine sector, exemplified in this paper by initiatives such as the Consortium for the protection of Etna DOC wines, demonstrates tangible progress towards ensuring transparency and accountability in food supply chains.

However, blockchain technology faces challenges such as data accuracy, scalability, interoperability, and adoption. Addressing these challenges requires a comprehensive approach that integrates blockchain with complementary technologies such as the Internet of Things, artificial intelligence, smart contracts, biometric authentication, and DNA barcoding. Furthermore, future research should focus on developing tailored blockchain solutions for the food industry, refining cryptographic techniques, exploring interoperability frameworks, and addressing regulatory and privacy concerns.

In conclusion, while blockchain technology holds significant promise in mitigating food fraud and enhancing supply chain transparency, its effectiveness relies on widespread adoption, collaboration, regulation and innovation across the food industry. By harnessing the potential of blockchain and complementary technologies, stakeholders can work towards building more transparent, resilient, and trustworthy food supply chains that benefit consumers, producers, and the economy as a whole.

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RISK MANAGEMENT IN R&D PROJECTS

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Summary: Risks appear in each project of various types. Risks in project are considered as threats or opportunities. One of the key process is the risk management. R&D projects have many risks because in these projects a new product or process is being developed. This paper presents the identified risks in two R&D projects financed from EU under the call Fast Track in Poland. In the first part the identified risks (while the project planning process) were assessed by two project teams to compare the planned risks with these that took place during the project realization. In the second part the types of risks of various categories chosen on the basis of the literature review were assessed. It was shown that there are various types of risks, usually the risk regarding research process or infrastructure have the highest scores but also the external risks should be considered in detail.

Keywords: project, risk, risk management

1. Introduction

Risk in project is considered as positive or negative so as an opportunity or a threat. Both types of risk should be identified and managed. The problem of risk was also reflected in the project management standards: POMBOK and PRINCE 2. The risk management has been designated as one of the main areas of the Project Management Body of Knowledge (PMBOK) by the Project Management Institute (Dziadosz & Rejment, 2015). In Prince 2 risk is divided into two types: project risk and business risk. Project risk is considered as threats directly to the project such as suppliers, resources, organization. Business risks are considered as those that

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may affect the delivery of the benefits to be gained from the project as for example changes in the market (Elkington & Smallman, 2002). Threats (negative impacts) and opportunities (positive impacts) should always be considered in relation to the project objectives and their impact on them. It is recommended to first develop a risk management plan, taking into account corporate and project strategies. Then, the risk management process first identifies and assesses the risks, and then prepares and implements a response plan. A risk response plan should be created and implemented in accordance with the selected risk management strategies (IPMA). Risk management is one of the greatest needs in project management (Rabechini & Carvalho, 2013). Risks are the inherent characteristics of the projects. The activity that has no risk cannot be called a project. Modern approaches to project management place risk management in the central point (Hillson, 2017).

The aim of this paper is to evaluate the risk management plan elaborated in two R&D projects financed from EU under the Polish call within The Smart Growth Operational Program. The Smart Growth Operational Program is the largest program in the European Union for the development of research and innovation. The areas and types of projects supported from it in 2014-2020 were specified in the Program itself and a detailed description of its priorities. The areas and types of projects have been clarified in the priority axes and activities into which they are divided: Support included in R&D by availability, supporting territory and business areas to support R&D&I activities, increasing the intensity of cooperation to take into account the innovation system, support for innovation in enterprises, increasing the scientific and research reach, development of modern scientific research infrastructure in the science sector, support for the creation of the international action programs.

2. Project Risks and Risks Management

Barghi and Sikari (2020) mentioned that general project risk management process consists of nine phases: 1) Identifying key aspects of the project; 2) Focusing on a strategic approach to risk management; 3) Identifying the time of occurrence of risks; 4) Estimating risks and the interrelationship; 5) Allocating ownership of risks and providing appropriate responses; 6) Estimating uncertainty; 7) Estimating the importance of the relationship between different risks; 8) Designing responses and monitoring the risk situation; and 9) Controlling the implementation stages. It is important to identify the risks what helps to reach the project's goal and also to limit losses, i.e. of time, work and money. On the basis of the review made some common types of risks are known (Indeed, 2023): Technology risks, Communication risks,

Scope creep risks, Cost risks, Operational risks, Health and safety risks, Skills resource risks, Performance risks, Market risks, External hazards risks.

Risk management process should be formed on the basis of these methodologies (Baccarini & Melville, 2011): (1) Communicate and consult with stakeholders throughout the project, (2) Establish the context for project risk management i.e. policies, roles, (3)Identify risks events and their causes, (4) Analyze risks – i.e. consequence and likelihood of each risk event, (5) Evaluate risks - prioritization of risk events for management, (6) Treat risks – i.e. implementation of strategies to manage risk events, (7) Monitor and review effectiveness of the project risk management process.

Lee et al. (2007) say that risk management in R&D projects is largely focused on specific technical aspects of the project rather than risks that may impact the success of the whole research project. According to DCITA (2003) the main categories of risks in R&D projects are: commercial, financial, health & safety, personnel, project management, operational management, natural disaster, project outcomes. According to MRC (2004) these categories of risks are: financial, ethics, feasibility, reputation. Winston (2006) categorized the risks into: internal, project, technical, external and Kasap et al. (2007) divided risks into 4 categories (fields): organization, environment, technology, market. So generally the risks can be divided into external, for example: market, legal and internal, for example: technology, personnel, organization etc. One the basis of the literature review made by Baccarini and Melville the following risk categories and their risks events were found (Table 1). Smith and Merritt (2002), Perera et al. (2014) made a definition of management of risks which describe it as a systematic approach to the identification, assessment, evaluation, and ranking of the associated risks followed by the allocation of the necessary resources to monitor, control, and minimize any adverse impacts of undesirable events. In the literature of project management various risk management frameworks for R&D projects can be found. Kwak and Dixon (2008) describe a framework containing of 13 best practices: develop a risk decision-making model, approach risk management analytically, involve team members, use flexible tools, draw upon academic research, use analytical tools, assess risks continuously, benchmark, incorporate risk management into project timelines, outsource, manage regulatory risk efficiently, use scenario planning and employ risk experts.

Table 1.
Risk categories in R&D projects and risks events

Risk category	**Risk events**
Commercial & Financial	Contractual conflict relating to Intellectual property
	Contractual disputes between funder and research team
	Inefficient funding
	Conflict regarding access and use of research results
Research Achievability & Integrity	Research has low chance of achieving research outcomes
	Research proposal is overly ambitious

	Misconduct or fraudulent behaviour
	Research data is falsified
	Plagiarised material
	Researchers make unjustified claims not supported by data
Research Methods & Process	Breach of health and safety compliance
	Research undertaken without approval of the research design
	Research methods outside of approved research design
	Data collection is unverified
	Data is not secured
	Data is lost
	Research methods are not adequately documented
	Misleading results from outliers being eliminated
	Research sample change their behaviors as they know they are being researched
Research Team	Researchers cannot be recruited
	Lack of quality researchers
	Researchers do not have adequate training
	Unrealistic expectations of researcher capabilities
External Stakeholders	Research results are not effectively promoted to target market
	Research fails to satisfy funder's needs
	Adverse media commentary of research
	Reputational lost as funder is not reputable
	Loss of confidence by funder through poor financial management
Ethics	Physical or psychological harm to research subjects
	Breaches of respect for cultural traditions and customs
	Conflict of interests are undeclared
	Misconduct or breaches of protocol are unreported
	Researchers fail to obtain consent.
	Breach of confidentiality
	Researched sample is disadvantaged by the research
Infrastructure	Loss of research resources due to emergency e.g. fire, flood
	Lack of suitable facilities to conduct research

Source: own elaboration

Wageman (2004) a framework that resents specific tools and techniques that may be used to aid in risk analysis and prioritization. These include checklists, templates, expert interviews, plan evaluations, decision analysis, network analysis, and cost and schedule risk simulation. Vargas-Hernández (2011) says about a framework utilizes a four-phase risk management methodology: identifying parameters, analyzing, solving and monitoring, and learning. Wang and Yang (2012) pay attention to a framework incorporates managerial flexibility into R&D project planning to decrease technical and market risks. Wang, Lin and Huang (2010) tell about a framework that aligns R&D project risk management with corporate strategy and a performance measurement system to increase success rates and achieve corporate objectives. Souza dos Santos and Cabral (2008) suggest to use a framework proposes a risk management model that combines FMEA with the PMBOK risk management methodology to improve risk identification and action planning. Carbone and Tippett (2004) mention about the implementation of FMEA method to project risk analysis (to improve the prioritization of risk contingency planning). Park (2010) shows a framework that presents a three-stage risk

management process consisting of risk assessment, risk management and performance measurement, and risk reduction and performance increase.

Risk management should be planned, implemented and monitored. Organization should elaborate risk management plan. The risk management plan should include definitions of methods used to identify, classify, evaluate, assess and possibly counteract risks and should take into account the principles of risk management in the organization and national or industry standards. If projects are a part of a program or portfolio, the risk management system should also specify which people are responsible for managing a given type of threats and opportunities and define ways and paths of delegating problems (up the hierarchy, down or horizontally) (IPMA). The first step in risk management is to identify the risk, then to assess the possibility of the risk and the impact. The third step is to prepare the response plan and to implement it. During the risk identification it is important to identify the source of the risk, the risk type (technical, external, organizational, project management). In the stage of the risk analysis the probability of the risk occurrence and the impact of the risk should be characterized.

According to International Project Management association (IPMA) in the phase of the risk identification the organization is responsible for continuously identifying all sources of risk and engaging others in this process. There are many sources, they can be internal and external. Various techniques for identifying risks and opportunities are available (e.g. experience, knowledge acquired from previous projects, industry literature, risk breakdown structures and interactive sessions with team members, including brainstorming, interviews with stakeholders and experts in a given field, among others including the Delphi method). The risk identification process not only recognizes threats, but also opportunities thanks to which, for example, the cost of partial products can be lower, the project can be implemented faster, it is more resistant to threats or simply the quality of the project can be improved. The impact of the environment on the project changes over time, so risk identification should be a permanent task.

In the phase of risk assessment the organization is responsible for continuously assessing identified threats and opportunities. Rating may be quantitative or qualitative. The best solution is to use both processes together and perform regular reassessments of threats and opportunities. Qualitative analysis may include a detailed analysis of the sources and identified risks; it also examines the conditions of their creation and their impact on the project. In the phase of the elaboration of risk response plan and implementation the organization is responsible for the ongoing process of selecting and implementing optimal responses to those identified risk. It involves assessing various possible reaction methods and ultimately selecting the most optimal one. For each threat, the following actions are possible, among others: deciding not to start or not to continue activity that leads to a threat, accepting or increasing a threat to enable an opportunity to arise, removal of the source of threat, change in probability, changing consequences, sharing risk with another entity or entities (including contracts and financing),

decision on risk acceptance based on available data, preparation of management reserve. Once appropriate responses have been implemented (which may involve designating a risk owner for specific or all risks), the risk must be monitored. Threats and opportunities, along with responses, should be assessed periodically. The likelihood and/or impact of risks may change, new circumstances may emerge, and new risks may arise for which a response plan may no longer be sufficient. The overall strategies used may need to be re-evaluated. In essence, risk management is not a periodic process - it should be ongoing, as all activities and activities may have aspects of risk. The last important phase is to evaluate the risk management plan when the project is over to collect information about the risks that took place, responses to risks and their result. Each organization should gather their experiences and lessons learned to be used in the next projects.

3. Research Background

Two projects are being considered. These project were financed from EU under the Polish call within The Smart Growth Operational Program (Fast track). The scope of the programme, the selection criteria were the same for these two projects. This programme was dedicated to innovative projects from various branches. Project No. 1 refers to the medical device industry, Project No. 2 to maritime industry. The budget of the project No. 1 was 1.300.000 €, the budget of the project No. 2 was 1.700.000 €. On the stage of project application form preparation one of the aspect that had to be characterized was the risk management plan. The risks were identified, measured and appropriate responses to risk were identified (Table 2). These projects are already closed. Projects No.1 finished by the end of 2023 and Project No. 2 in November 2023. Project managers the project team members who worked in these projects were asked to assess these risks from the perspective of these projects, i.e. if these risks appeared, if their responses were correct, risk management plan vs. real risks in these projects. Project managers, their assistants and finance specialists were asked to evaluate these risks after the end of these projects. They were asked to answer if the risk took place, what were the causes and if the neutralization actions were correct. They were also asked about other risks that appeared in these projects.

Table 2.
Risks in projects

Project No.1		
1.1.	Risk	difficulties in developing a displacement (with emphasis) to rotation converter model
	Type of the risk	Technological
	Cause of the risk	complicated structure, high mechanical loads, small displacements linear
	Risk impact	limiting the functionality of the system or inability to achieve the intended purpose of the project
	Probability	high, because no one in the world has ever done something like this, but everyone a new concept carries the risk of failure
	Prevention method	performing a number of laboratory tests and creating a large number of research models enabling the determination of the best mechanical design of the joint
	Neutralization if it appears	cause analysis, change of construction materials, shape change, elimination the most sensitive elements, shape optimization using MES, complete change of the mechanism concept conversion of pressure from displacement to rotation
1.2.	Risk	difficulties in developing a small-sized controlled clutch system
	Type of the risk	technological
	Cause of the risk	complicated structure, high technical requirements, high impact force, work under load
	Risk impact	limiting the functionality or preventing the machine from moving properly
	Probability	high
	Prevention method	conducting research preceded by a thorough understanding of various technologies
	Neutralization if it appears	analysis of causes, change of concept, reconstruction of the subsystem
1.3.	Risk	failure to achieve the assumed parameters
	Type of the risk	technological
	Cause of the risk	large amount of data sent, increasing the complexity of the system by adding additional data components
	Risk impact	limited functionality, incorrect test results for TRL 6 and TRL 9 levels
	Probability	moderate
	Prevention method	proper conduct of research work at previous stages, also taking into account mechatronic approach to design, very extensive experience of R&D staff
	Neutralization if it appears	changing integration methods, iterative modifications of components that are subject to the integration process, changing the integration concept or procedure, adapting the research procedure to the new integrated prototype
1.4.	Risk	administrative and legal problems, e.g. emergence of competition or patent infringement
	Type of the risk	Administrative/organizational
	Cause of the risk	searching for new technologies in many different areas, competitors constantly observing the market
	Risk impact	possibility of blocking research paths due to the groundlessness of their research due to lack implementation possibilities (patent lock)
	Probability	Low
	Prevention method	conducting research in unique research paths, constant monitoring of patent databases
	Neutralization if it appears	analysis of causes, elimination of faults, purchase of a license, protection and actions into a different extent avoiding any breaches that may have occurred
Project No.2		
2.1.	Risk	low efficiency of the electricity generation system
	Type of the risk	technological
	Cause of the risk	model inaccuracy, too many system components
	Risk impact	reducing the time of autonomous work (e.g. at specific times of use or places)

	Probability	low
	Prevention method	correct calculations and research
	Neutralization if it appears	the use of more effective solutions with higher than average energy generation efficiency electricity
2.2.	Risk	heavy battery pack
	Type of the risk	technological
	Cause of the risk	the need to store more energy than assumed in the calculations, higher losses
	Risk impact	high
	Probability	moderate
	Prevention method	correct simulation of energy demand
	Neutralization if it appears	change in the percentage of light cells in relation to heavy batteries
2.3.	Risk	the need to use solutions patented by other entities
	Type of the risk	administrative and legal
	Cause of the risk	the need to improve the system's operating parameters to meet the assumptions
	Risk impact	the need to introduce external technologies that may prove expensive to sell
	Probability	low
	Prevention method	constant analysis of research results and searching for new solutions
	Neutralization if it appears	negotiations and purchase of technology or use of open-source technologies

Source: own elaboration

Risk 1.1.: difficulties in developing a displacement (with emphasis) to rotation converter model.

Project manager: This risk was characterized correctly at the planning phase. It appeared and was one of the main risks and problems in this project.

Project assistant: More specialists had to be involved in this work package and also we needed more time to collect the expected results.

Finance specialist: Changes in the project budget we needed to pay for the expertise of the additional specialists.

Conclusions: if an important risk appears remember to have the appropriate reserve of time and budget to implemented the changes such as: the employment of specialists, increasing the duration of work packages and achievement of the planned mile stones. In R&D projects there are often high possibility of research risks because you want to create something that does not exist.

Risk 1.2.: difficulties in developing a small-sized controlled clutch system.

Project manager: It was expected that the risk might appear, and it did. We paid much attention and effort to this risk as it was connected with one of the main functionality.

Project assistant: We had to plan more time for testing, we needed mor worktime and the reorganization of the project schedule.

Finance specialist: We had to keep an eye on our budget and made some changes of costs.

Conclusions: This risk showed that although you plan your work correctly, do your best to assume the research problems, you cannot be sure. It is important to have a good and experienced research team that can think out of the box an is not afraid of taking challenges.

Risk 1.3.: failure to achieve the assumed parameters.

Project manager: It is a standard risk in R&D project, quite general. There is always a risk to fail to archive the assumed parameters at each stage of the project. If the parameters are the key parameters, the we have to response very quickly because there may be no sense of continuing the project.

Project assistant: Usually the fact of achieving the assumed parameters refers to the mile stone so to the end of the project phase. This kind of risk has to be carefully monitored.

Finance specialist: The lack of collecting the assumed parameters can have very serious consequences such as the completion of the project or the need to repeat the phase what have the financial after-effects.

Conclusions: In R&D project it is one of the most popular risks and indeed it happens very often. Organization should be prepared for this kind of risk.

Risk 1.4.: administrative and legal problems, e.g. emergence of competition or patent infringement.

Project manager: As it was a very unique project and the branch the competition appeared not to big a big problem, however the process of getting patent lasted longer than expected.

Project assistant: Much time was needed for the patent procedure.

Finance specialist: Various patent procedures involves much finance.

Conclusions: External risk such as competition or administrative processes also influence on the R&D projects.

Risk 2.1.: low efficiency of the electricity generation system and Risk 2.2.: heavy battery pack.

Project manager: These two risks were the main research/technology risks that influenced the project success. Therefore much effort was spend to achieve all the needed parameters. It resulted in the increase of the time of phase no 1 ad no. 2.

Project assistant: Whole project team was involved in avoiding these risks and plan B was elaborated.

Finance specialist: The increase of time of two project phases resulted in the increase of money, work, materials.

Conclusions: Research/technology risk are usually the most serious in R&D project.

Risk 2.3.: the need to use solutions patented by other entities.

Project manager: Before and during the project it is important to monitor the patents made by other organizations.

Project assistant: It is worth that one of the project team member review the patent base.

Finance specialist: It results in the additional financial resources needed.

Conclusions: These are the costs that cannot be predicted very detailed so may results in some changes in the project budget.

General conclusions from this "post-project" assessment: although, in R&D project risks connected with research and technology appear and are the basic ones as well as very important and usually the key risks, project managers and other members of the project team cannot forget about other risks, especially the external risks. During these evaluated project, for example was the Covid-19 pandemic that didn't have the direct, however influenced these project much. The pandemic caused the limited access to hospital what in project No. 1 resulted in the need for an extension of the testing phase. It also caused the limited access to electronical parts which were the element of this medical device. The same in project No. 2 - there also was the need to extend one of the phase of the project.

These members were also asked to assess the risk presented in Table 1 taking into consideration:

1) Probability values: likely=3, possible=2, unlikely=1
2) Consequence values: major=5, moderate =3, minor=1

In table 3 the result of the assessment of risks by these 2 project management teams. The sum of the assessment is presented (minimum 1, maximum 24).

Table 3.
Assessment of the risks made by the members of the two project teams

	Risk assessment by PM, PA and FS	
	Project No. 1	**Project No. 2**
Risk events		
Contractual conflict relating to Intellectual property	13	15
Contractual disputes between funder and research team	6	6
Inefficient funding	6	6
Conflict regarding access and use of research results	6	6
Research has low chance of achieving research outcomes	18	12
Research proposal is overly ambitious	6	10
Misconduct or fraudulent behavior	10	13
Research data is falsified	18	19
Plagiarized material	18	19
Researchers make unjustified claims not supported by data	14	13
Breach of health and safety compliance	16	18
Research undertaken without approval of the research design	18	10
Research methods outside of approved research design	6	6
Data collection is unverified	8	6
Data is not secured	18	18
Data is lost	18	18
Research methods are not adequately documented	16	14
Misleading results from outliers being eliminated	6	6
Research sample change their behaviors as they know they are being researched	6	6
Researchers cannot be recruited	13	19
Lack of quality researchers	12	15
Researchers do not have adequate training	9	12
Unrealistic expectations of researcher capabilities	6	6
Research results are not effectively promoted to target market	6	6
Research fails to satisfy funder's needs	16	18

Adverse media commentary of research	6	6
Reputational lost as funder is not reputable	6	6
Loss of confidence by funder through poor financial management	12	10
Physical or psychological harm to research subjects	14	6
Breaches of respect for cultural traditions and customs	6	6
Conflict of interests are undeclared	6	6
Misconduct or breaches of protocol are unreported	6	12
Researchers fail to obtain consent.	16	12
Breach of confidentiality	18	18
Researched sample is disadvantaged by the research	14	6
Loss of research resources due to emergency, e.g. fire, flood	12	21
Lack of suitable facilities to conduct research	8	18

Source: own elaboration

The sum of their indications in each risk group is presented on the Fig. 1. The highest scores were given in the category Research methods and Processes, a slightly higher for project No. 1 as it was very detailed and presented a new approach for a medical devices.

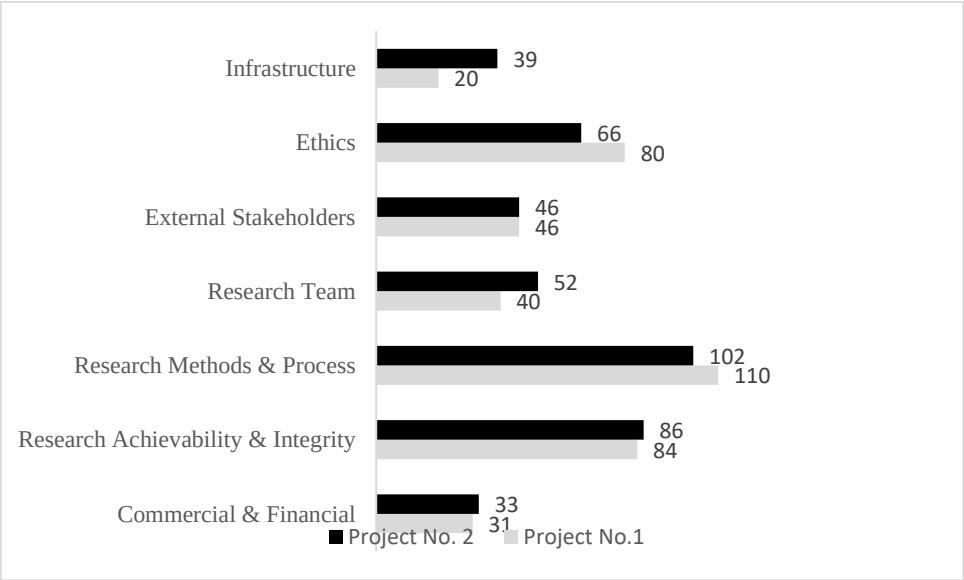

Figure 1. The results of the assessment of the risk categories by project teams

Source: own elaboration

The risks regarding to ethics were assessed higher for the project No. 1 because its aim was the medical device so testing this device under the real conditions was needed. Humans had to be involved in the experiments in the last phase. It influenced people body. The research achievability and Integrity was also assessed high for both projects. The external stakeholders' risks were assessed on the same level as well as Commercial and Financial.

4. Conclusions

In projects and in R&D projects there are always risks. Although risks in project should be considered in two ways as threats and opportunities, more attention is paid to risks as threats. It was shown that the most popular and highly considered risks regard Research Methods & Process and Research Achievability & Integrity what can be seen as the inherent characteristics of R&D projects. Project managers shouldn't forget about the external risks. It was shown as the result of comparison the risks analysis and the real risks that appeared in projects that much more attention was paid to the internal risks and research risks, for example: research method, infrastructure, scientists. Less attention was paid to the external risks, for example: changes of the market, legal affairs or competition. In a natural way R&D project are mostly connected to research risks but the external conditions also influence the project success, for instance: preferences of customers, competition, new markets. The risk analysis should be wider, not focused mainly on research risks. If the preferences of customers change, there is no need to develop a product that does not fulfill their requirements (even if it has the planned functions). If the competitors were quicker and launched a similar product first, the second product would have problems to reach the goals. On the other hand, if a new market opens, the would be the need for faster finishing the project to start the implementation phase quicker than planned. It all shows that the list of risks should be monitored and updated when needed. It cannot be done once while the project planning because the internal conditions and external conditions may change. This change can be both positive or negative. Projects members are usually prepared for risks as threats, know how to limit the risk, how to transfer it. Sometimes when risks as opportunities appear project members are not ready to strengthen it. The next important category of risks in R&D projects is ethics. Not only the ethics when it comes to conducting research, body research, testing etc. but also the ethics regarding the behavior of experts, project teams, for instance not to reveal or sell the research results, patents. These issues should be regulated while the recruitment process.

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SELECTED CONCEPTS OF RISK MANAGEMENT

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Summary: Risk management is a vital component of organizational strategy and operations, enabling organizations to identify, assess, mitigate, and monitor potential threats and opportunities. By systematically addressing risks, organizations can enhance their resilience, improve decision-making, and achieve their objectives amidst uncertainty. Effective risk management involves a structured process that includes risk identification, analysis, evaluation, treatment, and continuous monitoring. Key standards and concepts, such as ISO 31000:2018, ERM Framework or BCM provide comprehensive guidelines and principles for implementing robust risk management systems. These tools emphasize the integration of risk management into organizational processes, fostering a proactive and informed approach to managing risks. The benefits of effective risk management are manifold, including enhanced operational continuity, regulatory compliance, cost reduction, and increased stakeholder confidence. As the global business environment becomes increasingly complex and dynamic, the importance of risk management continues to grow, necessitating the adoption of best practices and standards to navigate uncertainties effectively. In this article There are characterised the most common concepts of risk management followed by ISO 31000:2018 standard in this paper. There has been highlighted the critical role of risk management in achieving organizational success and sustainability, underscoring the need for a systematic, integrated, and strategic approach to managing risks.

Keywords: risk management concepts, enterprise risk management, business continuity management, ISO 31000:2018

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1. Introduction

Risk management is an integral part of the life of every organization. It should be an integral part of the organizational strategy implemented in all organizations. The strategy should be constructed in such a way that risk management fulfils not only the function of a system enabling the avoidance of losses, but also allows for the recognition and use of opportunities and the creation of new opportunities for the organization. Top management should also be responsible for the strategy and associated risk management. This body should continuously monitor the flow of information in the enterprise and its structure in relation to the implementation of the strategy and risk management method. Risk management raises awareness of possible threats. This is facilitated by risk management guidelines published by various organizations, included in various standards and methods. According to this, implementing a process approach to risk management creates opportunities for the organization to minimize risks. Thanks to the systematic identification of risks, the introduction of control and intervention mechanisms and supervision procedures, the risk management system in the organization will protect it against threats and influence the quality of its management (Bromiley et al., 2015).

Risk is inherent in business activity. When we decide to run a business, we also decide on the risk associated with it. Risk is most often defined as an indicator of a condition or event that may result in losses. Risk can be measurable (expressed numerically) the probability of a situation occurring that is different than expected and the amount of losses that this different situation may cause. In colloquial terms, risk means a danger resulting from a specific event or is a consequence of a decision made (Kokot-Stępień, 2015). According to the definition form the ISO 31000:2018, risk is "the effect of uncertainty on objectives"(ISO, 2018). Therefore, every decision-making process involves greater or lesser risk. Therefore, more and more companies, not only large corporations, are interested in implementing risk management systems.

Risk in business activity can be considered in two aspects. In the negative concept, risk is treated as the inability to achieve the assumed goals or, in a worse case, incurring losses (Brustbauer, 2016). Considering risk in this way, enterprises will take all actions to reduce or eliminate this risk. In the positive concept, risk is treated as an opportunity to achieve an effect other than expected. By running a business or making a conscious decision involving risk, an enterprise gains the opportunity to achieve greater benefits. In this case, greater benefits are a reward for consciously taking risks (Zawiła-Niedźwiecki, 2013).

The basic goal of risk management is to improve the company's financial results and to ensure such conditions that it does not incur losses greater than assumed. Risk management is

to lead to a situation in which the organization (its management) is aware of the risk and its size, and in its current operations it does not exceed the risk limit consciously accepted as acceptable. Influencing risk must take into account the existence of opportunities and threats as well as the possibility of covering possible losses, and must also perceive losses as missing benefits due to not taking certain actions (Islam et al., 2013; Aven, 2016).

The aim of effective risk management is to analyse in detail and understand the nature and scope of potential risk, as this allows for timely selection of actions that will moderate or prevent negative effects. The aim should be to make a conscious decision as to the limits of permissible exposure to risk, in the context of the potential gain or loss of business benefits. Hence, a risk management strategy is an action plan in an area important for the organization, consisting in formulating goals and forms of action related to expected changes in factors affecting the level of probability of losing benefits or losses. It is intended to be a planned response to risk, formulated on the basis of knowledge about the sources and methods of its materialization in the form of damage and on the basis of knowledge of methods of prevention and methods of measuring risk and valuing damage as its effects(Ho et al., 2015).

The risk management strategy is divided into general and specific. The general strategy concerns setting goals, resources and risk assessment methods, as well as the principles of planning the organization's behaviour in the face of critical situations. This strategy must be integrated and result from the development strategy (business strategy) of the organization. It is therefore the development of uniform principles for describing, examining and modelling risk and organizational behaviour in response to it. The general risk management strategy may be (Soltanizadeh et al., 2016; Rehman & Anwar, 2019; Edjossan-Sossou ***et al***., 2020):

- expansive - the organization deliberately undertakes high-risk activities, seeing this as a way to achieve greater benefits than before,
- conservative - the organization takes risk carefully, but to an extent that causes some partial (or greater) losses, and on purpose
- does not take risks that exceed the established acceptable level,
- impassive – the organization does not undertake actions where the effects are not certain.

Detailed strategies refer to specific situations: types, places and dates of risk occurrence. Typical specific strategies are: risk retention, risk transfer, risk sharing, risk reduction. In addition to the risk management strategy, the organization should define its management policy, i.e. a set of intentions and principles of flexible decision-making conditioned by risk or aimed at moderating or preventing risk (Sutton et al., 2020). You can never eliminate risk completely, you only strive to minimize it. The risk that remains is called residual. As a rule, further risk minimization is economically unjustified, i.e. its cost would be greater than the potential losses. However, it is important to remember about the probability of an incident resulting from such

a minimized risk. The organization should be aware of the existence of residual risk and the need for a carefully considered decision to accept it.

Contemporary risk management refers to the division into the following basic risk groups: material, financial, strategic and operational threats, and also adopts the following six principles of risk management (Khan at al., 2015; Aven, 2016; Brocal et al., 2019; Mavrakana, 2019; Mahama et al., 2023):

1. Risk management in an enterprise should involve managing all its types simultaneously.
2. The company's top management must be directly involved in the risk management process.
3. All types of risk in an enterprise should be treated as a risk portfolio - which means that it requires understanding its individual elements and the relationships between them - and must be managed through the prism of the goals and processes of the entire organization.
4. It is necessary to use quantitative methods to measure risk.
5. The risk management tools and procedures used are common to all types of enterprises.
6. Risk is no longer minimized but optimized, and enterprise risk management becomes "making decisions and implementing actions leading to achieving an acceptable level of risk".

The increasing importance of risk management in the enterprise resulted in the emergence of public risk management concepts. They were created as a result of the initiatives of a number of institutions that promoted best practices in managing various types of risk. There will me characterised a selected concepts of risk management widely engaged in organizations.

2. Risk Management Concepts

Risk management concepts and standards are comprehensive frameworks designed to facilitate the identification, assessment, mitigation, and monitoring of risks within an organization. These tools integrate various processes, tools, and methodologies to ensure that risks are managed effectively and aligned with the organization's objectives. They also provide guidelines, principles, and best practices for organizations to establish and implement effective risk management processes as well as they are helping organizations enhance their resilience and achieve their objectives. This chapter explores some of the prominent risk management standards and concepts, their key features, and their significance in guiding organizations toward robust risk management practices.

2.1. Enterprise Risk Management (ERM)

In 2004, COSO published its first comprehensive guidance on enterprise risk management (ERM) – Enterprise Risk Management — Integrated Framework. Then, in June of 2017, COSO released a new, more detailed and complex ERM framework titled Enterprise Risk Management—Integrating with Strategy and Performance. Enterprise Risk management is a comprehensive, structured, and integrated approach to managing the wide array of risks an organization faces. It involves identifying, assessing, managing, and monitoring risks across all parts of the organization to help ensure the achievement of strategic and operational objectives. ERM aims to provide a holistic view of risks, enabling organizations to effectively mitigate potential negative impacts and capitalize on opportunities. The key components of ERM covers 5 items as follows (Hiles, 2012; Prewett &Terry, 2018; Shad et al., 2019; Olson & Wu, 2023):

1. Risk Identification. It includes systematic identification and risk cataloguing. Systematic identifications identifies risks through structured processes such as workshops, interviews, surveys, and data analysis. Risk cataloguing leads to creation of a risk register that includes risks from all areas of the organization, including strategic, operational, financial, compliance, and reputational risks.
2. Risk Assessment – it covers risk analysis and risk prioritization that evaluate the likelihood and potential impact of identified risks using qualitative and quantitative methods as well as ranking risks based on their severity and potential effect on the organization, often visualized through heat maps or risk matrices.
3. Risk Response Strategies:
    - Avoidance: Eliminating the risk by discontinuing the activities that lead to it.
    - Mitigation: Reducing the likelihood or impact of the risk through preventive measures.
    - Transfer: Shifting the risk to a third party, such as through insurance or outsourcing.
    - Acceptance: Acknowledging the risk and choosing to bear the consequences, often with contingency plans in place.
4. Risk Monitoring and Reporting – it includes continuous monitoring and reporting. This actions cover regularly tracking and reviewing risk indicators and the effectiveness of risk management strategies as well as communicating risk information to stakeholders, including management, the board of directors, and external parties, to ensure transparency and accountability.
5. Risk Governance and Culture. it covers leadership and oversight as well as risk culture. During this stage it is needed to establish clear roles and responsibilities for risk management, including oversight by senior management and the board and to promote a culture that encourages risk awareness and proactive risk management throughout the organization.

Implementing ERM within an organization provides a wide variety of benefits that can be associated to improved decision-making process that gives a comprehensive view of risks to support informed strategic and operational decisions. It also enhance risk awareness that increase understanding of potential risks and their implications across the organization. It provides greater resilience for the organization that strengthen the organization's ability to anticipate, prepare for, and respond to unexpected events. ERM also support organization's regulatory compliance, where ensuring adherence to legal and regulatory requirements related to risk management. It also gives value protection and creation by safeguarding organizational assets and enabling the pursuit of opportunities that align with the organization's risk appetite and capacity(Callahan & Soileau, 2017; Mccabe & Petersson, 2017; Lechner & Gatzert, 2018; Saeidi et al., 2019).

ERM is essential for organizations aiming to navigate uncertainties and achieve their objectives. By systematically managing risks, organizations can better protect their assets, enhance decision-making, and improve overall performance.

2.2. Business Continuity Management (BCM)

In an increasingly complex and interconnected global environment, organizations face a myriad of potential disruptions ranging from natural disasters and cyber-attacks to supply chain failures and pandemics. Business Continuity Management is a holistic management process that identifies potential threats to an organization and the impacts those threats might cause on business operations. BCM is a process that helps organizations prepare for, respond to, and recover from potential disruptions to their operations. The goal of BCP is to ensure that critical business functions continue to operate during and after a disaster or unexpected event, minimizing the impact on the organization and its stakeholders. It also provides a framework for building organizational resilience and the capability for an effective response that safeguards the interests of key stakeholders, reputation, brand, and value-creating activities. The key components of BCM covers 6 items as follows (Reuter, 2015; Torabi et al., , 2016; Fischbacher-Smith, 2017; Suresh, Sanders & Braunscheidel, 2020; De Matteis et al., 2023):

1. Risk Assessment and Business Impact Analysis (BIA):
   - Risk Assessment – it is identifying and evaluating risks that could potentially disrupt business operations, such as natural disasters, cyber-attacks, supply chain failures, or pandemics.
   - Business Impact Analysis (BIA) – it is determining the critical business functions and processes and assessing the potential impacts of disruptions on these areas. This includes identifying recovery time objectives (RTOs) and recovery point objectives (RPOs).
2. Strategy Development:

- Continuity Strategies – it is developing strategies to manage and mitigate the impacts of identified risks. This could include measures like redundancy, failover mechanisms, alternate work locations, and resource allocation.
- Resource Allocation – it is ensuring that necessary resources (people, technology, information, infrastructure) are available to support the continuity strategies.

3. Plan Development:
   - Business Continuity Plan (BCP) – it is creating a detailed plan outlining the steps to be taken before, during, and after a disruption. The BCP includes procedures for emergency response, crisis management, and recovery operations.
   - Communication Plan – it is establishing protocols for internal and external communication during a disruption, including communication with employees, customers, suppliers, and regulatory bodies.
4. Implementation:
   - Plan Execution – it leads to implementing the BCP and ensuring that all necessary measures and resources are in place.
   - Training and Awareness – it provides conducted training sessions and awareness programs for employees to ensure they understand their roles and responsibilities in the event of a disruption.
5. Testing and Exercising:
   - Testing the Plan – it allows to regularly test the BCP through drills, simulations, and tabletop exercises to identify any gaps or weaknesses.
   - Updating the Plan – it forces continuously improving the BCP based on the outcomes of tests and changes in the business environment or operations.
6. Review and Improvement:
   - Continuous Monitoring – it is monitoring the business environment and internal operations to identify new risks or changes in existing risks.
   - Plan Review and Update – it allows to regularly reviewing and updating the BCP to ensure it remains relevant and effective.

Similar to ERM, business continuity management provides a lot of benefits to the organization. It covers organization’s operational resilience by enhancing the organization's ability to continue critical operations during and after a disruption. It minimizes downtime by reducing the duration and impact of disruptions on business operations. BCM also strengthens stakeholder’s confidence through building confidence among stakeholders, including customers, suppliers, and investors, by demonstrating a commitment to business continuity. It provides regulatory compliance by easily allowing to meet legal and regulatory requirements related to business continuity and disaster recovery. Another crucial benefit for BCM is reputation protection by safeguarding the organization’s reputation by effectively managing

crises and maintaining operations (Zapłata, 2016; Azadegan et al., 2020; Corrales-Estrada et al., 2021).

One of the components of BCM, that very often stand alone is a Business Continuity Planning. Business Continuity Planning is a proactive process that prepares organizations for unforeseen events that could impact their operations. It involves identifying critical functions, assessing potential risks, developing strategies to mitigate those risks, and ensuring that resources are in place to maintain operations. The scope of BCP extends beyond disaster recovery, encompassing a broader approach to managing and mitigating risks that can disrupt business continuity. BCP is vital for ensuring that organizations can withstand and recover from unexpected disruptions. By systematically identifying risks, developing and implementing continuity strategies, and regularly testing and updating the business continuity plan, organizations can protect their critical operations and maintain stability in the face of adversity. Effective BCP not only enhances operational resilience but also builds stakeholder confidence, supports regulatory compliance, and protects the organization's reputation and market position. In an unpredictable world, a robust BCP is not just a strategic advantage but a necessity for long-term success and sustainability (Fani & Subriadi, 2019; Bajgorić et al., 2022).

2.3. ISO 31000:2018 Risk management standard

ISO 31000:2018 is an international standard for risk management that provides guidelines and principles to help organizations manage risks effectively. It has been developed by the International Organization for Standardization (ISO), and in its latest revision form the year of 2018 outlines principles, frameworks, and processes for risk management. It is designed to be applicable to any organization, regardless of size, industry, or sector. The standard emphasizes the importance of integrating risk management into all aspects of an organization’s governance, strategy, and planning, as well as its management, reporting, processes, policies, values, and culture. The standard helps organizations with (Silva Rampini et al., 2019; Herdmann, 2020; Dewantara et al., 2022):

- increasing the likelihood of achieving objectives.
- improving the identification of opportunities and threats.
- effectively allocating and using resources for risk treatment.

The latest version of ISO 31000 standard is based on risk management principles, framework as well as process. There are 8 principles as follows (ISO, 2018):

1. Integrated: Risk management should be an integral part of all organizational activities.
2. Structured and Comprehensive: A structured and comprehensive approach ensures consistent and comparable results.
3. Customized: The risk management framework and process should be tailored to the organization’s external and internal context and related to its objectives.

4. Inclusive: Involvement of stakeholders ensures that risk management is relevant and up-to-date.
5. Dynamic: Risk management needs to be dynamic, anticipating, detecting, acknowledging, and responding to changes.
6. Best Available Information: Decisions should be based on the best available information.
7. Human and Cultural Factors: Human behaviour and culture significantly influence all aspects of risk management.
8. Continual Improvement: Risk management should be continually improved through learning and experience.

The framework outlined in ISO 31000:2018 helps organizations integrate risk management into significant activities and functions. It includes (ISO, 2018):

1. Leadership and Commitment:
   - Top management should show leadership and commitment to risk management.
   - They should ensure that risk management is integrated into organizational processes.
2. Integration:
   - Risk management should be part of the organizational structure, strategy, and processes.
3. Design:
   - Understanding the organization and its context.
   - Articulating the risk management policy.
   - Defining roles, responsibilities, and authorities.
   - Allocating resources.
   - Establishing communication and consultation.
4. Implementation:
   - Developing risk management plans and processes and ensuring they are implemented effectively.
5. Evaluation:
   - Monitoring and reviewing the risk management framework and processes to ensure effectiveness.
6. Improvement:
   - Continually improving the framework and processes based on feedback and learning.

The risk management process in ISO 31000:2018 includes the following steps (ISO, 2018):

1. Communication and Consultation:
   - Engaging with stakeholders to understand the context and share risk-related information.

2. Scope, Context, and Criteria:
    - Defining the scope of the risk management process.
    - Understanding the external and internal context.
    - Establishing criteria for risk assessment.
3. Risk Assessment:
    - Risk Identification: Identifying risks that could affect the achievement of objectives.
    - Risk Analysis: Understanding the nature and level of risks.
    - Risk Evaluation: Comparing the results of the risk analysis with established criteria to determine the significance of risks.
4. Risk Treatment:
    - Selecting and implementing options for addressing risks.
    - Evaluating the effectiveness of risk treatment.
5. Monitoring and Review:
    - Continuously monitoring and reviewing risks, the effectiveness of the risk management process, and any changes in the context.

Being the most universal risk management standard ISO 31000:2018 provides a lot of benefits for the organization. It improves organizational resilience by enhancing the organization's ability to anticipate, respond, and adapt to unexpected risks. It enhances decision-making process by providing a structured approach to identify and manage risks, leading to more informed and effective decisions. It allows to increase stakeholder confidence by demonstrating a proactive approach to risk management, which can build trust among stakeholders. A ISO 31000 standard supports organization with better compliance by helping organizations comply with legal and regulatory requirements related to risk management as well as with operational efficiency by reducing losses and improves the allocation of resources by identifying and managing risks proactively (Muthuveeran et al., 2020; Parviainen et al., 2021; Argadinata et al., 2023).

ISO 31000:2018 provides a clear and comprehensive framework for managing risk that can be tailored to the specific needs of any organization. By following its guidelines, organizations can create a robust risk management system that enhances resilience, supports strategic and operational objectives, and improves overall performance.

3. Conclusions

All these concepts and standard are based on similar assumptions. The aim is to determine the relationship between the defined organizational goals and all risk management elements,

i.e. establishing the context, risk assessment, risk response and management, control activities, the principle of information and communication, and monitoring, which is carried out through continuous assessment of the achieved results. Risk management is a dynamic and integral part of organizational strategy and operations. By systematically identifying, analysing, evaluating, and addressing risks, organizations can navigate uncertainty, protect their assets, and achieve their objectives. A robust risk management process and framework not only enhance decision-making and operational resilience but also build stakeholder confidence and ensure long-term sustainability. Adopting and implementing these standards allows organizations to navigate uncertainties and achieve their objectives effectively.

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NOTIFICATIONS RELATED TO ALLERGENS IPUSTN THE RAPID ALERT SYSTEM FOR FOOD AND FEED (RASFF) IN 1984-2023

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Summary: In the period 1984-2023 in the Rapid Alert System for Food and Feed (RASFF) reported 2833 notifications of allergens (3.1% of all notifications in this system). The aim of the study was to analyse the notifications reported in the RASFF in 1984-2023 regarding allergens taking into account: hazard (allergen), product category, notification type, country of origin and notifying country. The preliminary results indicate the number of notifications under each of the listed variables. Whereas, to examine the similarities between hazards and hazard categories, two-way joining cluster analysis was used. Allergens concerned mainly the presence of sulphites in crustaceans and fruits and vegetables, milk in cocoa, coffee and tea and cereals and bakery products and gluten in cereals and bakery products. It also reported eggs, gluten, soya, milk, sulphites and peanuts in following products categories: dietetic foods, soups, broths, sauces and condiments, prepared dishes, confectionary and other food product/mixed. It is worrying that these were mainly alerts on products of European origin, i.e. from the Netherlands, the United Kingdom, Germany, Belgium, Italy, Poland, France and Spain. On the other hand, the same countries reported hazards related to allergens in the RASFF, which indicates the correct functioning of their supervisory authorities and concern for consumer safety. Further in-depth research could explore the linkages of hazards and products with countries of origin and notifying countries.

Keywords: RASFF, allergens, European Union, food safety, cluster analysis.

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1. Introduction

The Rapid Alert System for Food and Feed (RASFF) was established to ensure the rapid exchange of information between the food safety authorities of European Union (EU) member states, and the European Economic Area (EEA) more widely, in the event of a public health risk in the food chain. The RASFF was created already in 1979, however, nowadays the basis of its functioning is Regulation (EC) 178/2002 known as the General Food Law (EC, 2024b). In this system, four types of notifications are sent, i.e.: alerts, information, border rejections and news (EC, 2024a).

There were 2833 notifications on allergens in the RASFF, which accounted for 3.1% of all notifications in this system. The first notification for an allergen was made in the RASFF in 1984, but between 1984 and 2003 there were at most a few notifications per year. A clear increase in the number of notifications started in 2004 reaching more than 300 in 2019. After that, a decrease can be observed, with the most noticeable number being only about 50 notifications in 2022 and 2023 (Figure 1) (EC, 2023, 2024c). This could be due to the setting up of the Alert and Cooperation Network (ACN) in 2021, managing three networks: the RASFF, Administrative Assistance and Cooperation (AAC) and Agri-Food Fraud Network (FFN) (EC, 2024d), which has meant that information on allergens is no longer reported as frequently in the RASFF.

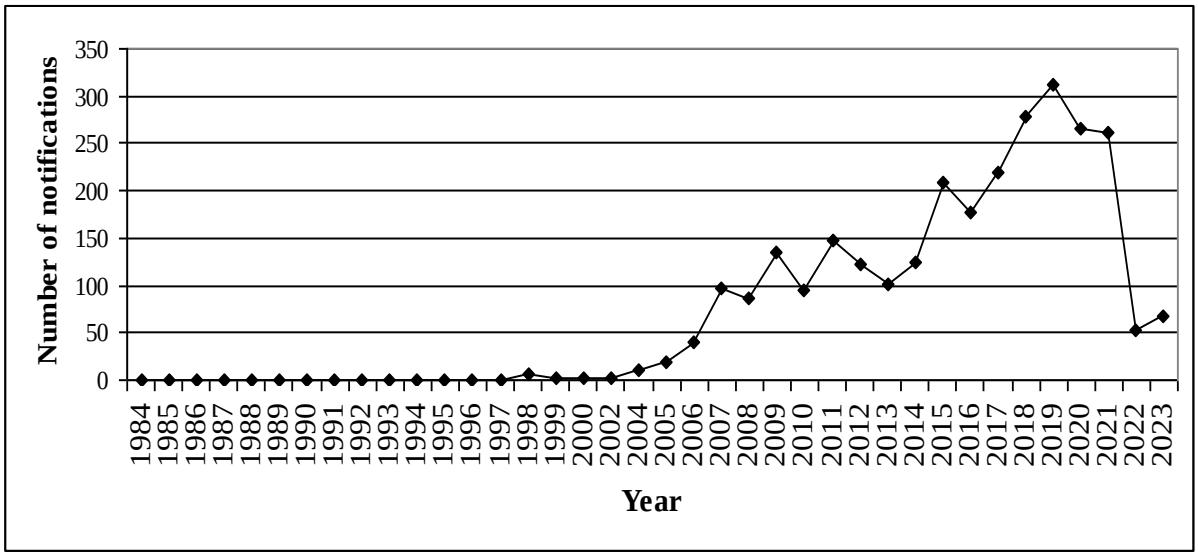

Figure 1. Notifications on allergens in the RASFF in 1984-2023

Source: own elaboration based on (EC, 2023, 2024c)

A map generated in VOSviewer, based on scientific papers with the keywords “allergens” and “European Union”, shows that their authors most often link the word “allergens” to “allergy”, “asthma” and also precisely to “food allergy” (largest elements in green). Thus, the topic addressed is of significant importance from the point of view of the health of the European consumer. Just as importantly, however, the research carried out on this issue in the last five years (i.e. after 2018) was often related to “safety”, “food safety” and “risk assessment” (elements in yellow) (Figure 2).

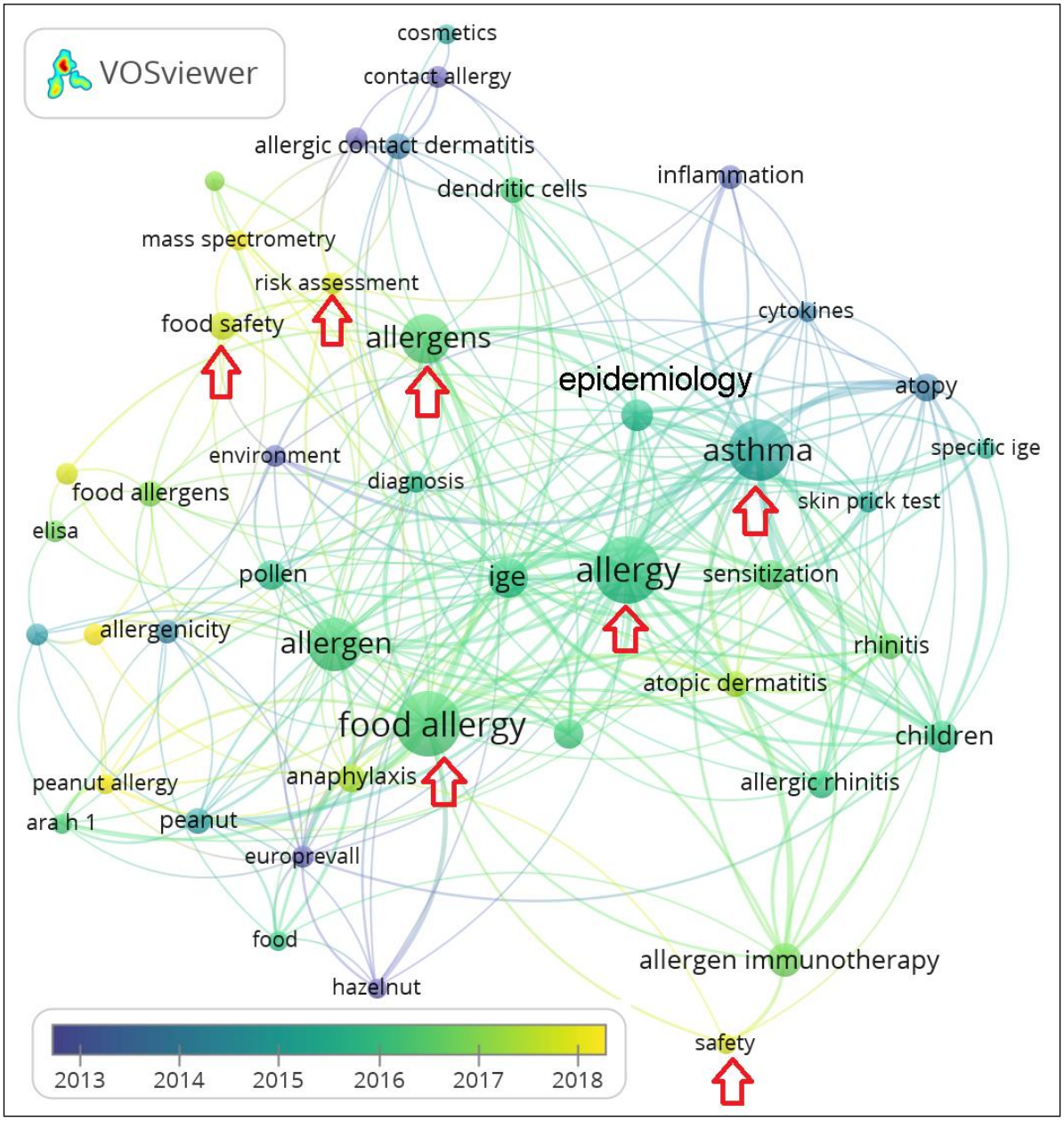

Figure 2. The overlay visualisation of the links between the keyword “allergens” and other words

Source: own elaboration

Notifications concerning allergens in the RASFF are noted by researchers, however this problem has not yet been more widely described. Therefore, the aim of this study was to analyse the notifications reported in the RASFF in 1984-2023 regarding allergens taking into account: hazard (allergen), product category, notification type, country of origin and notifying country.

2. Data and methods

The restored (archived) RASFF database contains data up to 2021 (EC, 2023). In turn, the currently available official RASFF database includes data from 2020 onwards (EC, 2024b). For the years 1984-2021, data was therefore exported from the archive database (EC, 2023), while for the years 2022-2023, data was retrieved from the currently available database (EC, 2024c). This data was then combined to obtain information on 2833 notifications relating to allergens notified between 1984 and 2023. The following variables were selected from them: hazard (allergen), product category, notification type, country of origin and notifying country. Data was processed in Microsoft Excel (Microsoft Corporation, Redmond, DC, USA) using the following functions: vertical search, filtering, sorting, transposition and pivot table.

The pivot table concerning data on allergens (in rows) and product categories (in columns) was then transferred to Statistica 13.3 (TIBCO Software Inc., Santa Clara, CA, USA) to perform two-way joining cluster analysis. It can be used when it can be expected that data included in both rows and columns can simultaneously contribute to the formation of meaningful patterns of clusters. The structure of the clusters in this method is by nature not homogeneous, however, it is believed that it can be a powerful analytical tool for data exploration (TIBCO, 2024). The results of this analysis were presented by means of a contour/discrete chart with blocks (squares) representing clusters. These were colour-coded, starting with white (smallest clusters or no clusters), through green, yellow, orange, red to brown (largest cluster) and indicating similarities in the number of notifications.

3. Results

Table 1 shows up to ten of the most frequently reported notifications concerning allergens submitted in the RASFF in 1984-2023, depending on the variable (hazard (allergen), product category, notification type, country of origin and notifying country).

Table 1.
The number of notifications concerning allergens reported in the RASFF in 1984-2023, depending on the variable

Variable	Value (number of notifications)
Hazard (allergen)	Milk (536), Sulphites (450), Gluten (290), Soya (247), Peanuts (199), Eggs (195), Mustard (141), Celery (117), Wheat (110), Almonds (81), Other hazards (467)
Product category	Cereals and bakery products (484), Prepared dishes and snacks (310), Confectionery (236), Fruits and vegetables (232), Soups, broths, sauces and condiments (215), Cocoa and cocoa preparations, coffee and tea (209), Other food product / mixed (151), Nuts, nut products and seeds (149), Meat and meat products (other than poultry) (137), Dietetic foods, food supplements, fortified foods (130), Other product categories (580)
Notification type	Alert (2110), Border rejection (89), Information (634)
Country of origin	Netherlands (316), United Kingdom (294), Germany (271), Belgium (202), Italy (186), Poland (136), France (125), Spain (121), China (110), Sweden (93), Other countries of origin (979)
Notifying country	United Kingdom (453), Netherlands (306), Italy (261), Sweden (212), Belgium (182), Denmark (182), Germany (173), Spain (150), Slovakia (121), Ireland (88), Other notifying countries (705)

Source: own elaboration based on (EC, 2023, 2024c).

Notifications associated with the first ten most frequently reported hazards accounted for 83.5% of all allergen-related notifications. The most commonly reported allergens were: milk, sulphites, gluten, soya, peanuts and eggs. They were submitted in various product categories (Figure 3).

The majority of the chart is taken up by hazards (allergens) reported in just a few notifications (white). In turn, the biggest problems are visible at the bottom of the chart and are: sulphites in bivalve molluscs and products thereof and fruits and vegetables, milk in cocoa and cocoa preparations, coffee and tea and cereals and bakery products and also gluten in cereals and bakery products (brown, orange and yellow). However, the right part of the chart occupy also notifications grouped in clusters of different shades of green, i.e.: eggs, gluten, soya, milk, sulphites and peanuts in following products categories: dietetic foods, food supplements, fortified foods, soups, broths, sauces and condiments, prepared dishes and snacks, confectionary and other food product/mixed. Milk, sulphites and peanuts were also notified in nuts, nut products and seeds. What is very worrying, however, is that the allergens were reported as alerts (three-quarters of all notifications). This means that products containing them were already on the common European market and the health risk was serious. The country reporting such risks had to initiate appropriate action (e.g. a product recall) and notify other EU member states to check whether the product was present on their markets and, if so, also initiate suitable action (EU, 2024a).

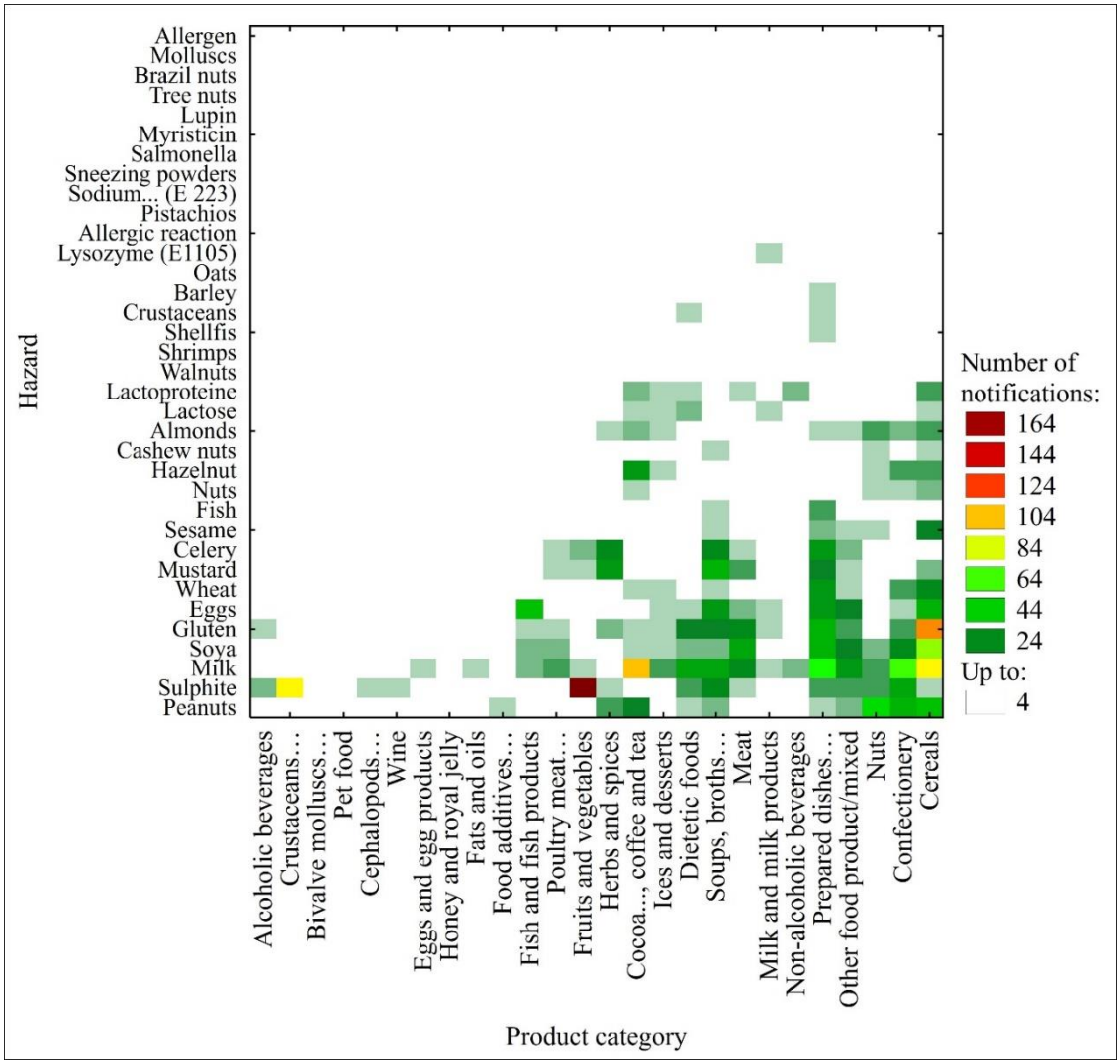

Figure 3. Results of two-way joining cluster analysis for notifications on allergens in the RASFF in 1984-2023

Full names of hazard (allergen): Sodium… (E 223) – Sodium metabisulphite (E 223)
Full names of product categories: Bivalve molluscs… – Bivalve molluscs and products thereof; Cephalopods… – Cephalopods and products thereof; Cereals… – Cereals and bakery products; Cocoa..., coffee and tea – Cocoa and cocoa preparations, coffee and tea; Crustaceans… – Crustaceans and products thereof; Dietetic foods… – Dietetic foods, food supplements, fortified foods; Food additives… – Food additives and flavourings; Meat… – Meat and meat products (other than poultry); Nuts… – Nuts, nut products and seeds; Poultry meat… – Poultry meat and poultry meat products; Prepared dishes… – Prepared dishes and snacks; Soups, broths… – Soups, broths, sauces and condiments.

Source: own elaboration based on (EC, 2023, 2024c).

This significant number of alert notifications finds its confirmation in the countries of origin of the notified products. Indeed, the reported products were mainly from the countries of the European Union, i.e. the Netherlands, the United Kingdom, Germany, Belgium, Italy, Poland, France and Spain. In turn, notifying countries were: the United Kingdom, the Netherlands, Italy, Sweden, Belgium, Denmark, Germany, Spain and Slovakia. The share of notifications reported

by all EU/EEA countries on products from all EU/EEA countries was 76.1% and on products from their own country was 34.7%. This shows the awareness of the surveillance bodies of the health risks associated with the presence of allergens in food. It is worth also noting that the United Kingdom was the most active country in terms of the number of notifications reported on allergens in the RASFF. However, following its exit from the European Union at the beginning of 2020, this country ceased to be a member of the system and therefore no longer submitted notifications between 2020 and 2023.

4. Discussion

Works related to allergens in the context of the RASFF most often only mention them, referring to the year or period and sometimes also the products (Cheftel, 2011; Uyttendaele et al., 2014; Ward, 2015; Banach et al., 2016; Mongomery et al., 2020; Kowalska and Maning, 2021; Huet et al., 2022). Other studies provide slightly more detailed information, including not only the period but also the specific allergen(s) and sometimes the products (Table 2), but rarely additional information.

Table 2.
Studies on allergen(s) reported in the RASFF by year(s) and product(s).

Year(s)	Allergen(s)	Product(s)	Reference
2004-2007	Gluten, Milk, Nuts, Soya	–	(Poms et al., 2010)
2009-2010	Allergen produced by *Anisakis*	Fish	(Vidaček, 2014)
2011-2014	Crustaceans, Eggs, Fish, Gluten, Milk, Nuts, Soya, Sulphites	Cereals and bakery products, Cocoa, coffee and tea, Confectionary, Fruits and vegetables, Prepared dished and snacks, Soups, broths, sauces and condiments	(Bucchini, 2016)
2011-2017	Eggs, Gluten, Milk	Cereals and bakery products	(Soon et al., 2020)
2012	Gluten/Wheat	–	(Pegels et al., 2015)
2015	Gluten/Wheat	–	(Rzychon et al., 2017)
2015	Gluten/wheat, Milk, Tree nuts	–	(Gendel, 2018)
2015	Histamine, Sulphites	–	(Ismail and Nielsen, 2017)
2016-2020	Gluten, Milk, Soya, Tree nuts	–	(Civera et al., 2023)
2018-2021	Milk (lactose and lactoprotein)	Cereals and bakery products, Dishes and snacks, Cacao and confectionary products	(Martínez-Pineda and Yagüe-Ruiz, 2022)
2019	Gluten, Milk, Soya	–	(Segura-Gil, 2022)
Before 2020	Milk	Cereals and bakery products	(Martínez-Esteso et al., 2020)
Before 2020	Milk	–	(Cordeiro et al., 2021)

Source: own elaboration

The most commonly indicated allergens in RASFF notifications included: gluten, milk, soya and nuts; eggs and sulphates were also listed. As far as products are concerned, cereals and bakery products, dishes and snacks as well as cocoa and confectionery products were mentioned in particular. Cucu et al. (2012) drew attention to hazelnut food contamination reported in the RASFF. They noted that inadvertent exposure to allergens present in these nuts is caused by carryover, inadequate cleaning of common processing equipment or reworking of products containing allergens.

The allergens and products pointed out are consistent with those identified in this study (Table 1 and Figure 1). It is worth noting, however, that the authors of the individual research identified the most frequently notified allergens and the most frequently reported products separately, so they do not always correspond with each other. Whereas the present study shows these relationships, as well as the similarities (Figure 1).

5. Conclusions

Between 1984 and 2023, there were 2833 notifications of products containing allergens in the Rapid Alert System for Food and Feed (RASFF), representing 3.1% of all notifications in the system. The aim of the study was to analyse the notifications reported in the RASFF in 1984-2023 regarding allergens taking into account: hazard (allergen), product category, notification type, country of origin and notifying country. The most frequently reported were: sulphites in fruits and vegetables and crustaceans, milk in cocoa, coffee and tea and cereals and bakery products and gluten in cereals and bakery products. It also submitted eggs, gluten, soya, milk, sulphites and peanuts in: dietetic foods, soups, broths, sauces and condiments, prepared dishes, confectionary and other food product/mixed.

The mentioned products were reported mainly with alerts and originated from European countries: the Netherlands, the United Kingdom, Germany, Belgium, Italy, Poland, France and Spain, which is particularly worrying due to the common market. However, products in question were notified mainly by similar countries, i.e.: the United Kingdom, the Netherlands, Italy, Sweden, Belgium, Denmark, Germany, Spain and Slovakia, which means that appropriate authorities are aware of the hazards associated with allergens. Nevertheless, further vigilance and cooperation of control authorities in this area is needed, and consumer awareness of the detailed composition of available food products needs to be developed. Further research could look at linking particular hazards and products to countries of origin and notifying countries.

There are also some limitations to the study carried out. During the study period, new member states joined the European Union, which may have increased the number of

notifications concerning allergens. In turn, the exit of the United Kingdom from the EU and changes in the RASFF related to the move of notifications related to these hazards to other systems may have contributed to a decrease in this number.

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Summary: The gastronomic market is quickly evolving and must adapt to constantly changing consumer preferences. Responding to these changes is crucial for maintaining competitiveness in the market. The objective of this paper is to identify the factors that influence consumer choices in the gastronomic market. This includes understanding the main reasons people choose certain dining places and the negative aspects that affect their decisions. Based on literature and our own research, the main factor influencing the choice of a dining establishment is food quality. Other important factors are opinions and reviews, as well as location. The primary factors that discourage visits to a particular restaurant, bar, or cafe are improper behavior and lack of interest from the staff. Guests also pay attention to cleanliness in establishments the hygiene of the staff. The research indicates how factors such as taste, smell, freshness, and food presentation affect food quality. Owners need to continuously monitor market trends and consumer preferences to effectively meet their needs. As a result, the gastronomic market is becoming more innovative and diverse, contributing to its further development and stabilization.

Keywords: food quality, guest satisfactions, dining choices

1. Introduction

The gastronomy market is evolving rapidly, responding to changing consumer preferences and expectations. In recent years, there has been a significant increase in the number of dining establishments, diversity of services offered, and revenue within the gastronomy sector.

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Financial results from restaurants have indicated a 19 percent increase in revenue in the first three months of 2023 and a further 17 percent in the second quarter compared to the same periods in 2022 (*Rynek*…,2023). To achieve the required food quality, it is crucial to consistently identify and enhance the factors that define quality (Konuk, 2019). It's important to identify what guests find valuable and implement specific actions to attain the expected outcomes (Gagić et al., 2015).

The food industry, particularly restaurants, has been increasingly challenged to satisfy the needs, wants, and demands of modern food consumers (Souki et al.,2020). This is because customers have grown more educated, mindful, selective, and demanding in their search for restaurants that serve healthy, fresh, natural, and tasty foods (Tariq et al., 2019; Sultan et al., 2018). Food quality plays a crucial role in the food service industry. Many researchers have studied various aspects such as taste, texture, color, food presentation and ingredients. They observed that customers often return to a restaurant due to its high food quality. In various studies, both fast-food and restaurants consistently rank food quality as the primary reason for customers deciding to revisit (Kumar, 2017). According to Kannan (2017), food taste and presentation play a significant role in the dining experience, positively influencing customer satisfaction and behavioral intentions. Quality attributes of food include elements such as the taste of the dish, color, flavor, texture, temperature, portion size, ingredients, the quality of the serving, decoration, and the presentation of the food (Bisui et al., 2022). The key factors influencing restaurant choice include also level of service, location, and interior design. Also important are opinions and reviews on social media and review platforms (*Rynek*…,2023).

In addition to food quality, attention should also be paid to the experiences related to the quality of service that the guest experienced from the restaurant staff (Hu et al.,2020). Apart from the quality of food and service, the restaurant also emphasizes the professionalism of its staff. Competence, politeness, and the staff's professional conduct towards guests are crucial components of overall quality. Restaurant owners and managers must recognize the significance of the chef, who is responsible for the taste, presentation, aroma, and overall quality of the food served. Equally important are the waiters, as they play a crucial role in the restaurant's quality by being in direct contact with the guests (Conić et al., 2023). Customer satisfaction in restaurant services is a blend of various elements such as food and beverages, employee behavior and attitude, food service, and the overall environment. Specifically, the satisfaction or dissatisfaction of customers, stemming from their interactions with employees, is influenced by the behavior of the staff. (Alhelalat et al., 2017) Furthermore, Medeiros and Salay (2013) noted that employee attitude and friendliness have a significant impact on customer satisfaction in the foodservice industry. The guests' experience with staff quality is significantly impacted by the cleanliness and tidy appearance of employees, along with their appropriate uniforms (Shokhsanam, 2021).

The quality of the restaurant's physical environment significantly impacts guests' restaurant choices, contributing to the overall success of the business (Zhong, 2020). The world's most prestigious restaurants are known for their distinctive look, recognizable visual style, and an atmosphere. These factors significantly enhance the desire to return to a particular restaurant and recommend it to others. (Savić, 2020). In recent years, the restaurant industry has also focused on creating aesthetic experiences for its guests. Aesthetic attractiveness includes not only the appearance of dishes served but also the environment, decor of the venue, appropriate music and lighting (Horng, 2020).

Restaurants base their products and services on the assumption that guests are mainly interested in offerings that are accessible and reasonably priced. The pricing significantly influences how guests perceive the overall value they receive. A positive perception of the price often leads to a higher likelihood of guests choosing to dine at a particular restaurant. (Conić et al., 2023).

The development of social media has led many businesses in the gastronomy industry to engage in such activities. Social media has increasingly impacted people's decision-making processes, enabling organizations to influence consumer decisions and behaviors (Hegyesné Görgényi, 2017). Customers increasingly provide real-time feedback through online portals about what they like and what needs improvement in a particular establishment. Favorable reviews shared by customers and self-published photos can contribute to spreading positive feedback about a specific gastronomic venue (Kieżel, 2018).

Research conducted by Kantar Polska in 2022 indicates that health and environmental issues are becoming increasingly important. This includes the availability of vegetarian and vegan dishes, as well as the use of local and organic products. The "Gastronomy in Poland 2023" report highlights that the COVID-19 pandemic has significantly altered consumer habits. Many consumers now pay greater attention to hygiene standards and prefer the option to order takeaway or delivery food (*Rynek*…,2023).

2. Methodology and Results

The aim of the study is to identify factors influencing consumer purchasing decisions in the gastronomic market. This includes primary motivations influencing the choice of dining establishments as well as negative factors impacting purchasing decisions. The research was conducted using a direct survey method with an online form. The survey was conducted among 276 respondents in the city of Krakow.

Over 90% of the respondents had higher education. The majority of respondents (89.1%) reported living in cities with populations over 100,000. About 9.1% of respondents live in rural areas, and 1.8% in cities with a population of less than 100,000. There were more male (52,2%) than female (47,8%) participants in the study. Data were collected from all age groups, with the largest group being respondents aged 30-40, 59.8% of all respondents belonged to this group. The next two largest groups were people aged 20-30 (22.5%) and 40-50 (14.5%). The least represented groups (0.7%) were respondents aged 50-60 and over 60 (Table 1.).

Table 1.
Characteristic of the respondents

Specification	Participation [%] *n=276*
Sex	
women	47,8
men	52,2
Age of respondents	
less than 20	1,8
20-30	22,5
30-40	59,8
40-50	14,5
50-60	0,7
more than 60	0,7
Level of education	
primary education	0,4
vocational education	3,6
secondary education	5,4
higher education	90,6
Place of residence	
rural areas	9,1
City under 100,000 inhabitants	1,8
city over 100,000 inhabitants	89,1

Source: own research

The vast majority of respondents use food service establishments several times a month (52.5%) and several times a week (30.8%). In turn, 8% of respondents indicated that they visit once a week, while 6.1% use food service establishments once a month or less frequently. Only 2.5% of the respondents use food service establishments daily.

Respondents mainly use food service establishments on weekends (64.1%), while 33.9% of respondents use them from Monday to Friday. Exactly half of the respondents visit food service establishments in the evening, 47.8% in the afternoon, and only 2.2% in the morning.

The amount respondents spend at a food service establishment is typically between 80-120 PLN per person during a single visit (36.2%). Subsequently, respondents indicated amounts in the ranges of 40-80 PLN (28.6%), 120-160 PLN (18.1%), and 0-40 PLN (10.5%). More than 160 PLN per person during a single visit is spent by 6.5% of respondents.

There are many reasons for using food service establishments. The main reason survey respondents visit these establishments is social occasions. More than half of the respondents (54%) chose this answer. A large group of consumers indicated having a meal during work breaks (15.6%) and a lack of time or motivation to cook (16.3%) as their primary reasons. Some respondents use food service establishments for business meetings (5.8%). Consumers also indicated the willingness to eat out (4.7%) and a lack of culinary skills (3.6%).

Respondents chose Italian cuisine as the most preferred type of cuisine (76.8%). American cuisine (9.1%) and traditional Polish cuisine (8%) are less popular. Respondents also mentioned Mediterranean cuisine (1.8%), Japanese cuisine (1.4%), and Chinese cuisine (1.8%).

The study showed that the quality of the served dishes had the greatest influence on the respondents' choice of a food establishment. More than half of the respondents (50.4%) indicated quality as the main factor influencing their choice. Other important factors included reviews and opinions (12.3%), location (9%), and menu variety (5.8%). For 5.4% of respondents, the waiting time for the order was the main factor. The price of the offered dishes and the level of service were the most important factors for 4.3% of respondents.

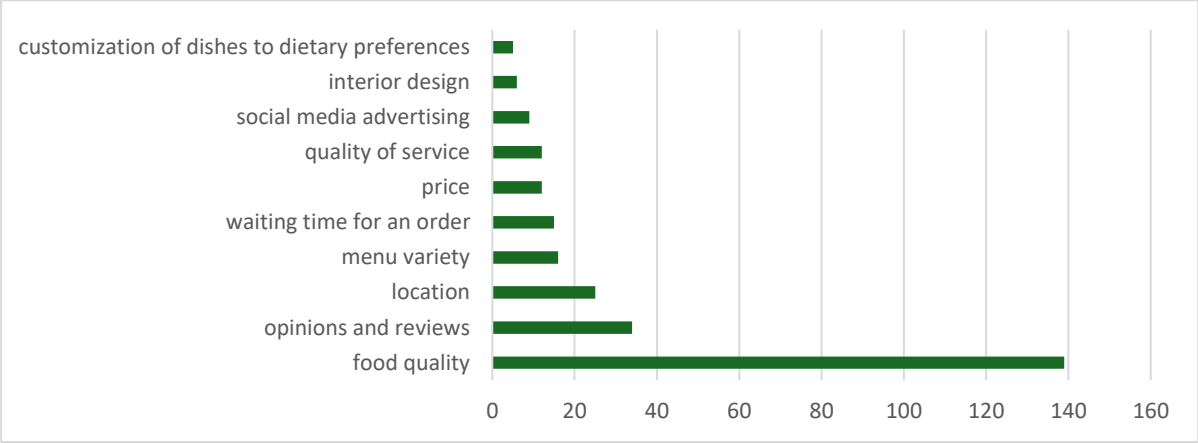
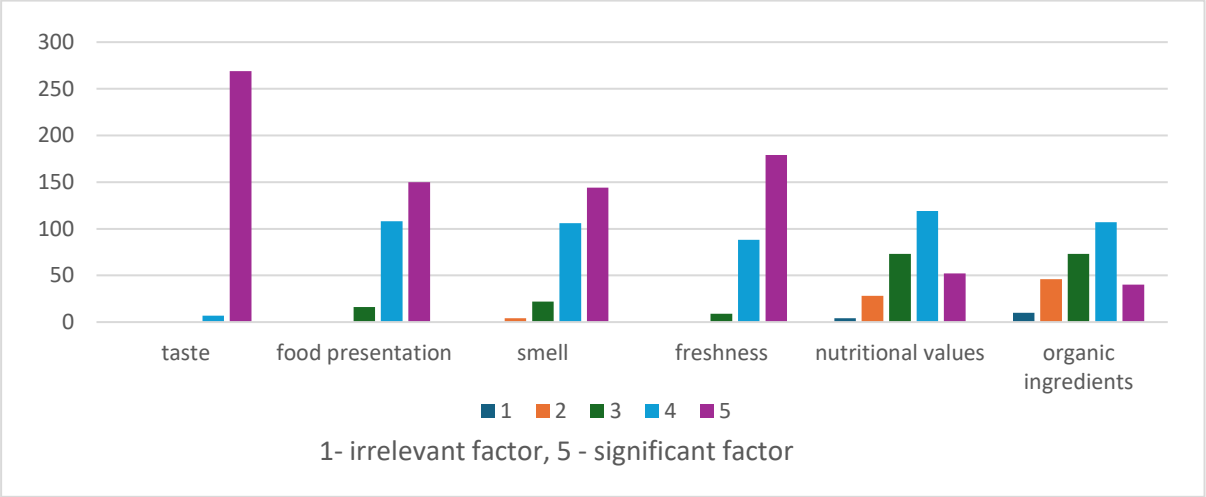


Figure 1. The main factor influencing the choice of a dining establishment

Source: own research

Respondents also answered a question about the importance of factors such as taste, food presentation, smell, freshness, nutritional values, and organic ingredients on the quality of dishes. The study showed that almost all respondents considered taste a significant factor. Taste achieved an average importance rating of 4.97 on a 5-point scale, where 1 = irrelevant factor and 5 = significant factor. The next factors were freshness (4.62), food presentation (4.46), and smell (4.41). Respondents considered nutritional values (3.68) and organic ingredients (3.44) to be less important factors.



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Among the main reasons that discourage visiting a particular food establishment, respondents indicated a lack of interest from the staff (44.6%), rudeness and impolite behavior of the staff (37.3%), poor hygiene (15.6%). Additionally, respondents mentioned the staff's lack of knowledge about menu items (1.1%) and long waiting times for orders (1.1%).

Respondents were also asked what they most miss in existing food establishments. The most popular answer was the ability to change ingredients in dishes (55.4%) and the ability to customize dishes to diets (e.g. availability of vegetarian, vegan, gluten-free, lactose-free options) - 12.7%. Respondents also mentioned no delivery options (11.2%) and the lack of WiFi access (10.1%). Only 6.9% of respondents noted that gastronomic establishments lacked play areas for children and this response was given 100% by women. Survey respondents indicated that they would gladly visit places that offer information on the caloric value of dishes in the menu or pet-friendly and adults-only places.

3. Conclusions

Research indicates that consumers are increasingly opting to use food service establishments, which contributes to the dynamic growth of the entire industry. The rise in popularity of these establishments results from dynamic changes in consumer preferences and a growing number of people preferring convenient dining options in the city. This clearly demonstrates the growing role of gastronomy in the economy and its ability to adapt to the changing needs and expectations of customers.

Consumers tend to visit food service establishments, especially on weekends, when social gatherings and opportunities to spend time with loved ones become the main motivation to use the services of restaurants, bars, or cafes. This trend shows that gastronomy not only meets culinary needs but also plays an important social role, creating spaces for relaxation, conversation, and celebration. Food establishments are becoming places where people can not only enjoy good food but also build relationships and enjoy shared experiences. Consumers are also increasingly visiting food service establishments during work breaks, mainly due to a lack of time or motivation to cook their own meals. This is a result of a lifestyle that increasingly demands quick and convenient dining solutions. Food service establishments offer quick access to a variety of dishes, satisfying the need to eat something tasty while relieving consumers of the duty to cook. Additionally, restaurants, bars, and cafes are becoming places for business meetings and informal conversations, making them attractive spaces for work and relaxation outside the home.

According to the study, the quality of dishes remains a key factor determining the choice of a specific food establishment by customers. Customers primarily consider taste, freshness, and the careful preparation of dishes. Similar results were found in studies conducted by GFK, as cited by Kieżel (2018). Reviews and opinions of other customers are also significant. Positive recommendations can greatly influence consumer decisions, while negative reviews can deter potential guests. Therefore, restaurant, bar, and cafe owners are increasingly focusing not only on the quality of food but also on ensuring positive customer experiences, which translates into the reputation and popularity of their establishment.

Based on responses to the question regarding the main factor in choosing a food service establishment, it can be inferred that for most respondents, the quality of service is not a priority. However, the importance of service becomes evident when respondents consider factors that might discourage them from visiting a restaurant. Over 80% of respondents agreed that inappropriate behavior by staff significantly influences their decision about choosing an establishment. Another important discouraging factor is the lack of cleanliness in the establishment. Similar studies were conducted by Gębowiec (2018). The surveyed group indicated that a lack of cleanliness in the establishment is more important than a lack of interest

from staff and impolite behavior by the personnel. Comparing these studies, the increasing influence of service quality on the perception of food establishments can be observed. This is also confirmed in the literature on the subject (Conić et al., 2023; Alhelalat et al., 2017).

According to the respondents, food service establishments lack the ability to modify ingredients in dishes and adapt the menu to various diets. The ability to customize dishes according to individual customer preferences, including ingredient substitutions, is increasingly desired, especially among people with allergies, food intolerances, or those preferring specific diets such as vegetarian, vegan, or gluten-free. The absence of these options may limit accessibility for a broad range of consumers seeking flexibility and personalization in their meal choices. Introducing such amenities could significantly improve customer experiences, increasing their satisfaction and loyalty.

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QUALITY OF COMMUNICATION IN SOCIAL MEDIA IN SELECTED AIRPORTS

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Summary: In the era of the development of internet technologies, social media has become a key communication tool for airports. The aim of this article is to analyze the quality of communication of selected Polish airports on social media and to evaluate their activities based on established criteria. The study attempts to answer the question of whether the way airports communicate on social media is sufficient. The research is based on the analysis of content published on social media. Data was collected from official profiles on platforms such as Facebook, Twitter, Instagram, YouTube, and TikTok. The results indicate differences in the quality of communication. Larger airports better utilize available technologies and communication tools. The findings suggest that effective communication on social media can significantly impact the image and competitiveness of airports.

Keywords: quality of communication, social media, airports

1. Introduction

In the modern economy, an important aspect of the functioning of any organization is the effectiveness of its communication activities. The development of the Internet has provided airports with the opportunity to communicate with customers through multiple channels.

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Airports now use websites, social media, mobile apps, and even regular email to communicate and conduct business with their customers (Halpern & Regmi, 2013). Although websites are still quite common, businesses are increasingly recognizing the potential of social media. As a result, they take specific actions to establish a presence on these platforms, using them as channels for customer service, advertising products and services, and increasing their audience reach. This, in turn, helps them grow their market share and impacts their revenues (Wattanacharoensil & Schuckert, 2015). It is anticipated that the role of social media will continue to grow, making it important to actively incorporate them into business practices.

In light of this, it is worthwhile to ask about the possibilities of building a competitive advantage for airports based on the quality of communication in social media. Consequently, the following research questions have been formulated:

- Is the way airports communicate on social media sufficient compared to the current communication capabilities of the Internet?
- To what extent does the communication of airports differ from that of airlines?
- Can the size of an airport affect the quality of communication?

The scientific literature contains many studies focusing on communication in social media, but few of them concentrate on the quality of communication. Therefore, this study aims to verify which factors can be considered as significantly influencing the quality of communication in social media based on the conducted research.

The purpose of this article is to analyze the communication activities of selected Polish airports on social media and assess their quality based on established criteria.

2. Literature Review

The quality of communication is a crucial element in many areas, including business and everyday life. In scientific literature, various studies address different aspects of communication quality, which can be defined in numerous ways depending on the context.

Cohen et al. (2021) studied the quality of communication among healthcare workers to improve communication and the quality of healthcare, aiming to prevent adverse events related to information transfer errors and oversights. Meanwhile, Mazur et al. (2023) conducted research on the quality of communication between patients and medical staff from the perspective of doctors and nurses, with the goal of enhancing the communication skills of healthcare workers. In both cases, the authors note that despite many studies on medical communication, few have focused on the quality of communication. Anggoro (2020) examined

communication issues between Indonesian and Thai nursing students, demonstrating that language and cultural barriers can affect communication quality.

According to Hollebeek (2014), communication quality refers to the extent to which communication is clear, accurate, relevant, and effective in achieving intended goals. High-quality communication ensures that the message is easily understood and that appropriate actions can be taken based on it. Therefore, businesses communicate with the market to elicit specific reactions, such as behaviors and attitudes from potential customers (Wiktor, 2012).

Research conducted in various fields demonstrates that the quality of communication can be multidimensional and dependent on the studied environment. Bembenek (2017), in his research on the quality of marketing communication within clusters (i.e., concentrated groups of organizations), considered factors such as:

- the prevalence of using a common internal communication network;
- the exchange of market information among cluster members;
- promotional activities;
- exhibition and trade fair activities;
- contacts and presence in the media;
- regular meetings of members or integration events;
- internal cluster press (including newsletters);
- publications in foreign languages (industry materials, catalogs, press);
- promoting pro-ecological behaviors;
- the market significance of the cluster's brand.

The quality of communication on social media is a crucial element of contemporary companies' marketing strategies. Effective communication on social media can significantly impact consumer engagement, brand relationship building, and ultimately, purchasing decisions. The quality of communication on social media refers to how effectively a brand conveys its message to its audience (Hollebeek et al., 2014).

According to research published by Hollebeek (2014), key elements of communication quality on social media include interactivity, authenticity, content relevance, and audience engagement. Studies show that content that is more interactive and authentic generates higher user engagement. On the other hand, Ashley & Tuten (2015) propose various metrics for evaluating the quality of communication on social media, such as engagement metrics (e.g., number of likes, comments, shares), content reach, and the quality of interactions with users.

Despite the availability of publications describing communication quality, it has not been sufficiently characterized in the context of social media. Nonetheless, various authors have studied its individual elements that impact quality. Based on the available literature, we can distinguish the following criteria for assessing communication quality on social media (Ashley & Tuten, 2015; Reda & Zellou, 2023; Thomas & Dittman, 2016):

- credibility and quality of information sources - the information sources should be reliable, with accurate, up-to-date information supported by evidence;
- user engagement and interactions - this includes the number of likes, comments, shares, and other forms of interaction;
- consistency and clarity of communication - maintaining a uniform communication style and ensuring messages are clear and understandable;
- frequency and regularity of publication - regular content posting helps maintain audience interest;
- visual quality and aesthetics - high visual quality of content, including photos and videos, and aesthetically pleasing posts consistent with the brand image;
- accessibility and audience adaptation - personalizing content and tailoring messages to specific audience groups, including publishing content in different languages and considering diverse cultural perspectives;
- speed and effectiveness of response - the response time to user questions and comments and the efficiency of those responses;
- content relevance and substantive value - content should be relevant and interesting to the audience, providing valuable information.

Lupa-Wójcik (2015) points out that for a company, communication quality is expressed through its impact on specific consumer decisions. For recipients, communication quality equates to the level of satisfaction it provides in meeting their expectations. Rogala (2013) notes that the most frequently cited definition of communication quality in literature combines the categories of effectiveness, efficiency, and proficiency.

Aubert et al. (2013) define communication quality as the extent to which the provided information is complete, reliable, accurate, and purposeful, as well as the quality of form, which includes delivering information in a timely manner, with the appropriate level of openness and formality, tailored to the audience, and maintaining bidirectionality. Service (2005) emphasizes that ensuring communication quality is crucial for the listener to understand the speaker's intended message, not just the transmission of the message itself.

It is also important whether the communication was conducted in a user-friendly manner (Park et al., 2014), as the form of communication can be as important as its content (Aubert et al., 2013). Shelby (1998) identified the following components of communication quality: attribute quality, correctness (technical quality), audience adaptation (functional quality), and norm-based preferences (aesthetic quality). However, the literature most often presents a multidimensional view of communication quality, as proposed by Zaremba (2006), who identifies five basic criteria of communication quality: timeliness, clarity, accuracy, relevance, and credibility.

3. Research Methodology

As part of the study, a literature review and an analysis of currently available communication solutions on social media platforms were conducted. Based on the established criteria for assessing communication quality, a review of the social media activities of the examined companies was performed. The research methods included content analysis, interaction analysis, and comparative analysis. The analysis focused on the number of followers on social media profiles, the amount of published content, user interaction, and the possibility of communication via chat.

The basis for addressing this topic comes from the results of a survey conducted from July to September 2023, in the form of an online questionnaire among a group of 102 air travelers. When asked about communication on social media, 65% of respondents indicated that this type of communication from airports provides additional value for them.

The study focused on the social media profiles of Warsaw Chopin Airport, Krakow Airport, and Rzeszow Airport, and observed their activities on social media. The selection of these airports was based on two criteria: the first being revenue, with the chosen airports generating the highest income from their operations in 2022 (*Raport…*, 2023). The second criterion was the classification of airports into three categories: central airport, major national airports, and regional airports.

To better illustrate the social media activity of the airports, a comparison was made with the activity of the only Polish airline, LOT Polish Airlines.

4. Results

For the purposes of the study, an analysis of the social media presence of the examined companies was conducted as of April 11, 2024. First, the information on official websites regarding social media presence was verified to confirm the credibility and quality of the information sources. Among the airports, Krakow Airport stands out the most, with its website containing links to five platforms (YouTube, Facebook, X, Instagram, and LinkedIn), similar to LOT Polish Airlines. Warsaw Chopin Airport has links to YouTube, Facebook, and X on its website, while Rzeszow Airport only has links to YouTube and Facebook. Profiles on other platforms that were not listed on the websites were found through links provided in their social media accounts. All found profiles indicated that they were official accounts, except for the Rzeszow Airport profile on TikTok. The content posted there suggests that the profile is managed by the airport, but without official confirmation, it cannot be considered a reliable

information source. Next, the number of followers on each account was checked, and the collected data is presented in Table 1.

The analysis indicates that the most popular communication channel with the largest number of followers for the largest airport in Poland - Warsaw Chopin Airport is the platform X (formerly Twitter). For the other examined companies, their profiles on Facebook have the most followers. This is not surprising, as Facebook is the most popular social networking service for both individual and business users. This is also confirmed by the studies of Pabisek (2016), which describe Twitter and Facebook as the most popular social networking services used by airports.

Table 1.
Number of Followers on Social Media Profiles as of April 11, 2024

	Warsaw Chopin Airport	**Krakow Airport**	**Rzeszow Airport**	**LOT Polish Airlines**
YouTube	6 880	1 350	511	21 400
Facebook	136 000	69 000	40 000	376 000
Twitter	221 100	14 900	1005	13 600
Instagram	37 400	8 450	3392	105 000
LinkedIn	12 000	3 000	3 000	67 000
TikTok	14 600	---	3 100	---

Source: own study

Among the platforms frequently used by airports are also Instagram and LinkedIn, while YouTube and TikTok are used sporadically or not at all, which is noticeable by the number of posts and followers on these profiles.

As part of the study, the activities of selected airports on social media were reviewed, along with the number of published materials in the first quarter of 2024. The number of posts serves as a basis for assessing user engagement and interaction, and consequently for evaluating quality. The analysis covered activities on YouTube, Facebook, Twitter, Instagram, and TikTok. LinkedIn was excluded from the analysis due to the inability to accurately estimate the publication dates of content. The collected data is presented in Table 2.

Warsaw Chopin Airport, as the largest airport in Poland, did not show proportionally greater activity relative to the number of passengers served compared to LOT Polish Airlines and Krakow Airport during the studied period. However, the activity of Rzeszow Airport was noticeably lower than the others. On TikTok, the profile "@rzeszow.airport" posted only two new materials during the study period, and there is no confirmation from the airport whether this is an official channel. It is also concerning that there are no responses to users' questions under the posted materials, indicating a lack of regularity, credibility, and efficiency in communication, which affects the quality of communication. In contrast, the profile of the

Warsaw airport shows better results, publishing more materials and interacting with users under the posts.

Table 2.
Number of Posts Published in Q1 2024

	Warsaw Chopin Airport	**Krakow Airport**	**Rzeszow Airport**	**LOT Polish Airlines**
YouTube	15*	4	0	34*
Facebook	139	97	53	130
Twitter	104	202	16	89
Instagram	37	43	44	72
TikTok	20	---	2	---
Total Posts	315	346	115	325
Number of passengers served in 2023	18 472 491	9 399 281	1 020 189	10 027 734

* *The number includes video materials and shorts*

Source: own study

On YouTube, each of the examined enterprises has a profile. However, LOT Polish Airlines stands out in terms of activity and communication. Videos are published systematically, from once to several times a month, with clear thematic content and substantive value. The videos include English subtitles, and some are published entirely in English. The materials are informational and promotional. This is different for the examined airports, where materials appear sporadically. The published content lacks consistency and regularity. For instance, Krakow Airport posts a new video once a month, mostly containing seasonal holiday greetings, which do not provide substantive value. The least active is Rzeszow Airport, which did not post any material during the studied period. Warsaw Chopin Airport also publishes videos rather sporadically but compensates by posting short "shorts" videos similar to those on TikTok.

Twitter, which has been business-oriented for years, is becoming increasingly popular among regular users. Krakow Airport stands out with the most publications on Twitter, posting several entries daily, similar to Chopin Airport and LOT Airlines. Informational posts in English also appear on their profile. Conversely, Rzeszow Airport is the least engaged on this platform, publishing only a few entries monthly.

Instagram, as a tool commonly used for sharing information through photos and short stories, finds its application in the international communication of the studied enterprises. The quality of communication in this case can be indicated by the descriptions of the analyzed profiles, which are in English, showing a focus on foreign audiences. The visual quality is also noticeable; however, there is a lack of a consistent theme and color scheme in the posted

content. On this platform, LOT Polish Airlines performs the best, standing out with the highest quality photos and the number of interactions.

The primary and most frequently used communication channel with users is Facebook. Content on this platform is most frequently commented on and liked by users. The posted content includes information about flight connections, news, and current activities. Users eagerly engage by reacting and commenting on the added materials, but they do not always receive responses to their questions asked in the comments. For Krakow Airport, many comments in the form of questions remained unanswered during the study period. A similar situation is observed for Rzeszow Airport. Posts are liked and commented on enthusiastically, but only a small number of inquiries receive responses, which could result in user dissatisfaction.

The situation is different for Warsaw Chopin Airport and LOT Airlines. Responses to user comments are quite frequent, even if they are not direct questions. There are also instances of commenting on each other's content, which constitutes a form of cross-marketing. However, such comments on Krakow Airport's posts often go unanswered.

It is also worth noting that Warsaw Chopin Airport has a second Facebook profile conducted exclusively in English, though it is unclear whether this is an official profile.

Facebook's communication capabilities include not only commenting and reacting to posts but also direct contact via chat or Messenger. Therefore, an attempt was made to investigate the response time of the examined enterprises by sending a query to each one. Chopin Airport in Warsaw responded in 47 minutes, Krakow Airport in 95 minutes, while Rzeszow Airport took over 4 business days to respond. LOT Polish Airlines, however, provided an immediate response thanks to a chatbot that allows selecting the conversation language, including English, thus accommodating foreign audiences while maintaining bidirectional communication. Such actions contribute to high communication quality by providing quick and effective responses.

5. Summary

This study provides original insights into the quality of communication on social media, particularly that conducted by airports. The analysis revealed differences in the quality of communication conducted by airports, taking into account the technological capabilities currently offered by social media. Larger airports, such as Warsaw Chopin Airport, use social media in a more advanced manner, allowing for more effective communication and better audience engagement. They publish more materials, engage their users more efficiently, and provide better visual quality. However, there are still areas for improvement, especially when

compared to the profiles managed by airports, as noted in the study by Antczak & Huderek-Glapska (2020), which indicates that the marketing activities of the LOT Polish Airlines on social media demonstrate an insufficient utilization of their potential.

Communication conducted through chat, among other methods, addresses the needs of the modern passenger who requires immediate contact, especially in crisis situations where social media can become a virtual customer service center. However, this study indicates that airports are not sufficiently prepared for this. Pabisek (2016) also highlights this in her study, warning that without ensuring adequate quality, airports cannot quickly respond to crisis situations. Similarly, Akyol et al. (2016) recommend more informal communication with stakeholders, as a formal communication style can sometimes hinder close contact between passengers and the airport.

The study also confirms that airport communication differs from that of airlines, which often have more developed strategies and budgets for social media activities. Szymczak (2018) notes that this may be because airlines have historically invested more in online communication, allowing them to build and maintain relationships with passengers at every stage of their journey. Martin-Domingo et al. (2019) present a different perspective, stating that social media is more frequently used by North American airports, larger airports, and those managed by private companies. Furthermore, Díaz & Consuegra (2016), analyzing airline websites, found that the aviation industry comprises three distinct business segments: influential, follower, and passive, which could be compared to the airport classification criteria presented in this study.

The results indicate that the size of an airport impacts the quality of communication on social media. Larger airports have better resources, translating to higher quality and efficiency in their activities. Conversely, smaller airports, such as Rzeszow Airport, despite being active on social media, often do not achieve the desired effectiveness and communication quality.

Despite the noticeable activity of airports on social media, there are areas that require improvement in communication quality, as they affect brand perception and passenger choice of the airport (Spyra & Witczak, 2017). This, in turn, influences the revenues generated, which can account for over 60% of income from non-aviation services (Wilczyńska-Strawa, 2022). Marketing communication tools are a strong showcase and can be an effective element in building a competitive advantage (Szymczak, 2018).

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KNOWLEDGE REGARDING CIRCULAR ECONOMY STANDARDS IN COMPANIES WITH AN IMPLEMENTED QUALITY MANAGEMENT SYSTEM

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Summary: The aim of the study was to assess the level of knowledge concerning the circular economy standards, namely BS 8001:2017 and XP-X30-901:2018. Based on questionnaire, 100 organizations from Poland was studied. The main assumption for the organizations was the implementation and certification of management system complained with the requirements of such standard as ISO 9001, ISO 14001 or ISO 45001.The main conclusion from the study is, that surveyed respondents are unlikely to know the requirements of both the BS 8001:2017 and XP-X30-901 standards. The research was conducted before the publication of the ISO series of 59000 standards. There is a chance, that international standard concerning the circular economy will be more recognizable by organizations that national standards that were introduced in the past.

Keywords: circular economy, management system, ISO 9001, ISO 59000

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1. Introduction

Although there was a breakthrough in the 1960s in the approach to the environment and its connections to socio-economic development, the dominant economic model is still the linear model, which relies on the exploitation of cheap raw materials and energy without reusing waste (Özkan et al., 2020). This model leads to material value chain losses, shortens product lifespans, generates excessive waste, and contributes to ecosystem degradation (Korhonen et al., 2018). Therefore, reducing the negative impact of companies' activities on the environment has become an important challenge for both public administration and private enterprises (van Berkel & Kortman, 1993).

Accelerating changes in the environment and technology impact the development of companies seeking innovative ways to achieve strategic goals and long-term success (Wojnarowska et al., 2022). At this level, one of the ways to achieve a balance between economic, social, and environmental goals is to introduce a business model based on the assumptions of the circular economy (Lüdeke-Freund, 2020). For companies, this means implementing strategies and actions that meet the current needs of the company and its stakeholders while also protecting and enhancing the human and natural resources necessary in the future (Ketprapakorn & Kantabutra, 2019).

The main goals of implementing circular economy strategies in organizations include reducing the consumption of primary raw materials and waste production (Smol & Kulczycka, 2019) and protecting the environment and preventing pollution (Ma et al., 2018). This means that transitioning to a new economic model requires entrepreneurs to take a strategic approach that incorporates environmental goals into long-term operations (Cwiklicki & Wojnarowska, 2020). It is also necessary to adopt management based on environmental management systems (EMS) and its tools. The most commonly implemented environmental management systems are ISO 14001 and EMAS (Robèrt, 2000). The standard ISO 14001:2015 defines an environmental management system as "part of the management system used to manage environmental aspects, fulfil compliance obligations, and address risks and opportunities" (ISO 14001, 2015). The main goal of these systems is to reduce the negative impact of activities on the environment. Environmental management systems (EMS) are supported by various additional instruments that have been developed since the 1970s. During this time, many methods and solutions for environmental management in companies have been developed. A review of these tools was published by UNEP in 1995, and although it is not comprehensive, it constitutes a solid source of support for EMS (Nowicki et al., 2020).

In the context of the circular economy, two standards have been specifically dedicated to this topic: the British standard BS 8001:2017 Framework for Implementing the Principles of

the Circular Economy in Organizations: Guide and the French standard X PX 30-901:2018 Circular Economy: Circular Economy Project Management System: Requirements and Guidelines. Additionally, there are standards whose requirements refer to the circular economy, as reflected in the standards ISO 14009:2020 and ISO 20400:2017 (Muradin & Foltynowicz, 2019).

In 2017, BSI (British Standard Institution) published the world's first standard on the circular economy, aiming to help organizations and individuals implement more circular and sustainable practices in their businesses. This may include improved ways of working, delivering products and services in line with circular economy (CE) principles, or even redesigning the entire business model and value proposition. The standard is divided into two areas: the first explains what the circular economy is and why it is worth transitioning to a more sustainable mode of operation, while the second focuses on implementing the requirements of the standard (Nowicki et al., 2020). The standard emphasizes the CE, which promotes optimal resource use through reuse, repair, refurbishment, regeneration, and recycling of materials and products. It encourages the preservation and regeneration of natural capital by returning biological nutrients to the biosphere (Nowicki et al., 2021). Design and innovation in processes and products, such as for repair, reuse, or recycling, can be complemented by business model designs and innovations, such as performance-based models, to manage the circulation of products and materials within the system. The standard consists of three main elements: principles, structure, and guidelines containing additional recommendations. These guidelines facilitate the implementation of the standard by organizations (BSI, 2017).

Implementing circular economy principles (CE) according to the standard's guidelines provides organizations with an opportunity to rethink their approach to conducting business, allowing them to operate in a more circular, sustainable, and competitive manner (Kafel & Nowicki, 2022). Business opportunities can arise from understanding resource utilization and introducing new ways of working both within the company and across the value chain.

The principles of the circular economy (CE) are as follows (BSI, 2017):

1. **Systems Thinking:** Organizations adopt a holistic approach to understand how their decisions and actions interact within the broader systems they belong to.
2. **Innovation:** Organizations continuously innovate to create value and enable sustainable resource management by designing processes, products/services, and business models.
3. **Stewardship:** Organizations manage the direct and indirect impacts of their decisions and actions within the broader systems they belong to.
4. **Collaboration:** Organizations collaborate both internally and externally through formal and informal arrangements to create shared value.
5. **Value Optimization:** Organizations maintain products, components, and materials at their highest value and utility throughout their lifecycle.

6. **Transparency**: Organizations are open about decisions and actions that affect their ability to transition to a more circular and sustainable mode of operation. They are prepared to communicate this information clearly, accurately, promptly, honestly, and comprehensively.

The circular economy standard also proposes flexible frameworks for organizations to help them determine the extent to which they want to implement CE principles and transition to a more circular and sustainable mode of operation. This part of the standard serves as a guide divided into eight implementation stages. These enable organizations to tailor their approach to their individual needs and goals, ensuring optimal implementation of CE principles (Nowicki et al., 2020).

1. **Framing:** Organizations should determine the significance of the circular economy to their business and decide where to begin.
2. **Scoping:** Organizations should take into account their vision, strategic plan, and direction regarding CE to closely examine the opportunities and/or requirements.
3. **Idea Generation:** Organizations should create a list of ideas and options that could solve identified problems or capitalize on opportunities from stage 2, prioritizing them in line with CE vision, strategic plan, and goals.
4. **Feasibility:** Organizations should assess the practicality of implementing the prioritized ideas and options identified in stage 3.
5. **Business case:** Develop a business case to secure resources for piloting new ideas and options, then implement, scale, and grow them.
6. **Piloting and Prototyping:** Organizations should experiment with ideas and options on a small scale to test their practical feasibility.
7. **Delivery and Implementation:** Organizations should scale, implement, and integrate proven approaches to transition to a more circular and sustainable mode of operation.
8. **Monitor, Review and Report:** Organizations should monitor performance to ensure ongoing success and continuous transformational improvement.

Implementing any business model does not automatically mean transitioning to a more circular and sustainable mode of operation. The best results can be achieved through a systems approach that considers the entirety of an organization's actions and their impact on different aspects of business (Kafel & Nowicki, 2022).

The French standard published by AFNOR in 2018 represents another standardized standard concerning the circular economy (CE). It outlines the requirements for project management systems led by organizations to improve environmental, economic, and social outcomes and contribute to the development of the circular economy. Like the British standard, it applies to organizations of all sizes and across all sectors. In this document, the term "project" refers to any goal of change supported by an organization, aimed at transforming its operations

towards more efficient resource use and reduced environmental impact. Projects may involve various aspects of an organization's activities, such as actions, products, or services identified by the organization. The standard includes requirements and practical recommendations for initiating, planning, implementing, measuring, and managing projects, adopting an open and holistic approach. In particular, it outlines the steps organizations must take to ensure their projects contribute to transitioning to a circular economy (AFNOR, 2018).

The standard was constructed in accordance with management meta-standards and the guidelines of the HLS (High-Level Structure) model. In addition to systemic issues arising from the HLS structure, a key element is the requirements for a CE project management system that addresses direct and indirect impacts. The standard provides organizations with broader methodological frameworks based on cross-analysis, including the seven areas of action in CE project management proposed in the standard (AFNOR, 2018).

The seven areas of action in CE project management according to the French standard published by AFNOR in 2018 are:

- **Sustainable Procurement:** This area includes considering the environmental and social impact of the resource production cycle, both renewable and non-renewable, essential for the production of goods or services. It may involve extraction processes, natural resource utilization, and replacing non-renewable raw materials with renewable or secondary materials.
- **Ecodesign:** Involves systematically integrating environmental aspects from the design and development stages of products (goods, services, systems) to reduce negative impacts on the environment throughout the product's lifecycle, in accordance with ISO 14006.
- **Industrial Symbiosis:** Involves linking or associating different phases of production, manufacturing processes of goods or services to optimize the management of functions, goods, stocks, and flows of materials and energy. Symbiosis can include substitution synergies between economic entities or combining flows of materials, energy, water, infrastructure, goods, or services.
- **Functional or Service Economy:** Promotes the use of products instead of ownership, for instance, through selling services related to the product instead of the products themselves. This approach aims to optimize usage.
- **Responsible Consumption:** Takes into account the economic, social, and environmental impact of purchasing and using a product or service, promoting reuse, repair, and waste management.

- **Product Lifetime Extension:** Focuses on ensuring products or services are delivered in conditions that enable extending their use phase, maintaining their initial performance.
- **Efficient Management of End-of-Life Products and Materials:** Involves converting waste, including recycling, into substances, materials, or products that can fulfil their original functions or be used for other purposes.

These areas of project management are key for organizations aiming to transition to a more circular mode of operation (Kafel & Nowicki, 2022).

In the context of CE project management, the listed areas of action should be analysed in three dimensions: environmental, economic, and social. This three-dimensional analysis arises from the assumptions of the standard and the proposed cross-analysis.

- **Environmental Dimension:** Focuses on minimizing negative environmental impact, such as reducing emissions, minimizing waste, sustainable management of natural resources, and protecting biodiversity.
- **Economic Dimension:** Concerns effective and cost-efficient project management, optimizing costs, generating economic value, and increasing the efficiency of processes and actions.
- **Social Dimension:** Focuses on the social benefits resulting from projects, such as improving quality of life, creating jobs, supporting local communities, and sustainable development.

Together, these three dimensions provide a holistic view of projects and their impact on the environment, economy, and society, which is crucial for an effective transition to a circular and sustainable mode of operation (Nowicki et al., 2020).

The aim of the article is to determine the relationship between the integration of organizational management systems and knowledge of standards for implementing the assumptions of the circular economy concept.

2. Methodology

The research results presented in this article are only a fragment of broader research in the field of management systems and the concept of circular economy. The research was conducted using a survey questionnaire, the development of which was based on a literature review and supplemented with a pilot study using the case study method. For the purposes of this article, one question from the entire survey questionnaire was used, which concerned knowledge of

standards for implementing the assumptions of the circular economy concept – according to BS 8001:2017 and XP – X30 – 901:2018. The question used a 5-point Likert scale (definitely not - 1, probably not - 2, I don't know/no opinion - 3, probably yes - 4, definitely yes - 5). The overall research included various management systems. However, for the purposes of this article, only the results relating to three management systems were used, which, according to the ISO survey, are the most popular management systems implemented and certified in organizations in Poland. These include: a quality management system consistent with the requirements of the ISO 9001:2015 standard, an environmental management system consistent with the requirements of the ISO 14001:2015 standard, and an occupational health and safety management system consistent with the requirements of the ISO 45001:2018 standard (aka OHSAS 18001). The basic criterion related to the selection of the organization in the case of this article was having an implemented and certified quality management system in accordance with the requirements of the ISO 9001:2015 standard. The reason why only organizations with an implemented and certified ISO 9001:2015 QMS were included was the greatest popularity of this system and the system's integration possibilities with the other two management systems. The implementation and certification of a QMS compliant with ISO 9001:2015 was the basic criterion. Therefore, the test results in which this system was not implemented and certified were rejected. After selecting the results, 100 respondents' responses were finally included in the presented article.

The respondents in the conducted research were representatives of organizations operating in Poland with implemented and certified formal management systems. The surveyed respondents were differentiated by their place of employment in the organization. However, due to the differences resulting from the respondent's employment department, it was decided to reduce departments in favor of certain areas of employment in the organization. Five such areas were distinguished among the surveyed respondents. Figure 1 shows the percentage share of individual areas of employment in the surveyed sample.

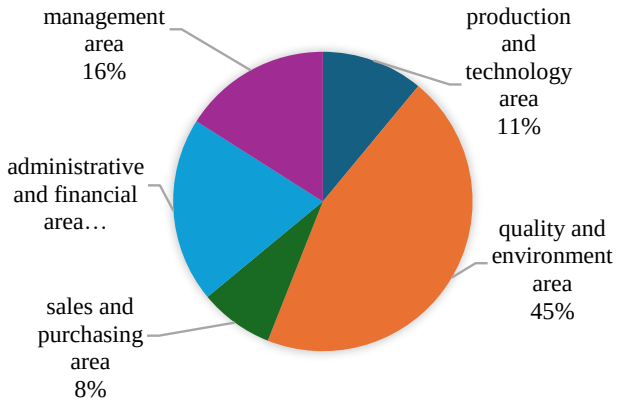

Figure 9. Area of employment in the organization

Source: own research

According to Figure 1, the largest part of respondents was professionally related to the quality and environmental area (45%). The second largest area of employment in the surveyed sample was related to the organization's administration and finances (20%). The next ones were: management area (16%), production and technology area (11%) and sales and purchasing area (8%).

The surveyed respondents also represented organizations with diversified main types of activities. Figure 2 shows the share of individual main types of activities of the surveyed organizations.

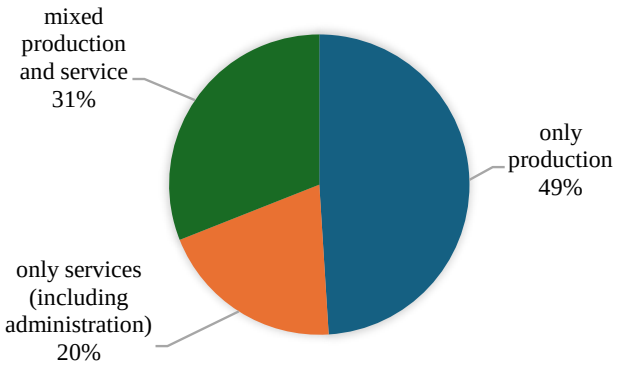

Figure 2. Main type of activity

Source: own research

According to Figure 2, the largest part of the surveyed organizations (almost 50%) were organizations dealing mainly with production. There were 20% of organizations dealing mainly with services (including administration). However, mixed type of activity referred to 31% of the surveyed organizations.

In order to determine whether there are any relationships between the integration of formalized management systems and knowledge of the requirements of standards for the implementation of the assumptions of the circular economy concept, three groups of organizations were distinguished:

• group 1 – organizations that have implemented and certified only a quality management system consistent with the requirements of ISO 9001,

• group 2 – organizations that have an implemented and certified quality management system consistent with the requirements of ISO 9001 and an environmental management system consistent with the requirements of ISO 14001, but do not have an implemented and certified occupational health and safety management system consistent with the requirements of the ISO 45001 standard,

• group 3 – organizations that have all 3 systems implemented and certified.

In order to determine these connections, a descriptive statistical analysis was conducted taking into account these three groups of organizations and the results of respondents in general. Mean and median values were used.

3. Results

The first part of the descriptive data analysis took into account generally the respondents' answers regarding their knowledge of two standards for implementing the assumptions of the circular economy concept: the British standard: BS 8001:2015 and the French standard: XP - X30 - 901:2018. The results of individual indications are presented in Figure 3.

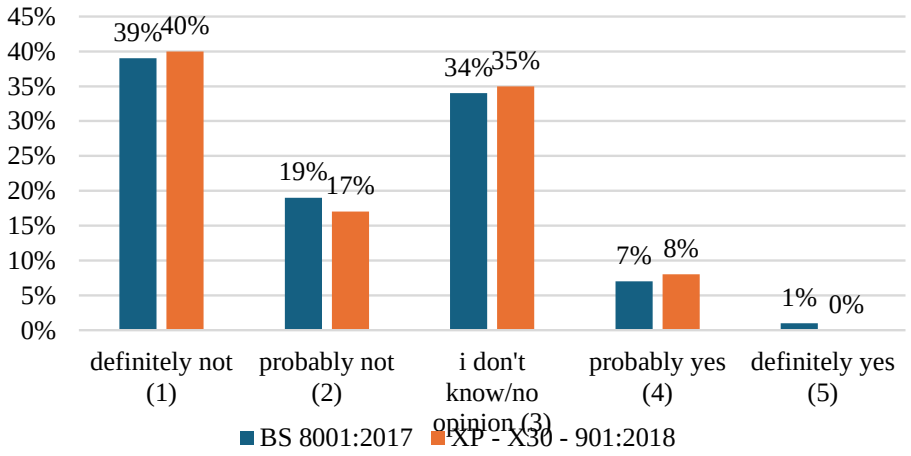

Figure 3. Percentage of responses related to knowledge of circular economy standards

Source: own research

Based on Figure 3, it can be indicated that most indications regarding knowledge of the requirements of both circular economy standards concerned the answers: definitely not and I don't know/I have no opinion. Based on these results, it can be concluded that most of the surveyed respondents definitely do not know or rather do not know the guidelines of both standards – around 60% of surveyed respondents for each standard. A small part of the surveyed organizations indicated that they rather knew or definitely knew the requirements of these standards. Nevertheless, there are definitely fewer of them than in the case of respondents who did not know these guidelines. Typically, respondents who indicated knowledge of these standards worked in the areas of production and technology as well as quality and environment.

In the next part of the analysis of the results, we checked the answers given by the respondents divided into three groups. The results of this analysis for individual standards are presented in Table 1.

Table 1.
Descriptive statistics

BS 8001:2017				
Group	Respondents number	% resopondents number	Average readings	Median
General	100	100%	2,12	2
Group 1	47	47%	2,19	2
Group 2	23	23%	1,87	2
Group 3	26	26%	2,15	2
XP – X30 – 901:2018				
General	100	100%	2,11	2
Group 1	47	47%	2,23	2
Group 2	23	23%	1,87	2
Group 3	26	26%	2,04	2

Source: own research

Based on data from Table 1, it can be concluded that in each case - both for the organization in general and for a specific group - the average is approximately 2. This means that, on average, surveyed respondents are unlikely to know the requirements of both the BS 8001:2017 and XP-X30 - 901 standards. The median indicator shows that in each case, 50% of respondents indicated rather no, definitely not answers. This situation is noticed both among the entire research sample, as well as for individual groups of organizations that characterize the integration of management systems. Regardless of whether the organization has implemented and certified only the QMS, or whether the other two management systems, i.e. the EMS and the occupational health and safety system, are integrated with it, on average, the representatives of these organizations do not know the requirements of the circular economy standards. It can therefore be concluded that the implementation and certification of management systems and their integration are not important in the case of knowledge of the requirements of circular economy standards.

4. Conclusions

The main conclusion from the study is, that surveyed respondents are unlikely to know the requirements of both the BS 8001:2017 and XP-X30-901 standards. Despite the selection of a research sample that included only organizations with implemented management systems, the level of knowledge of the requirements of CE-related national standards systems is very low.

Surprisingly the organizations with implemented EMS complied with ISO 14001 are generally not well informed about the CE standards existence and requirements.

As the big interest in circular economy is observed, also the normalization activities are developing. The International Standardization Organization published in 2024 the first standards in the ISO 59000 family. Given the very poor knowledge of the requirements of national standards regarding CE, there is some chance that this situation will change after the introduction of the international standard. The ISO 59000 family is applicable to any type of organization support organizations in contributing to the United Nations Agenda 2030 for Sustainable Development by facilitating a transition to a circular use of resources. Moreover it is designed to harmonize the understanding of the circular economy and to support its implementation and measurement (ISO, 2024).

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FEMALE IMMIGRANT ENTREPRENEURSHIP IN CHEMISTRY OF GERMANY

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Summary: Entrepreneurs in the chemical industry are more likely to be covered by men (Walther, et al., 2024). This has been proven unchanged after more than 20 years of progress in the STEM society. By the same, a chemistry student in Germany is 54 % less likely to start a business than a student from another subject area (Walther, et al., 2023). The willingness to start a business in other nations such as Poland is also significantly higher, which can be attributed to cultural influences (Walther, et al., 2023). However, start-ups are important for the transfer of innovations from the university environment to the chemical industry. Innovations are expected to reshape the chemical industry towards sustainability and transform their respective sectors. Therefore, we conducted a comparative study among male and female chemistry students with and without migration background from all grades in Germany and compared them with each other to understand motivations, barriers and intentions. By including samples of students with significant differences in cultural, economic, and educational backgrounds, we developed and tested hypotheses about the influence of these factors on the intentions, perceptions, motivations, and barriers of four groups. We distinguished between intrinsic and extrinsic factors. We found a number of significant differences between the four groups. We discuss the results and suggest new approaches for the education of chemistry students and for future research approaches.

Keywords: chempreneurs, entrepreneurs, culture, migration, education

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1. Introduction

"Chemical entrepreneurship" refers to the commercial application of innovations in chemistry to a market or buyer (Oyeku, et al., 2015) and can equally aptly be labelled as chempreneurs. The innovations for such chempreneurs are defined as new processes, products or procedures that are characterised by the combination of idea, invention and dissemination (Wolf, et al., 2021). Technology transfer for innovations takes the form of patents, spin-offs from the university or the founding of a company (Wolf, et al., 2022). Due to the products, applications and concepts of the chemical industry in everyday life, the application possibilities for innovations from chemistry are necessary and important in the context of global challenges such as human health, plant production, energy conversion and storage, safe and abundant water, climate change and others (Confalone, 2014). In Germany, the chemical industry contributes 6.7 % to gross domestic product, ranking third in the world behind the USA and China (Federal Ministry for Economic Affairs and Energy, 2017; Rudnicka, 2023). Bridging the gap between science and entrepreneurship is therefore important for the expansion and continued existence of the chemical industry in Germany (Sachse & Martinez, 2016).

Female Migrant Entrepreneurship (FME) is made up of the "dual characteristic" of ethnicity and gender. Despite over 20 years of progress, entrepreneurship in the STEM, science, technology, engineering and mathematics, community remains male-dominated (Minniti, 2004; Kelley et al., 2017). A comparative study between chemistry students in Germany and Poland found that male chemistry students were twice as likely to start a business (Walther et al., 2024). The reasons for this may be that the general gender distribution of students in STEM degree programmes shows a 40 % share of female students (Wolf et al., 2021), female students are socialised differently (Walther et al., 2024) and or, for example, their social environment illustrates different expectations (Walther et al., 2024). Successful and experienced female founders can help as a positive example For example, BioNTech SE, one of the companies that developed vaccines to combat the Covid pandemic, was founded by German innovators in 2008 (Federal Ministry of Education and Research, 2020). As part of the founding team, Dr Özlem Türeci, a second-generation founder with a migration background, is an example of STEM-related entrepreneurs in Germany (Spiegel, 2021). Due to the specificity of STEM students in terms of their learning patterns, behaviours and self-efficacy, it is not advisable to generalise from other study programmes or cultures (Rittmayer & Beier, 2009). This study focusses on identifying the action gap between the idea and starting a business among chemistry students with and without a immigration background separately by gender in Germany.

2. Literature Review

The foundations of research with the subjective norm go back to the foundations of the theory of planned behaviour (Ajzen, 1991). According to the TPB, human behaviour is determined by three factors and their beliefs. The basic model comprises the attitude, the subjective norm and the perceived behaviour of the mediator control. In their corresponding aggregates and behavioural beliefs a positive or negative attitude towards the behaviour. The effects of the attitude towards a behaviour and the subjective norm on the intention are moderated by the perception of behavioural control. In general, the more favourable the attitude and subjective norm and the greater the perceived control, the stronger the person's control over their intention to perform the behaviour in question should be (Ajzen, 2006). The basic model is modelled according to the research question and application, which means that different "relevant behaviours", i.e. target variables or questions, can be investigated, such as entrepreneurial behaviour (Boissin et al., 2009). In this study, the TPB model was supplemented by the variables start-up knowledge, perceived educational support, perceived support from the university/research institution and perceived career opportunities (Cook et al., 2000; Zapkau et al., 2015; Roy et al., 2017).

In addition to regular immigration, there were several large waves of immigration in German history after the Second World War. From the 1960s onwards, immigration in the western part of Germany (FRG) took place on a significant scale through the recruitment of "guest workers" from southern Europe with the aim of satisfying the growing economy's unmet need for labour. Until 1990, immigration between East and West Germany differed fundamentally in terms of the type, extent and countries of origin of the migrants due to the respective form of government. In 2021, there were around 11.82 million people with foreign citizenship living in Germany; the countries of origin of these people were Turkey (12.4 %), Poland (7.4 %), Syria (7.3 %), Romania (7.1 %) and Italy (5.5 %). In the 2012 survey year, the GEM reports focused on the topic of "migration entrepreneurship", with migrants in "innovation-driven countries" (predominantly high-income countries according to the country categorisation currently used in the GEM reports) showing a higher willingness to start a business than non-migrants (Sternberg et al., 2024). The second generation of migrants in Germany has a higher willingness to start a business than the first generation, which was explained by high barriers to starting a business such as bureaucracy or the duration of a start-up another reason for this can often be a lack of knowledge of the language and authorities (Sternberg et al., 2024) The TEA rate of people without a migration background (~ 7 %) differs significantly from that of people with a migration background a (~ 14 %) (Sternberg et al., 2024). In a comparison of men and women with a migration background, there is no difference

in the TEA rate between the sexes in 2021, while the TEA rate among German citizens without a migration background was 8% for men and 5 % for women (Sternberg et al., 2022).

The relationship between immigration and entrepreneurship is largely well studied in industrialised countries (Kazlou & Klinthall, 2019) and can be attributed to the combination of new capital flows and increasing human capital (Li & Zahra, 2012). Another source of influence is the regional context in which the entrepreneurs act, which is determined by the prevailing formal and informal rules. The combination of the characteristics of gender and migration status forms the basis for FME research. There are studies with a qualitative research design (Essers et al., 2013; Munkejord, 2017). A positive relationship between the motivation to start a business and the willingness to take risks has been demonstrated, with women being more risk averse the more opportunity is the driving factor (Block et al., 2015). Other approaches pursue a theorisation of the phenomenon and/or the conceptualisation of the research field (Baycan-Levent, 2010; Essers et al., 2010; Azmat, 2013; Villares-Varela et al., 2017). Studies with participants from Germany are sparse (Hillmann, 1999; Leicht, 2009; Bührmann et al., 2010; Zyvura et al., 2018). Existing research on the topic of FME has assigned greater significance to the "gender" factor than to the "migration background" factor (Baycan-Levent et al., 2006). Deepening the gender-specific dimension to include the factor "migration background", for example, contributes to a better understanding and can be helpful for deriving measures and support, such as the reconciliation of work and family life. Institutional factors, both formal (laws, norms, regulations and religion) and informal (social networks, family roles and cultural expectations) influence the way women start and build their businesses (Munkejoord & Camilla, 2015). Another research found that women in low-income countries tend to be more entrepreneurial than women in high-income countries (Minniti, 2011).

In the context of STEM students, initial qualitative research has already taken place as part of a gender-sensitive entrepreneurship and peer mentoring programme in Canada, which suggests a strengthening of entrepreneurial self-efficacy and entrepreneurial intentions (Elliott et al., 2020). At the same time, female chemistry students in Germany and Poland are significantly less likely to start a business (Walther et al., 2024). The willingness to start a business as a TEA rate of chemistry students in a direct comparison by gender in 2023 was for Polish men (29.5 %), Polish women (14.2 %), German men (12.6 %) and German women (4.8 %), which puts Polish women above the average of German chemistry students regardless of their gender (Walther et al., 2024). Due to the immigration density of Polish citizens in Germany with over 2 million people and thus the second most common country of origin, the willingness of Polish chemistry students to start a business also has an influence on the overall willingness to start a business in Germany (Bund - Länder Demografie Portal, 2024; Walther et al. 2023).

The following hypotheses were derived from the theories and findings of the literature, H1: Chemistry students with a migration background are more likely to set up a company than students without., H2: FMEs are more likely to start a business than their female colleagues., H3: Female chemistry students rate motives lower, regardless of their migration background. and H4: Female chemistry students rate barriers higher, regardless of their migration background.

3. Methodology

This study is part of a comparative study of German and Polish chemistry students that analyses innovation-oriented technology transfer from the students' perspective. Due to time and cost constraints, a longitudinal design with one measurement point (August 2022 - January 2023) was chosen. An online questionnaire was used to collect data, which was translated into several languages and checked for loss of meaning. The target group consisted of students of chemistry and related disciplines who were contacted by email, in person during lectures or via social media such as Instagram. Questions from various studies were used for the survey, which were adapted to a 6-point Likert scale to force the selection. Absolute ignorance (1) to extensive knowledge (6) for questions on basic knowledge, or I don't know (0), strongly disagree (1) to strongly agree (6) for the others. The probability of starting a business was surveyed using two different question types, firstly the probability of starting a business after graduation from very unlikely (1) to very likely (6) (Walther et al., 2023).

A total of 4,367 people and 120 professors or student representatives were contacted. In February 2023, we received completed questionnaires from 1,287 participants, a response rate of 29.4 %, which is acceptable compared to other web-based (Cook et al., 2000). Before conducting our statistical analyses, we excluded 320 participants due to incomplete data. We also excluded participants who reported that they were not currently a student (n = 135), or belonged to another field, or were studying in another country (n = 21). The final sample thus consisted of 811 students, 498 from Germany and 313 from Poland. The students were confronted with the question "Do you have a migration background" in order to be able to separate them according to the presence of a migration background and gender. The average time spent in the questionnaire was 9.25 minutes. A summary of the distribution of study participants can be found in Table 2.

Table 2.
Composition of the study participants

SUB groups		migration Background		no migration Background	
		Male	**Female**	**Male**	**Female**
Number		48	65	191	187
Age ± SD		23,2 ± 3,52	23,9 ± 3,40	23,4 ± 3,76	22,7 ± 2,96
Nationality	**German**	27	34	184	173
	other	21	31	7	14
University Type	**Public**	45	56	155	136
	Private	3	9	36	50
desired degree	**Bachelor**	25	37	95	101
	Master	13	14	47	51
	PhD/Doctor	10	14	49	35
income	**No income**	20	23	65	72
	Part time job	25	37	111	105
	Full time job	3	5	15	10
Social capital	**yes**	22	28	82	68
	no	26	37	109	119
department	**Other**	6	12	28	44
	Chemistry	35	47	129	105
	Business Chemistry	7	5	34	28

Source: own study

The statistical analysis was carried out using IBM SPSS Statistics version 28.0.1. The students were asked about their 'migration background' and the answers were categorised accordingly. Before the ANOVA test, the normal distribution was tested using Shapiro-Wilk tests. As the data was not normally distributed, the Kruskal-Wallis test for independent samples was used. This compares the ranks of the data. The result of the ANOVA is the standardised z-value and the p-value. The significance threshold was 5 %. The probability of starting a business was calculated based on the participants who chose this option as a career path. The results were presented graphically, with significant differences highlighted. The mean values of a category are shown and the significance relates to at least one question in this category. Significant results are presented in a table with factor, country, number and proportion of 'don't knows' responses, sample size (n), mean, median, z-score and p-value. A complete list of all questions can be found in the study by Walther et al. (2024, 2023).

4. Results

The analysis of the ANOVA comparisons for the Entrepreneurial Intentions can be found in **Table 3**.

Table 3.
Results ANOVA comparison on the Entrepeneurial intentions

Question / Factors	Migration background	Gender	n	mean	median	Migration Background				No Migration Background	
						Male		Female		Male	
						z	p	z	p	z	p
How likely do you think it is that you will start a business after graduation?	Yes	Male	48	2.3	2						
		Female	65	2.6	2	- 1.126	1.000				
	No	Male	191	2.3	2	0.096	1.000	1.600	0.658		
		Female	187	1.9	2	1.920	0.329	3.646	0.002	2.870	0.025

Source: own study

Table 3 shows clear differences between the comparison groups. Gender-specific and cultural differences also become clear when comparing migration status or gender. Here, German female students with a migrant background have an average rating of 2.6 and students without a migrant background have an average rating of 1.9 for willingness to start a business. At the same time, the direct comparison of the genders without a migration background shows the corresponding significant difference with the higher ratings for men. This leads directly to the conclusion that gender has an influence on the willingness of chemistry students to start a business. This connection has already been postulated for Germany and Poland with a significant effect of men and an up to twice higher willingness to start a business (Walther et al., 2024).

Table 4 contains the questions with significant differences in the areas of foundation knowledge and subjective norm.

Table 4.
Results ANOVA comparison for questions without the answer option "I don't know"

Question / Factors	Migration background	Gender	n	mean	median	Migration Background				No Migration Background	
						Male		Female		Male	
						z	p	z	p	z	p
To what extent do you know about the tasks involved in setting up a business?	Yes	Male	48	2.4	2						
		Female	65	2.0	2	1.288	1.000				
	No	Male	191	2.6	2	- 1.031	1.000	- 2.865	0.025		
		Female	187	2.1	2	1.143	1.000	- 0417	1.000	3.416	0.004
People I care about expect me to start a business after I graduate.?	Yes	Male	48	1.5	1						
		Female	65	1.7	1	- 0.410	1.000				
	No	Male	191	1.3	1	1.843	0.392	2.616	0.053		
		Female	187	1.2	1	2.619	0.053	3.485	0.003	1.227	1.000

Source: own study

As Table 5 shows, significant differences for women with a migrant background and men without a migrant background can only be found in the questions 'To what extent are you familiar with the tasks involved in setting up a business?' and 'The people who are important to me expect me to set up a business after I graduate...'. In addition, the comparison between the genders shows a significant difference for participants without a migration background. This result indicates that women born in Germany perceive greater pressure on their decisions.

Table 5.
Results ANOVA comparison for questions with the answer option 'I don't know'

Question / Factors	Migration background	Gender	„I don't know" n	„I don't know" %	n	mean	median	Migration Background				No Migration Background	
								Male		Female		Male	
								z	p	z	p	z	p
The more I try to find out about different career options, the more confused I get.	Yes	Male	0	0.0	48	2.7	3						
		Female	3	4.6	62	3.3	3	- 1.723	0.509				
	No	Male	9	4.7	182	2.6	2	0.398	1.000	2.692	0.043		
		Female	6	3.2	181	3.1	3	- 1.659	0.583	0.422	1.000	- 3.180	0.009
I give a lot of thought to choosing the right career.	Yes	Male	0	0.0	48	4.5	5						
		Female	1	1.5	64	5.0	6	-2.230	0.155				
	No	Male	1	0.5	190	4.5	5	-0.114	1.000	2.818	0.029		
		Female	3	1.6	184	4.7	5	-0.776	1.000	2.066	0.233	-1.039	1.000
I can imagine that being an entrepreneur would give me great satisfaction.	Yes	Male	6	12.5	42	3.7	4						
		Female	8	12.3	57	3.5	4	0.728	1.000				
	No	Male	18	9.4	173	3.5	4	0.733	1.000	- 0.144	1.000		
		Female	23	12.3	164	2.5	2	3.878	0.001	3.399	0.004	4.997	<0.001
I am not willing to take risks when choosing a job or a company.	Yes	Male	2	4.2	46	3.2	3						
		Female	5	7.7	60	2.9	3	1.469	0.852				
	No	Male	3	1.6	188	3.2	3	0.326	1.000	- 1.580	0.685		
		Female	7	3.7	180	3.4	3	- 0.745	1.000	- 2.756	0.035	- 1.694	0.542
Economic security is important to me.	Yes	Male	0	0.0	48	5.1	5						
		Female	1	1.5	64	5.3	5.5	1.000	1.000				
	No	Male	1	0.5	190	4.8	5	1.821	0.411	3.343	0.005		
		Female	3	1.6	184	5.1	5	0.390	1.000	1.736	0.495	- 2.234	0.153
Starting a business after my studies is for me, possible.	Yes	Male	6	12.5	42	3.1	3						
		Female	7	10.8	58	3.2	3	- 0.242	1.000				
	No	Male	22	11.5	169	3.8	4	- 2.671	0.045	- 2.705	0.041		
		Female	36	19.3	151	3.1	3	- 0.096	1.000	0.209	1.000	3.964	<0.001
It would be easy for me to develop a business idea.	Yes	Male	4	8.3	44	2.9	3						
		Female	7	10.8	58	2.7	2	1.874	0.366				
	No	Male	13	6.8	178	2.8	2	0.781	1.000	-1.608	0.647		
		Female	19	10.2	168	2.4	2	2.555	0.064	0.382	1.000	2.801	0.031
I know all about the practical details required	Yes	Male	2	4.2	46	2.0	2						
		Female	5	7.7	60	1.6	1	2.517	0.071				
	No	Male	5	2.6	186	1.9	2	-0.130	1.000	-3.466	0.003		

to start a business.		Female	6	3.2	181	1.6	1	2.080	0.225	-1.066	1.000	3.494	0.003
...to create something on my own.	Yes	Male	1	2.1	47	5.0	5						
		Female	2	3.1	63	5.2	6	- 1.629	0.620				
	No	Male	5	2.6	186	4.9	5	0.728	1.000	2.968	0.018		
		Female	4	2.1	183	4.9	5	0.426	1.000	2.626	0.052	- 0.472	1.000
...the creation of jobs.	Yes	Male	1	2.1	47	3.4	3						
		Female	0	0.0	65	4.0	4	- 2.143	0.197				
	No	Male	10	5.2	181	3.4	3	- 0.048	1.000	2.772	0.033		
		Female	8	4.3	179	3.8	4	- 1.755	0.476	0.835	1.000	- 2.654	0.048
...the difficulty of finding the right job.	Yes	Male	3	6.3	45	2.4	2						
		Female	6	9.2	59	3.0	2	-1.444	0.892				
	No	Male	22	11.5	169	2.6	3	-0.401	1.000	1.445	0.890		
		Female	20	10.7	167	3.2	3	-2.800	0.031	-1.218	1.000	-3.694	0.001
...a lack of initial capital.	Yes	Male	1	2.1	47	4.7	5						
		Female	7	10.8	58	5.1	6	- 2.068	0.221				
	No	Male	23	12.0	168	4.6	5	0.731	1.000	3.483	0.003		
		Female	21	11.2	166	4.8	5	- 0.211	1.000	2.458	0.084	- 1.421	0.932
...a lack of entrepreneurial competence.	Yes	Male	2	4.2	46	4.4	5						
		Female	6	9.2	59	4.6	5	- 1.028	1.000				
	No	Male	22	11.5	169	4.1	4	1.284	1.000	2.749	0.036		
		Female	23	12.3	164	4.4	4	- 0.342	1.000	0.956	1.000	- 2.468	0.081
...the current economic situation.	Yes	Male	4	8.3	44	4.0	4						
		Female	10	15.4	55	4.6	5	- 1.986	0.282				
	No	Male	32	16.8	159	4.0	4	0.248	1.000	2.837	0.027		
		Female	39	20.9	148	4.5	5	- 1.929	0.322	0.446	1.000	- 3.269	0.006
...the fiscal charges (taxes, court fees, etc.).	Yes	Male	5	10.4	43	4.0	4						
		Female	10	15.4	55	4.2	4	- 0.604	1.000				
	No	Male	50	26.2	141	3.3	3	2.302	0.128	3.296	0.006		
		Female	54	28.9	133	4.0	4	0.061	1.000	0.834	1.000	- 3.229	0.007
...a of knowledge in the business world.	Yes	Male	1	2.1	47	4.8	5						
		Female	2	3.1	63	4.7	5	- 0.441	1.000				
	No	Male	10	5.2	181	4.3	5	2.090	0.220	2.919	0.021		
		Female	16	8.6	171	4.9	5	- 0.542	1.000	- 0.029	1.000	- 4.045	<0.001
...a lack of knowledge of the market.	Yes	Male	2	4.2	46	4.7	5						
		Female	2	3.1	63	4.8	5	- 1.163	1.000				
	No	Male	12	6.3	179	4.1	4	2.684	0.044	4.568	<0.001		
		Female	17	9.1	170	4.8	5	- 0.344	1.000	1.141	1.000	- 4.677	<0.001
...a lack of experience in management.	Yes	Male	2	4.2	46	4.4	5						
		Female	1	1.5	64	4.7	5	- 1.048	1.000				
	No	Male	13	6.8	178	4.1	4	1.565	0.705	3.166	0.009		
		Female	14	7.5	173	4.6	5	- 0.677	1.000	0.617	1.000	- 3.477	0.003

Source: own study

The variable "The more I try to find out about different career options, the more confused I get." this variable was also rated higher by women without a migration background than by their male colleagues. This difference can therefore be attributed more to gender-specific differences. For the variable "I can imagine that being an entrepreneur would give me great satisfaction." a significantly higher rating was given by men when comparing the groups of men with a migration background vs. women without and men without a migration background vs. women without. In addition, the comparison of women with and without a migration background shows a significantly higher rating of this variable for women with a migration background. This difference can be attributed to cultural influences in Germany.

The variable "I am not willing to take risks when choosing a job or a company." was rated significantly lower by women with a migration background. This indicates a low level of anxiety. In comparison to the variable "Economic security is important to me." women with a migration background gave a significantly higher rating than men without a migration background, which in turn suggests a greater need for security.

The students' assessment of the variable "Starting a business after my studies is for me, possible." shows significant differences in the comparison of men with and without a migration background as well as in the comparison of men with a migration background with women without a migration background. Men without a migrant background have the highest rating of the applied comparison with m = 3.8, followed by women with a migrant background with an m = 3.2. The comparison of men and women regardless of migration status also shows significantly higher ratings for men for all three variables (Walther et al., 2023). It can therefore be concluded that there are fundamental differences between the sexes in Germany.

The variable "...the creation of jobs." was rated higher by women without a migration background than by men without a migration background, which indicates a gender-specific difference. The variables "...to create something on my own." And "...the creation of jobs." were each rated higher by women with a migration background compared to men without such a background, indicating a combination of cultural and gender-specific differences. This can be confirmed by the gender comparison in Germany (Walther et al., 2024).

In 10 comparisons of variables, significantly higher ratings were shown for women with a migration background compared to their male colleagues without a migration background. In addition, a comparison of men and women without a migration background showed 6 variables with significantly higher ratings for women. It can therefore generally be concluded that women rate barriers higher regardless of their migration background. The comparison of men with and without a migration background, on the other hand, showed "...a lack of knowledge of the market." and "...a lack of experience of accounting." significantly higher ratings for men with a migration background. While for the variable "...a lack of support from people around me." the men without a migration background had significantly higher ratings.

5. Discussion

Based on the results, the hypotheses were answered as follows. H1: 'Chemistry students with a migration background are more likely to start a business than students without a migration background' is accepted for FMEs, H2: 'FMEs are more likely to start a business than their female colleagues' is accepted, H3: 'Female chemistry students rate the motives lower, regardless of their migration background' is rejected and H4: 'Female chemistry students rate the barriers higher, regardless of their migration background' is accepted.

Our study shows significant differences in the willingness to start a business. The probability of starting a business is highest among women with a migration background. We argue that education is a factor that strengthens and develops the intrinsic aspects of students (Walther et al., 2024). From this point of view, we consider additional offers and references to further career opportunities and dependent on gender and migration background as an opportunity for students. In this context, it is necessary to expand existing support programmes, with networks serving as catalysts. Furthermore, the introduction of a cooperative innovation strategy such as that of the Fresenius University of Applied Sciences called PANDA, parallel to entrepreneurship education, is recommended (Wolf et al., 2021). In this way, students learn not only the theoretical basics but also the practical perspectives of starting a business, whereby possible barriers can be broken down and start-up knowledge can be built up. A combination with other subjects is conceivable in which students can benefit from their fellow students, such as marketing or advertising (Elliott et al., 2020).

Limiting factors or possible sources of error in this study are the low number of participants with a migration background. In addition, the survey is not representative. A possible influencing factor on the survey results could be the regional focus of the participating students. A representative survey with more participants is therefore recommended for future research in order to be able to better apply the dual characteristic as in FME. In addition, the use of further statistical analysis methods such as ordinal regression analysis is conceivable (Walther et al., 2023). For further research, the use of other countries for comparison is recommended. When implementing entrepreneurship education among chemistry students, it is advisable to utilise the findings from this study. The experienced role models can be utilised and built upon, and women in particular can be further motivated to start a business (Walther et al., 2024). In general, however, it is advisable to investigate the effects further after the implementation of a semester or year and to make any necessary adjustments to the lessons. Implementation in phases, such as in a Plan-Do-Check-Act cycle (PDCA cycle), would be helpful here in order to incorporate the circumstances and changed starting situations of the respective students into the programme and thus ensure optimal use of potential and skills.

6. Conclusions

The start-up knowledge variables show significantly higher ratings for male participants regardless of their gender. Since the survey and the variables are self-assessment questions, it should be noted that this does not necessarily mean that they have a higher level of knowledge, but this can be used as a starting point to reduce potential barriers such as "insufficient start-up knowledge". The subjective norm shows higher assessments of students with a migration background for the perceived pressure for the expectations of a start-up. There may be a connection here with possible backgrounds of the students such as founders or businesses within the family, whereby the pressure to continue the family tradition is perceived. These variables can be used to ensure that the inclusion of experienced founders in entrepreneurship education leads to students gaining more experience and spending more time working on/discussing the topics in their social environment. The variables of perceived career options show significantly high ratings for the FMEs, while at the same time the variable "I am not willing to take risks when choosing a job or a company" shows significantly low ratings for the FMEs in comparison. This combination with the high willingness to start a business suggests a desire for independence when choosing a career. The significantly higher ratings given by the FMEs to motives such as "...to create something on my own" and "...the creation of jobs." confirms this trend. While the barriers confirm gender-specific differences from previous studies (Walther et al., 2024). This further confirms the need for entrepreneurship education as part of the training of scientists.

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