Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 2458-9403
Vol. 12 Issue 3, March - 2025

A Novel Food Traceability System For Ready Meals: An Expert's Perspective

Dimitris Papakyriakopoulos,
Department of Business Administration,
University of West Attica,
Athens, Greece

Faidon Komisopoulos
Department of Business Administration,
University of West Attica,
Athens, Greece

Theodoros Xanthopoulos
Department of Business Administration,
University of West Attica,
Athens, Greece

***Abstract*— Ensuring food safety and maintaining consumer trust are of extreme significance in the food industry. This paper explores the creation of a novel traceability system that utilizes domain expertise to tackle challenges in the ready meals supply chain. The proposed system efficiently monitors ingredients, processing procedures, and distribution networks to guarantee product authenticity and prompt action in the event of potential food safety issues. At the stage of conceptual design, we selected to involve decision makers and it turned out that they had significantly changed the initial technical design. By combining technological advancements with in-depth industry knowledge, this research aims to create a robust traceability framework that enhances food safety, consumer confidence, and supply chain efficiency while keeping the cost of initial adoption of the system low. This study shows how traceability in food supply chain is understood by different managerial perspectives.**

Keywords—food traceability, ready meals, food safety, supply chain, expert perspective

I. INTRODUCTION

The food supply chain has become increasingly complex, necessitating robust working systems to ensure and support food safety, quality, and transparency. A key concept surrounding these systems is traceability, which is the ability to track a food product from its origin to the consumer [1]. In recent years, the significance of food supply chain traceability has amplified due to a series of food safety incidents, a growing emphasis on sustainability, increasing consumer prices, supply disruptions, and other socio-economic factors. One possible solution to the challenges arising from food supply chain traceability is through the intervention of technology.

The objective of this paper is to propose a novel, cost-effective food traceability information system. The cost reduction is based on the lack of sensors and any other related data-capturing devices, which, from a business point of view, seems to be an important investment for companies, and they consider it before recognizing the benefits and value they can offer [2]. Therefore, the proposed system tries to address the perception of the management executives regarding the role of technological intervention and the reduction of the relative production flexibility required. The proposed system is designed exclusively for the monitoring of ready meals, and in this paper, the perceptions of those involved in the requirements collection phase are highlighted to demonstrate the underlying complexity of supply chain traceability.

The paper is organized as follows: Section 2 provides a brief literature review of traceability; Section 3 describes the proposed system and section 4 presents perspectives emerged during the discussion with experts.

II. LITERATURE REVIEW

In this section we present the traceability in food supply chain, the role of technology as enabler and how ready meals play a significant role in the food supply chain.

A. Traceability in food supply chain

Traceability in the food supply chain has gathered the interest of the academic community and there are studies describing food traceability systems ([3] and [4]), success factors in system development [1], adoption barriers and challenges [5] and [6]. Traceability is a capability of the supply chain and depending on the interest of the study, the needs of the partners and the capabilities of the system that implements it, it can further take different forms. [4] distinguish nine different traceability types:

- Product traceability which is usually related to determining the physical location of the food at any stage in the supply chain
- Process traceability which tracks types, parameters and sequence of activities carried out in food throughout the supply chain
- Forward traceability includes the downstream path of the supply chain from the producer of raw materials to the consumer,
- Backward traceability refers to the upstream path of the supply chain from the point of final consumption to the producer (upstream)

- Genetic traceability that focuses more on the certification processes and the identification of genetically modified foods
- Input traceability for the purpose of monitoring properties on all different incoming materials as well as suppliers,
- Disease and pest traceability aimed at monitoring and detecting biological hazards in food,
- Measurement traceability for monitoring measurements of interest the supply chain,
- Logistics traceability which the interest is in the monitoring of materials transported along the supply chain and
- Quality traceability with an emphasis on the monitoring of properties related to quality and food security.

Having multiple types of traceability underscores the challenges of implementing a food traceability system. It is apparent that the existence of multiple types of traceability might affect and blur the common understanding required to operate on a collaborative platform in a supply chain.

The supply chain provides a unified perspective in which various participants use resources to move products from producers to final consumers. The importance of information has proven to be important, and traceability systems meet the demands of the supply chain. The interesting thing is that the relevant studies that exist refer to the traceability of a specific species (e.g., meat, fish, agricultural products), and there is no work done at the supply chain level for ready meals. A possible explanation can be based on the view of [5], who claim that traceability differs between disciplines. The next table summarizes different initiatives regarding traceability in the supply chain.

TABLE I. INDICATIVE FOOD TRACEABILITY IMPLEMENTATIONS

Supply chain	Research Objective	Technology enablers	Result	Source
Agrofood	Reliable product information	RFID, Blockhain	Trust	[7]
Fisheries	Monitor and configure transport parameters	Forecasting models, Web services, Sensor network	Risk reductio and losses during transport	[8]
Meat	Life cycle traceability	RFID	Security	[9]
Grain	Reduction of asymmetric information	Blockchain (smart contracts), Sensor, Sensor network, Cams	Trust and transparency	[10]
Frozen fruits	Monitoring of transport conditions	Sensor network	Configuration parameters of supply chain	[11]
Fresh fruits	Export trade of a special variety	Sensor network	Quality characteristics	[12]

B. Technology enablers for food traceability

Blockchain technology has emerged as a transformative solution for the food processing industries, offering a wide range of applications that enhance transparency, traceability, security, and efficiency. One of the most significant applications of blockchain technology in the food processing industries is its ability to enhance traceability and transparency throughout the supply chain. Blockchain provides a decentralized and immutable ledger system that allows all stakeholders, including farmers, processors, distributors, and consumers, to access information about the origin, quality, and movement of food products in real-time [13] and [14]. For instance, blockchain can be used to track the journey of a food product from the farm to the consumer's table, ensuring that each step of the process is documented and verifiable. This level of transparency not only builds trust among consumers but also helps in identifying and addressing issues related to food safety and quality in a timely manner as [15] and [16] suggest. Similarly, blockchain technology has been discussed in the context of addressing food fraud and counterfeiting issues, by providing a secure and transparent way to verify the authenticity of food products. [13]. Another role of blockchain technology has been recognized regarding the improvement of food safety and quality control by providing a secure and tamper-proof record of food production and distribution processes. By integrating blockchain with Internet of Things (IoT) devices, food processing industries can monitor and verify the conditions under which food is produced, stored, and transported [17].

From a supply chain perspective, blockchain can streamline food processing operations by automating processes, reducing administrative costs, and improving collaboration among stakeholders. Smart contracts, which are self-executing contracts with predefined rules, can be used to automate payments, inventory management, and other supply chain processes [15]. Moreover, it has the potential to promote sustainability in the food processing industries by optimizing resource usage and reducing waste as [18] and [19] suggest. The food processing industries are subject to strict regulations and standards, and blockchain technology can help companies comply with these requirements more effectively. The provision of a secure and transparent record of the entire supply chain events, it is possible to for all the training partners to demonstrate compliance with food safety and quality standards [20] and [21]. Finally, blockchain has an impact on consumers' preferences through the provision of access to detailed information regarding the food product. The presence of a QR code or by using a mobile app, consumers can access information about the origin, ingredients, and production process of a food product, enabling them to make informed decisions about their diet and health [13] and [14].

C. The importance of ready meals supply chain

The term ready meal, also referred to as a convenient meal or pre-packaged meal, is a product quite widespread in Europe. [22] distinguish four categories of ready meals which are: (i) Ready to eat, such as main takeout dishes, salads, etc., which are consumed as purchased, (ii) Ready to heat, such as

frozen and frozen entrees (e.g. pizza), as well as dehydrated and canned foods, which require heating before consumption, (iii) Ready to end-cook, such as dehydrated pasta dishes that require more than 15 minutes of heating before consumption and (iv) Ready to cook, which is minimally prepared food that still requires full cooking of some or all of its ingredients.

The categorization is not the only one and in fact it arises from the perspective of the final consumer. The knowledge gained on consumer attitudes towards ready meals is quite varied and it is difficult to draw unified conclusions. For example, [23] studied a sample of citizens of Luxembourg and found that the increased consumption of ready meals, combined with other factors such as gender, age and socio-economic status increase the risk of obesity. Although consumers are aware of the possible health effects of ready-made meals, they still prefer them, compensating for other factors such as time scarcity or lack of cooking skills [24].

What most sources seem to agree on is that the market for ready meals will continue to grow for the next decade at rates of 6% to 11% depending on the available study source. The production of ready meals is a task that can be implemented from a restaurant to a specialized production unit.

Depending on the target markets industries usually produce three main categories of ready meals: (i) Fresh meals intended for immediate consumption, (ii) Preservable meals with an expiration date of 3-4 weeks and (iii) Frozen meals with a consumption horizon of 1 year. Most of the production stages are the same (e.g. selection of materials, export from warehouse, unpacking, preparation of materials and execution of recipe, portioning, packaging and transport) but the way of cooling the finished product, packaging and transport requirements differs. Recent academic sources refer on issues of environmental impact [25] and nutritional value [26] of ready meals, confirming the suggestion of [27] that the academic focus on ready meals has shifted mainly to the consumer side.

Business and consumer perspectives on traceability according to a recent study diverge [28]. In this work, businesses that prepare meals for retail sale and are usually classified in the hospitality industry (e.g. hotels, catering companies) as well as consumers of ready meals were questioned about the need for traceability. The results showed that businesses are aligned with existing policies and understand the importance of traceability, however providing information only on product safety and quality is not enough for the consumer to purchase. There are issues of interest to consumers (e.g. environmental protection) which businesses prioritized to a lesser extent.

III. THE PROPOSED SYSTEM

A. Stakeholders

The Stakeholders in a ready meal tracking platform are usually from major industries operating in the food supply chain industry. A few factors such as the number and operational heterogeneity of stakeholders, the complexity of cooking, the variety of foods stored and handled, the type of demand served (e.g. retail, service contract) express the contextual complexity need to be met by traceability information systems. The next list identifies the stakeholders involved in the proposed project platform.

- Food supplier: A ready meal recipe requires the mixing of different ingredients and include various heterogenous agents (e.g. farmers, breeders and fishermen). Hence this stakeholder consists of various groups of companies depending on the product they offer.

- Ready meals manufacturer: They develop recipes, source ingredients, cook and package meals, ensuring food safety and quality.

- Distributor: Provides transportation of goods and ready meals (as final products) across the supply chain.

- Government agency: Responsible for protecting public health by ensuring the safety, quality, and proper labelling of food products.

- Consumer: Purchases ready meals. It is challenging to represent in detail because it takes different forms like a hospital, university, catering services or even a single household.

The generic presented stakeholders have different characteristics and provide different views regarding the proposed information system. Apart from the consumer, most of the stakeholders are aware of the significance of traceability in a supply chain. In addition, there are stakeholders that could be additionally included in such as retail companies that distribute ready-to-eat meals from their shelves, technology providers that offer specialized services on blockchain infrastructures (e.g. data transfer between different blockchains), food quality control laboratories that issue certificates of suitability, etc. This is a strong indication that the context of the study is complex and mandates.

B. Proposed system architecture

The proposed system was designed with modular architecture to be able to support as many entities as possible. Initially the emphasis was on supporting the product traceability, but after a few improvement cycles and discussions he decided to provide tools for the end consumer, such as Nutrient profiler and Environmental Footprint were developed. In summary the following list presents the software modules of the proposed platform with a brief description.

- Production ledger: Gathering and storing the information that documents the entity of the suppliers

and the validation of the related location codes (Global Location Number - GLN). In addition, this module offers functions for organizing information that specializes in site characteristics (crop history, harvests, etc.) according to use.

- Quality Control: Definition and monitoring of quality control procedures as implemented by each production unit. Support of common quality standards (eg ISO 22000, HACCP) and accompanying certificate forms as derived from laboratory measurements.

- External traceability: Monitoring and recording of the transport project between two consecutive points. Tracking and recording of shipments (departure, transport and arrival events) can be supported by location tracking and recording of transport conditions.

- Internal traceability: Define events according to GS1 and EPCIS to monitor the production process [29]. EPCIS master events are defined by supplier and item to support tracking of traded items. Provide interfaces with production lines to determine batch labeling within the production facility up to pre-departure for downstream parts of the supply chain. Retention of data to support batch recall.

- Nutrient profiler: Support the nutritional characteristics of ready meals according to the creation ingredients and additives recorded by the production process.

- Food and product labeling: Tool to create valid labels of the codes that are traded and implement the recommendations of GS1.

Environmental Footprint: Determination of the environmental footprint of ready meals covering the entire supply chain and provided the data is provided by the participants. The factors considered vary depending on the packaging materials, the preparation process of the ready meal, the origin of the raw materials, etc.

- Consumer mobile application: Providing ready meal information to the final consumer.

- Blockchain infrastructure: The proposed platform leverages blockchain infrastructure to store data that serves transparency and trust between the involved roles.

The next figure illustrates the proposed architecture and depicts the interaction between the traceability system and the stakeholders.

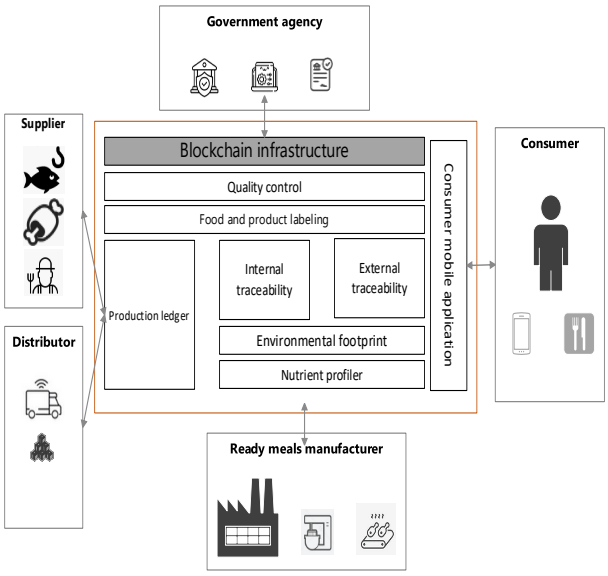

Fig.1: Proposed system's architecture

We consider the replacement of automatic data capturing devices (such as IoT sensors) with semi-automated approach supported by mobile devices and QR codes. The underlying idea is that a human controlled technological intervention will increase the adoption likelihood by the users and foster a more flexible working system. Such an approach allows some very-small and small-medium enterprises, usually located at the upper tier of supply chain, to participate with minimum entry cost.

The general principle of the proposed system is when an event occurs in the supply chain (e.g. harvest a new batch of tomatoes, deliver frozen fish, cook chicken curry) then it should be recorded based on GS1 standards and represented with a QR code. The events are pre-defined and associated with different roles. It is also possible to create a new event to better reflect the operational capability and requirements of a trading partner. In addition, the execution of a receipt within the ready meals manufacturer requires a few sequential steps and blend of semi-final products. The traceability within the production plant is crucial because a significant number of materials are processed daily during the meal preparation. Thus, the module of internal traceability will provide the required tools and services to synchronize the execution of a ready meal receipt with the mixture of ingredients used.

To increase the trust between the trading parties the adoption of blockchain infrastructure. Blockchain creates a trusted environment where all parties can verify the authenticity and integrity of transactions, reducing the need for intermediaries and building confidence in the relationship [30], [31], [32] and [34].

To this end the proposed system could offer some functionality to tackle ready meals traceability. The next section encodes user's perspectives and some requirements asked by the users.

IV. EXPERT'S PERSPECTIVES ON FOOD TRACEABILITY

During the conceptual design of the proposed system, we had the opportunity to share some

technical approaches with business experts. In this section we present the perception of users and how these perspectives transformed to system requirements in brief.

In this section we briefly present the discussions with different experts related to ready meals. Although we had in-depth interviews with various experts, in this section we selected to present in brief interaction we had with marketing, sales, supply chain and government agency experts.

The discussion with a marketing expert was influential because it convinced the team to introduce consumer as key user to the platform. At the early design stages the consumer was out of the scope because the focus was on the operational support of the companies. The marketing expert pointed out that consumers receive trust likewise as any other trading partner and we should include in the scope of the system. Moreover, the marketing expert proposed engaging the consumer by providing additional content and the target groups Millennials and Gen Z, prioritize ethical consumption. Implementing traceability in packaged ready meals not only aligns with current consumer trends and values but also enhances brand reputation, ensures food safety, and provides a competitive advantage. In the same direction was the discussion with sales experts. The latter think that they can effectively communicate the value of traceability in packaged meals, it as a new tool to drive sales and differentiate from competitors.

Contrary to the consumer centric discussion, a supply chain expert focused on the practical and operational aspects of traceability, the increased visibility, risk management, and overall supply chain improvement. The Government expert perspective is at a more generic level and discussed the topics of public health and regulatory compliance.

Table II depicts the relationship between the topics introduced and justified by the experts (some quotes are also included) and how these perspectives had influenced the proposed system. In some cases the impact is not on the system itself but shaped by some post-implementation configuration parameters.

It is apparent that the expert opinion was fully utilized under this research. However, we note that all the experts addressed different perspectives on the topic of traceability and didn't encounter how we can achieve traceability, but how we can capitalize it. All the experts were aware about how slow food traceability is currently, how stressful on the personnel are the recall incidents and they all agree that even a small improvement would be welcomed by the industries involved.

Traceability in food supply chains, and in particular for ready meals, is a multifaceted phenomenon that require further study and has impacts on various fields of the social life. The implementation of traceability systems opens numerous avenues for future research like the study of the efficacy of different traceability technologies, the impact on supply chain transparency, and the effects on consumer trust and behavior.

The use of technologies such as blockchain and data analytics in traceability represents a significant integration of advanced technology into the food industry. In a globalized food supply chain, traceability becomes even more critical. Research can focus on the challenges and solutions for implementing traceability in international contexts, considering factors such as differing regulations, technological infrastructure, and economic conditions.

Looking ahead, future trends in traceability might include the integration of artificial intelligence and machine learning to predict and mitigate risks, the use of more sophisticated sensors for real-time monitoring, and the development of global standards for traceability. These trends present exciting opportunities for cutting-edge research and innovation.

TABLE II. INDICATIVE INDICATIVE LENS SUGGESTED BY THE EXPERTS

Expert	Topic	Quotes	Impact
Marketing	Consumer trust	*"…consumers are increasingly conscious about the origins of their food. Traceability provides transparency, allowing customers to see exactly where their meal ingredients come from…"*	Introduction of consumer in the scope of the system
	Modern consumer requirements	*"…products that align with their values, such as sustainability, ethical sourcing, and environmental impact…"*	
	Customer Engagement	"*…QR codes on packaging can link to detailed information about the meal's ingredients, offering an educational and engaging experience…*"	
Sales	Build brand trust	"*…we show our commitment to quality and food safety. This can significantly enhance our brand's reputation, leading to increased customer loyalty…*"	Initiate discussions regarding the Return On Investment of the proposed system
	Premium pricing	*"Traceability adds value to our products, justifying a premium price point."*	
Supply chain	Enhanced Visibility	*"…greatly enhances supply chain visibility. It allows us to track every step of the process, from raw material sourcing to final delivery, ensuring we have real-time insights into our operations."*	Distinguish internal and external traceability modules Set experiments to examine the ability of the system to recall management issues
	Recall Management	*"…traceability systems enable us to conduct precise and efficient recalls. We can identify the specific batches affected and isolate them quickly, minimizing the impact on consumers and reducing the overall cost of the recall process..."*	
	Risk management	*"By having detailed information about each step, we can anticipate potential disruptions and develop contingency plans to ensure continuity of supply. This proactive approach is essential for maintaining a resilient supply chain."*	
Government agency	Public health	*"Traceability systems are essential for enhancing food safety and protecting public health. By enabling the tracking of food products from farm to table, we can*	Adoption of Blockchain to enhance

		quickly identify and isolate sources of contamination, thereby preventing foodborne illnesses and ensuring the safety of our food supply."	regulatory compliance
	Regulatory Compliance	*"…is crucial for ensuring compliance with food safety regulations. These systems help food producers, processors, and distributors meet regulatory requirements and avoid legal penalties."*	

V. Conclusions

The development of a novel food traceability system for ready meals has underscored the critical importance of integrating technological innovations with industry expertise. This study highlights that ensuring food safety, enhancing supply chain transparency, and addressing consumer trust requires a tailored approach that accounts for the unique challenges of the ready meals industry. The proposed system not only aligns with existing regulatory frameworks but also introduces scalable solutions to minimize adoption barriers, making it accessible even to small and medium-sized enterprises.

Expert insights have proven instrumental in shaping the system's design, ensuring that it meets the practical needs of stakeholders across the supply chain. From enabling consumers to access detailed product information to providing manufacturers with tools for internal and external traceability, the platform demonstrates its capacity to enhance operational efficiency and consumer engagement. Moreover, the integration of blockchain technology reinforces data transparency and trust among all trading partners, addressing the increasing demand for accountability in the food industry.

In conclusion, this research paves the way for further exploration into the integration of advanced technologies like artificial intelligence and IoT for real-time monitoring and predictive analytics in traceability systems. By fostering collaboration among stakeholders and prioritizing consumer-centric features, the proposed traceability platform can serve as a model for the broader food industry. Future work could focus on refining system modules, addressing interoperability challenges, and evaluating the long-term impact of traceability systems on supply chain sustainability and consumer behavior.

Acknowledgment

This work was supported by the "RESEARCH AND INNOVATION COLLABORATION IN REGION OF ATTICA" in Program "Attica 2014-2020" [grant number ATTP4-0352041]

References

[1] Bateman, A. (2015). Tracking the value of traceability. *Supply Chain Management Review*, *9*, 8-10.

[2] Duan, Y., Miao, M., Wang, R., Fu, Z., and Xu, M. (2017). A framework for the successful implementation of food traceability systems in China. *The Information Society*, *33*(4), 226-242.

[3] Lin, Q., Wang, H., Pei, X., and Wang, J. (2019). Food safety traceability system based on blockchain and EPCIS. *IEEE access*, *7*, 20698-20707.

[4] Islam, S., Cullen, J., and Manning, L. (2021). Visualising food traceability systems: A novel system architecture for mapping material and information flow. *Trends in Food Science & Technology*, *112*, 708-719.

[5] Galvez, J. F., Mejuto, J. C., and Simal-Gandara, J. (2018). Future challenges on the use of blockchain for food traceability analysis. *TrAC Trends in Analytical Chemistry*, *107*, 222-232.

[6] Liu, R., Gao, Z., Snell, H. A., and Ma, H. (2020). Food safety concerns and consumer preferences for food safety attributes: Evidence from China. *Food Control*, *112*, 107157.

[7] Tian, F. (2016, June). An agri-food supply chain traceability system for China based on RFID & blockchain technology. In *2016 13th international conference on service systems and service management (ICSSSM)* (pp. 1-6). IEEE.

[8] Zhang, Y., Wang, W., Yan, L., Glamuzina, B., and Zhang, X. (2019). Development and evaluation of an intelligent traceability system for waterless live fish transportation. *Food control*, *95*, 283-297.

[9] Yiying, Z., Yuanlong, R., Fei, L., Jing, S., and Song, L. (2019). Research on meat food traceability system based on RFID technology. In *2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC)* (pp. 2172-2175). IEEE.

[10] Zhang, X., Sun, P., Xu, J., Wang, X., Yu, J., Zhao, Z., and Dong, Y. (2020). Blockchain-based safety management system for the grain supply chain. *IEEE Access*, *8*, 36398-36410.

[11] Xiao, X., He, Q., Li, Z., Antoce, A., and Zhang, X. (2017). Improving traceability and transparency of table grapes cold chain logistics by integrating WSN and correlation analysis. *Food Control*, *73*, 1556-1563.

[12] Wang, X., Fu, D., Fruk, G., Chen, E., and Zhang, X. (2018). Improving quality control and transparency in honey peach export chain by a multi-sensors-managed traceability system. *Food control*, *88*, 169-180.

[13] Drishya, C., Subhasri, D., Dutta, S., Moses, J. A., & Anandharamakrishnan, C. (2024). Block chain management for the food industry. In *Emerging Technologies for the Food Industry* (pp. 133-156). Apple Academic Press.

[14] Ghode, D. J., Wagire, A. A., Dwaramwar, P. A., & Khobragade, R. H. (2023). Blockchain Technology Enabled Traceability Framework: Food Supply Chain Perspective. *Journal of Graphic Era University*, *12*(01), 1-14.

[15] Jalagam, M., Thanuja, R. N., Vaishnavi, Y. L., Naresh, K., & Suryakanth, V. G. (2024, October). Decentralized Applications for Agricultural Supply Chain: Exploring the Potential on the Ethereum Blockchain using Smart Contracts. In *2024 IEEE International Conference on Blockchain and Distributed Systems Security (ICBDS)*, 1-4. 17-19 October 2024, Pune, India.

[16] Kshetri, N. (2023). Blockchain's Role in Enhancing Quality and Safety and Promoting Sustainability in the Food and Beverage Industry. *Sustainability*, *15*(23), 16223.

[17] Sugandh, U., Nigam, S., Khari, M., & Misra, S. (2023). An approach for risk traceability using blockchain technology for tracking, tracing, and authenticating food products. *Information*, *14*(11), 613.

[18] Camel, A., Belhadi, A., Kamble, S., Tiwari, S., & Touriki, F. E. (2024). Integrating smart Green Product Platforming for carbon footprint reduction: The role of blockchain technology and stakeholders influence within the agri-food supply chain. *International journal of production economics*, *272*, 109251. https://doi.org/10.1016/j.ijpe.2024.109251

[19] Hurduzeu, G., & Popescu, M. F. (2023). Blockchain in Agriculture: Transforming the Food Supply Chain for Transparency and Efficiency in the European Union. *Agricultural Economics and Rural Development*, *20*(2), 145-153.

[20] Rakhra, M., Singh, P., Khanna, A., Angra, P. K., Kumar, A., & Katoch, N. (2024). Developing a Blockchain Framework for Enhancing Security in Food Supply Chains. In *2024 International Conference on Electrical Electronics and Computing Technologies (ICEECT)*, 29-31 August 2024, Greater Noida, India.

[21] Zhang, X. (2024). Blockchain Technology Adoption in the Food Supply Chain: Challenges and Recommendations for Modern Businesses. *Highlights in Business, Economics and Management*, *28*, 150-156.

[22] Costa, A. I. D. A., Dekker, M., Beumer, R. R., Rombouts, F. M., and Jongen, W. M. (2001). A consumer-oriented classification system for home meal replacements. *Food Quality and Preference*, *12*(4), 229-242.

[23] Alkerwi, A., Crichton, G., and Hébert, J. (2015). Consumption of ready-made meals and increased risk of obesity: findings from the Observation of Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) study. *British Journal of Nutrition*, *113*(2), 270-277.

[24] Ahlgren, M., Gustafsson, I. B., and Hall, G. (2004). Attitudes and beliefs directed towards ready-meal consumption. *Food Service Technology*, *4*(4), 159-169.

[25] Calderón, L., Herrero, M., Laca, A., and Díaz, M. (2018). Environmental impact of a traditional cooked dish at four different manufacturing scales: from ready meal industry and catering company to traditional restaurant and homemade. *The International Journal of Life Cycle Assessment*, *23*, 811-823.

[26] Kanzler, S., Manschein, M., Lammer, G., and Wagner, K. H. (2015). The nutrient composition of European ready meals: protein, fat, total carbohydrates and energy. *Food chemistry*, *172*, 190-196.

[27] Scholliers, P. (2015). Convenience foods. What, why, and when. *Appetite*, *94*, 2-6.

[28] Tessitore, S., Iraldo, F., Apicella, A., and Tarabella, A. (2022). Food traceability as driver for the competitiveness in Italian food service companies. *Journal of Foodservice Business Research*, *25*(1), 57-84.

[29] GS 1(2022, September) EPCIS Standard. www.gs1.org. https://ref.gs1.org/standards/epcis/

[30] Tama, B., Kweka, B., Park, Y., and Rhee, K. (2017, August). A critical review of blockchain and its current applications. In *2017 International Conference on Electrical Engineering and Computer Science (ICECOS)* (pp. 109-113). IEEE.

[31] Feng, H., Wang, X., Duan, Y., Zhang, J., and Zhang, X. (2020). Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges. *Journal of cleaner production*, *260*, 121031.

[32] Creydt, M. and Fischer, M. (2019). Blockchain and more-Algorithm driven food traceability. *Food Control*, *105*, 45-51.

[33] Jin, S., Zhang, Y., and Xu, Y. (2017). Amount of information and the willingness of consumers to pay for food traceability in China. *Food Control*, *77*, 163-170.