Market Study for a Traceability System

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Traceability is becoming an essential tool for both the industry and consumers to confirm the characteristics of food products, leading industries to implement traceability to their merchandise. In order for the Computer Technology Institute and Press “Diophantus” (CTI) to help small and medium-sized enterprises (SMEs) implement traceability systems based on open innovation, principles were introduced.

Keywords: traceability ; pork meat ; market research

1. Traceability

In the last years, the food scandals in Europe and China unveiled the importance of an all-encompassing food traceability system. The UK mad cow disease, the 2013 horsemeat scandal in the European Union (EU), and the 2008 melamine scandal in China [1] were only a few of them and showed the need for new regulations and procedures about food fraud and food safety. Situations such as these not only erode the reputation of companies and have economic impacts [2] but can also be dangerous for consumers’ health, whether they are intentional or not [3].

Food traceability is the ability to access specific information about a food product that has been captured and integrated with the product’s recorded identification throughout the supply chain.

In any case, traceability refers to a system that can continuously track a food product and its history and location. The main principles of traceability were defined by Codex Alimentarius Commission (CAC) as the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution [4]. This is one of the main definitions but several others have been proposed depending on standardization, organizations, legislations, and the academic literature [5].

Practically, a system such as this encompasses the creation of identification for each product in all the stages of the supply chain (farm to fork). This ID is coded on the product and corresponds to a file containing information about the history of the product and its components, both in the previous and next stages of the chain (sequential traceability) and in the current stage (internal traceability).

Traceability shows the complete history of the product, which is very advantageous, especially during crisis management, as a defective product can be located and recalled at any step. Furthermore, traceability can also provide information that allows better control of all the processes (e.g., optimal use of raw materials, inventory control, production planning, troubleshooting should an issue arise, quality control, etc.). Traceability can also be used at any time in order to substantiate the company’s claims about the characteristics of its products (e.g., quality, origin, GMOs, etc.) [5][6][7][8].

Obviously, an effective traceability system must be very complex to include all the information needed for each product and all the procedures for making said product. However, it is difficult for small and medium-sized enterprises (SMEs) to implement a traceability system on their own, mainly due to lack of funds or know-how [9].

Traceability systems are also critical in terms of commerce. An implemented traceability system can allow seamless global trade of products that have verified origins [10]. The EU, China, Canada, India, and other countries heavily promote traceability. However, since there will inadvertently be variations of what these traceability systems contain due to differences across geographies, cultures, and products, there is a need to make traceability components compliant with standards shared by all partners, which will, in turn, make it easier to share and compare information [10]. Recently, consumers’ perception of Greek traditional foods using variables related to package, product, quality, process, and personal information was investigated [11]. The results show that consumers considered questions on package information “quite important” and “very important” by an average of 68%, on food information by 64%, on quality information by 69%, on the production process by 78%, and on personal information by 65%.

Many different techniques have been used to prove traceability and food authenticity. Analytical methods such as GC, HLPC, and several spectroscopic and DNA analysis techniques are being used to confirm traceability and determine if a product has been adulterated [12][13].

The leaps made in technology have helped to overcome several issues concerning traceability. For example, portable spectroscopy devices can provide rapid, on-site, easy-to-use, and cost-effective food analysis throughout the whole food supply chain. Furthermore, blockchain technology could improve traceability throughout the entire supply chain combined with other approaches. However, such platforms are impossible to be used in several parts of the world. If digitization is not advanced enough, and is not in many instances, any potential system will be unavailable and unusable to companies and end-users alike [14]. Cell phones have abilities that can be used to make traceability more efficient and make traceability information more available to consumers. By scanning a code (QR code, bar code, etc.) or using NFC technology, consumers can trace information and can be easily connected to databases that have all the available information (food origin, feeds, and date of slaughtering for meat, pesticides that were used on fruits and vegetables, etc.) from the point it was produced to the point of sale [15].

There is also a high interest in specifically implementing blockchain in traceability systems. It has been shown that blockchains and other distributed ledger technologies can help implement traceability and sharing of information for small and medium enterprises [16]. Blockchain's capacity of irreversibly storing data, as well as other features it has, has shown promising results as it can create a secure string of information that can be shared with everyone (industry, consumers, and authorities) [17]. However, as of now, only a few programs have been launched concerning traceability, making it too soon to tell whether this is something that will be genuinely beneficial to the industry as well as consumers [18][19]. Furthermore, many challenges need to be addressed as to how an implementation such as this one will happen [20], considering it requires costly infrastructure changes [21].

Nevertheless, some severe issues concern consumers and the meat-producing industries considering meat traceability. As of now, there is no unifying framework concerning meat traceability, which leads to confusion as different principles and guidelines exist simultaneously [22]. However, to this end, new research efforts are being made so that all participants follow the same procedures, while new flexible and user-friendly traceability systems are also being proposed [6][22][23].

2. Current Status of Pork Production in Greece

Pork meat consumption fluctuates annually in Greece. Consumption fell slightly by 7.3%, reaching 884 thousand tons in 2017, remaining almost at the same level as in 2016. The degree of self-sufficiency in the domestic meat market has remained stable at about 52% over the last five years [24].

Pork outperforms consumer preferences over other types of meat:

- The per capita consumption of pork has remained stable at 27.2 kg/person in recent years;
- Poultry meat follows, with an annual per capita consumption of 26.9 kg/person in 2017;
- Beef/veal (15.4 kg/person);
- Sheep and goat meat (6.8 kg/person).

Pork consumption amounted to 292.5 thousand tons in 2017. A percentage of 53% of the pork in the domestic market was imported from 2013–2017. On the other hand, pork-meat exports were very limited, covering only 9–11% of production. The degree of self-sufficiency in pork has shrunk by 9% over the last seven years [24].

3. Open Innovation

SMEs have limited resources and capabilities, which restricts them significantly [25]. This can be helped by implementing open innovation to provide a viable solution. Open innovation is a relatively new term; it first appeared in the 2003 book of Chesbrough, and it proposed that companies combining internal and external ideas when innovating would benefit more than by adhering to the traditional research and development model [26]. The prevailing definition for open innovation is purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively [27]. This means practically that, instead of a closed-off research and development process with an in-house team, collaborations are promoted between different partners combining forces. As a result, diverse collaborators such as companies, research centers, universities, and even people working on the project have a positive

effect as the different perspectives and backgrounds of everyone involved lead to the creation of better products, services, or research [28].

The research institutes participating in open innovation reaped many benefits as it was found that it strengthened the position of the public research institute, increased internal networking, and broadened and improved the capabilities and knowledge of the involved researchers [29]. Furthermore, research consistently shows that open innovation has been beneficial to firms that have used it [30]. More specifically, there have been many success stories when open innovation was used in the food industry, creating fascinating results [31].

As new technology appears to need multidisciplinary development, open innovation can help, as a single organization struggles to provide what is needed, especially if it is a smaller one [32].

For a successful open collaboration to provide the necessary results, finding the right partners for the project is vital. Computer Technology Institute and Press “Diophantus” (CTI) was approached for this project. CTI Diophantus has the know-how to create and implement a complete traceability system. This system will allow consumers, using various types of smartphones, etc., to access all information available for the products through an integrated data center.

This collaboration is beneficial as an SME would not have been able to spend funds and time to create or license a traceability system just for themself. On the other hand, CTI Diophantus can further proceed with the research work created from all the steps towards implementing the traceability system in real life. This is quite significant, as SMEs are usually more directed to using open innovation during the commercialization and seldom during the research phase, as in this case [33].

References

1. Pei, X.; Tandon, A.; Alldrick, A.; Giorgi, L.; Huang, W.; Yang, R. The China melamine milk scandal and its implications for food safety regulation. Food Policy 2011, 36, 412–420.
2. Li, S.; Wang, Y.; Tacken, G.M.L.; Liu, Y.; Sijtsema, S.J. Consumer trust in the dairy value chain in China: The role of trustworthiness, the melamine scandal, and the media. J. Dairy Sci. 2021, 104, 8554–8567.
3. Visciano, P.; Schirone, M. Food frauds: Global incidents and misleading situations. Trends Food Sci. Technol. 2021, 114, 424–442.
4. FAO Codex Alimentarius. Principles for traceability/product tracing as a tool within a food inspection and certification system. Cac/Gl 2018, 1, 1–423.
5. Islam, S.; Cullen, J.M. Food traceability: A generic theoretical framework. Food Control. 2021, 123, 107848.
6. Charalampous, V.; Margariti, S.V.; Salmas, D.; Stylios, C.; Kafetzopoulos, D.; Skalkos, D. Design and develop cloud-based system for meat traceability. CEUR Workshop Proc. 2020, 2761, 475–484.
7. Galimberti, A.; Casiraghi, M.; Bruni, I.; Guzzetti, L.; Cortis, P.; Berterame, N.M.; Labra, M. From DNA barcoding to personalized nutrition: The evolution of food traceability. Curr. Opin. Food Sci. 2019, 28, 41–48.
8. Espiñeira, M.; Santaclara, F.J. What Is Food Traceability? Elsevier Ltd.: Amsterdam, The Netherlands, 2016; ISBN 978-0-08-100321-3.
9. Curto, J.P.; Gaspar, P.D. Traceability in food supply chains: Review and SME focused analysis—Part 1. AIMS Agric. Food 2021, 6, 679–707.
10. Qian, J.; Ruiz-Garcia, L.; Fan, B.; Robla Villalba, J.I.; McCarthy, U.; Zhang, B.; Yu, Q.; Wu, W. Food traceability system from governmental, corporate, and consumer perspectives in the European Union and China: A comparative review. Trends Food Sci. Technol. 2020, 99, 402–412.
11. Skalkos, D.; Kosma, I.S.; Vasiliou, A.; Guine, R.P.F. Consumers’ trust in greek traditional foods in the post covid-19 era. Sustainubility 2021, 13, 9975.
12. Bianchi, F.; Giannetto, M.; Careri, M. Analytical systems and metrological traceability of measurement data in food control assessment. TrAC-Trends Anal. Chem. 2018, 107, 142–150.
13. Wadood, S.A.; Boli, G.; Xiaowen, Z.; Hussain, I.; Yimin, W. Recent development in the application of analytical techniques for the traceability and authenticity of food of plant origin. Microchem. J. 2020, 152, 104295.
14. McVey, C.; Elliott, C.T.; Cannavan, A.; Kelly, S.D.; Petchkongkaew, A.; Haughey, S.A. Portable spectroscopy for high throughput food authenticity screening: Advancements in technology and integration into digital traceability systems.

Trends Food Sci. Technol. 2021, 118, 777–790.

15. Ma, T.; Wang, H.; Wei, M.; Lan, T.; Wang, J.; Bao, S.; Ge, Q.; Fang, Y.; Sun, X. Application of smart-phone use in rapid food detection, food traceability systems, and personalized diet guidance, making our diet more health. Food Res. Int. 2022, 152, 110918.
16. Hashimy, L.; Treiblmaier, H.; Jain, G. Distributed ledger technology as a catalyst for open innovation adoption among small and medium-sized enterprises. J. High Technol. Manag. Res. 2021, 32, 100405.
17. Iftekhar, A.; Cui, X. Blockchain-based traceability system that ensures food safety measures to protect consumer safety and COVID-19 free supply chains. Foods 2021, 10, 1289.
18. Feng, H.; Wang, X.; Duan, Y.; Zhang, J.; Zhang, X. Applying blockchain technology to improve agri-food traceability: A review of development methods, benefits and challenges. J. Clean. Prod. 2020, 260, 121031.
19. Galvez, J.F.; Mejuto, J.C.; Simal-Gandara, J. Future challenges on the use of blockchain for food traceability analysis. TrAC-Trends Anal. Chem. 2018, 107, 222–232.
20. Pearson, S.; May, D.; Leontidis, G.; Swainson, M.; Brewer, S.; Bidaut, L.; Frey, J.G.; Parr, G.; Maull, R.; Zisman, A. Are Distributed Ledger Technologies the panacea for food traceability? Glob. Food Sec. 2019, 20, 145–149.
21. Creydt, M.; Fischer, M. Blockchain and more—Algorithm driven food traceability. Food Control. 2019, 105, 45–51.
22. Kafetzopoulos, D.; Stylios, C.; Skalkos, D. Managing traceability in the meat processing industry: Principles, guidelines and technologies. CEUR Workshop Proc. 2020, 2761, 302–308.
23. Haleem, A.; Khan, S.; Khan, M.I. Traceability implementation in food supply chain: A grey-DEMATEL approach. Inf. Process. Agric. 2019, 6, 335–348.
24. ICAP CRIF Business Information Services|ICAP CRIF in Greece MEAT; ICAP CRIF: Athens, Greece, 2018.
25. Gamage, S.K.N.; Ekanayake, E.M.S.; Abeyrathne, G.A.K.N.J.; Prasanna, R.P.I.R.; Jayasundara, J.M.S.B.; Rajapakshe, P.S.K. A review of global challenges and survival strategies of small and medium enterprises (SMEs). Economies 2020, 8, 79.
26. Chesbrough, H.W. Open innovation. In The Routledge Companion to Innovation Management; Routledge: London, UK, 2019; p. 24.
27. Chesbrough, H. Open Innovation: The New Imperative for Creating and Profiting from Technology; Harvard Business Press: Boston, MA, USA, 2006; pp. 1–9.
28. Tang, T.Y.; Fisher, G.J.; Qualls, W.J. The effects of inbound open innovation, outbound open innovation, and team role diversity on open source software project performance. Ind. Mark. Manag. 2021, 94, 216–228.
29. Van Lancker, J.; Wauters, E.; Van Huylenbroeck, G. Open innovation in public research institutes -success and influencing factors. Int. J. Innov. Manag. 2019, 23, 1950064.
30. Lu, Q.; Chesbrough, H. Measuring open innovation practices through topic modelling: Revisiting their impact on firm financial performance. Technovation 2021, 102434.
31. Miglietta, N.; Battisti, E.; Campanella, F. Value maximization and open innovation in food and beverage industry: Evidence from US market. Br. Food J. 2017, 119, 2477–2492.
32. Uribe-Echeberria, R.; Igartua, J.I.; Lizarralde, R. Implementing open innovation in research and technology organisations: Approaches and impact. J. Open Innov. Technol. Mark. Complex. 2019, 5, 91.
33. Bertello, A.; Ferraris, A.; De Bernardi, P.; Bertoldi, B. Challenges to open innovation in traditional SMEs: An analysis of pre-competitive projects in university-industry-government collaboration. Int. Entrep. Manag. J. 2022, 18, 89–104.