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The impact of digital technologies on Food Companies' Information Systems: a literature review

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Abstract. Made in Italy companies, and in particular those operating in the food sector, play a fundamental role in the Italian economy and represent its most dynamic component. Technologies, and in particular smart technologies, are becoming a key factor so as to be progressively adopted in manufacturing companies, in particular in the manufacturers of machines, plants, production equipment, food processing and preservation. Therefore, the implementation and use of innovative accounting information systems also seem essential to transform the strategic planning process by providing new relationships with employees, customers and suppliers, new ways of data analysis to support strategic actions [1], changing competitive dynamics and suggesting new sources of innovation [2]. The rise of the fourth industrial revolution [3] is opening new growth opportunities for territories and businesses, which can achieve superior performance through these technological processes. The aim of this research is to identify, through a systematic literature review, what is the state of the art on information systems and technologies of the digital world and how they affect organizations belonging to the food sector.

Keywords: food, technology, information systems, smart technologies.

1 Introduction

In today's economy, businesses are increasingly characterised by a global competition and the rise of the fourth industrial revolution [3] is opening new growth opportunities for territories and businesses, which can achieve superior performance through these technological processes. The implementation and use of innovative accounting information systems is essential to transform the strategic planning process by providing new relationships with employees, customers and suppliers, new ways of data analysis to support strategic actions [1], changing competitive dynamics and suggesting new sources of innovation [2].

Thus, towards an entirely collaborative business model, modern companies have to improve their own business practices and to share with their suppliers, distributors, and customers the critical in-house information they once aggressively protected [4] if they aim to upgrade their capabilities and remain competitive.

Smart technologies, embedding all those technological innovations, such as blockchain, artificial intelligence, IoT, and big data analytics, emerged during the actual fourth revolution, play a relevant role in today's competitive environments and can have

a major impact on business sustainability [5]. This emphasis is driving companies to make relevant investments to explore smart technologies to build or improve their sustainable business models [6,7].

The food industry is an example of a dynamic environment with customers with high expectations for food safety and a growing demand for sustainability produced food [8]. Companies fulfilling these demands must consider all three dimensions of economical, environmental, and social sustainability. In this perspective, the companies operating in the food sector have to maintain control over their supply chain, overall performance to achieve a competitive advantage with the implementation of dynamic capabilities [9].

In a recent research, it is widely acknowledged that accounting information systems applications can transform the existing technical and social relationships in business sector, as it connects businesses, suppliers and consumers and creates new business models, while innovative and user-friendly Decision Support Systems can support the farmer-manager in the difficult process of farm management and decision-making, simulate different scenarios and policies and propose alternative production plans [10].

In the threshold of the 21st century even more businesses are trying to compete in the global competitive market, improve their function and gain a competitive advantage by using information systems and information technology. Often, food companies use information systems to improve the management of their functions and they apply such systems in human resources, in finance and accounting, in sales and marketing, in operational functions and in production [11].

The aim of this research is to identify, through a systematic literature review, what is the state of the art on information systems and technologies of the digital world and how they affect organisations belonging to the food sector. Our main purpose is to understand the achievement of previous literature on the food sector and the impact of innovative information systems that imbed digital smart technologies. We conducted a literature review through the Scopus database examining publications over the past decade since the emergence of the fourth industrial revolution and the spread of related technologies. Our contribution is aimed at clarifying the main streams of research in order to highlight future trends.

The following of the paper is organised as follows. After the introduction, a section containing the research methodology adopted for the review and the data collection process is provided. Section 3 describes the main research trends and topic streams are explained in Section 4. Section 5 provides primary conclusions.

2 Research Methodology and Data collection

For this research a literature analysis was conducted for "*the collection, handling and analysis of quantitative bibliographical data, derived from scientific publications*" [12, p. 181].

Authors Denyer and Tranfield [13, p. 216] state that "the most common technique in managerial research is the traditional literature review in which the researcher summarizes and interprets previous contributions in a subjective and narrative way".

Starting from this definition it was decided, for this study, to use a literature review to examine the current status of existing studies on the topic of information systems and the various types of intelligent technologies applied to the food industry by analysing the resulting papers on the basis of the principles descriptive analysis and content analysis [14].

The research was conducted on the Scopus database, main database of scientific articles, in June 2022.

The research of the papers on information systems and smart technologies in the food sector has been carried out following different phases, discussed and agreed by the Authors of this paper, (Figure 1) in order to obtain a sufficient number of significant papers on these issues.

In the first phase the search was carried out with the following string: (TITLE-ABS-KEY ("food") AND TITLE-ABS-KEY ("information system*") AND TITLE-ABS-KEY ("technolog*") OR TITLE-ABS-KEY ("artificial intelligence") OR TITLE-ABS-KEY ("internet of") OR TITLE-ABS-KEY ("smart technolog*") .

As you can see from the string, quotes were used to get from the results, papers that had inside them the precise words and asterisks were used to get results with all the possible declinations of those words. The keywords were searched in TITLE-ABSTRACT-KEYWORDS to obtain the results that were as consistent as possible with the research topic. Boolean AND characters were also used for the first three keywords to obtain papers on information systems and technology in the food sector; OR was then used to search for different and more specific types of technologies. This search yielded 1368 results. As we intend to examine the studies on the recent trends of smart technologies used in information systems of companies operating in the food sector and since the expression "Industry 4.0" (the term used to identify the fourth industrial revolution for which smart technologies are the originators) was coined for the first time at the Hannover fair in 2011 in Germany, the research was mainly limited to documents published in the period 2012-2022. This second limitation produced 806 results. In the third phase the research was further refined by limiting the research to articles published only in journals (thus excluding conference papers) and articles in the research area "Business, management and accounting" as it is the research area of our interest. This limitation produced 37 results. Only for one paper of the 37 results obtained, neither the complete text nor the abstract was available and, therefore, it was decided to exclude it from our analysis as it was not possible to conduct the analysis on that paper. In conclusion, the final sample of papers to be analysed consists of 36 articles.

The analysis process was conducted on two dimensions: horizontal and vertical. In the horizontal dimension the attention has been turned to the use of the technologies in the information systems of the companies of the field of the food on the timeline: a descriptive analysis of the literature was carried out by analysing the distribution of papers per year of publication, analysing the distribution of articles according to the journal in which they were published, identifying the most commonly used keywords and, finally, identifying the most cited papers; in the vertical dimension, instead, the

articles have been read in their entirety to identify areas of research common to the documents subject to our analysis [15].

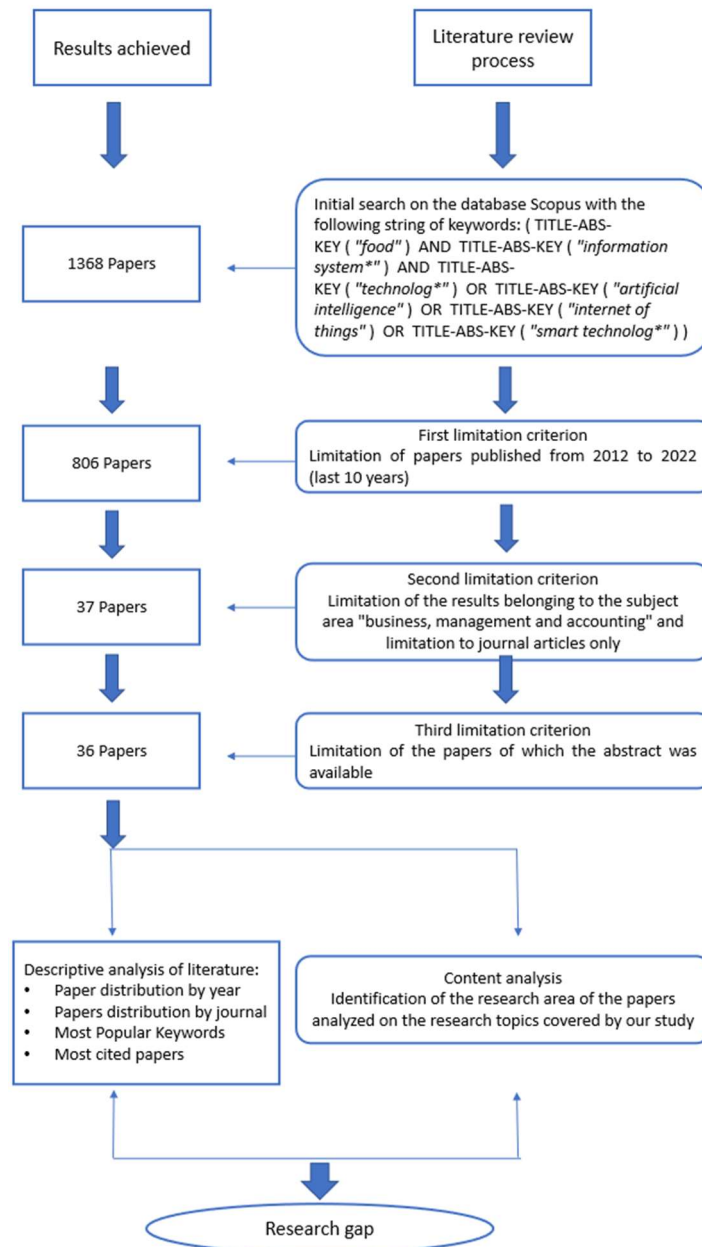


Fig. 1. Research process

3 Classification of the reviewed literature

3.1 Publication per years

Figure 2 shows the trend of publications on information systems and the main technologies in the food sector over the years. As we can see from the figure, the trend of publications over the years is fluctuating: in 2013 and 2017 there are peaks in the number of publications with, respectively, 6 and 7 articles on these issues published in recent years; In 2015, however, we find only one paper published. After a decline in 2019, year in which there are only 2 publications, the papers are held constant at 4 publications in the last 3 years.

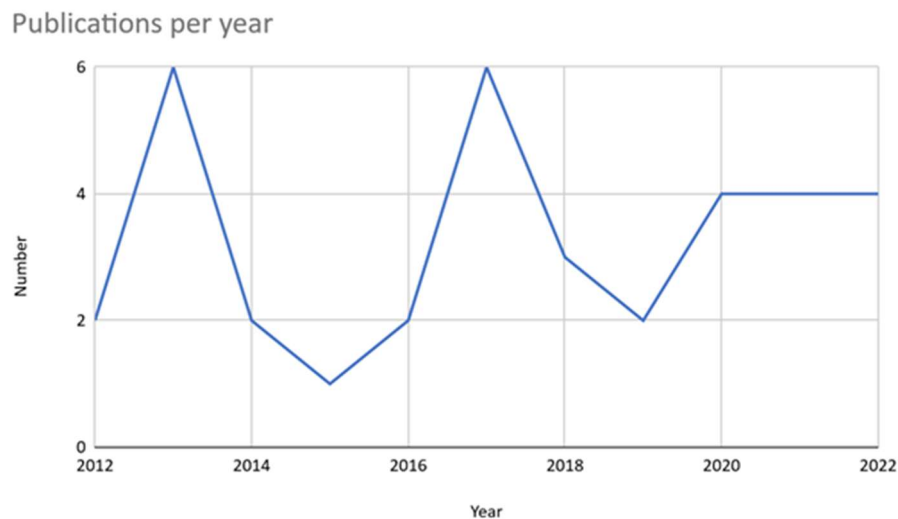


Fig. 2. Publications per year

3.2 Publication per journal

Figure 3 shows the classification of the individual journals according to the number of contributions published on the subject under our analysis. From Figure 3, the journals with the largest number of articles published were Industrial Management and Data

| KEYWORDS | N° |
|---------------------------------|----|
| Information System | 8 |
| Agricultural information system | 4 |
| Supply chain management | 3 |
| Technology | 3 |
| Technology acceptance model | 3 |
| Adoption | 2 |
| Blockchain | 2 |
| Business Intelligence | 2 |
| Decision making | 2 |
| Food industry | 2 |
| Food supply chain | 2 |
| Food traceability systems | 2 |
| Future internet | 2 |
| Global positioning system | 2 |
| Information technology | 2 |
| Supply chains | 2 |

Table 1. Most popular keywords

3.4 Most cited papers

The following Table 2 shows the 10 most cited papers in the literature.

| N. | Authors | Title | Year | Source title | Cited by |
|----|--|---|------|---|----------|
| 1 | Hew J.-J., Wong L.-W., Tan G.W.-H., Ooi K.-B., Lin B., | The blockchain-based Halal traceability systems: a hype or reality? | 2020 | Supply Chain Management | 26 |
| 2 | Sitek P., Wikarek J., Nielsen P., | A constraint-driven approach to food supply chain management | 2017 | Industrial Management and Data Systems | 25 |
| 3 | Verdouw C.N., Vucic N., Sundmaecker H., Beulens A.J.M., | Future Internet as a Driver for Virtualization, Connectivity and Intelligence of Agri-Food Supply Chain Networks | 2013 | International Journal on Food System Dynamics | 24 |
| 4 | Yoo C.W., Parameswaran S., Kishore R., | Knowing about your food from the farm to the table: Using information systems that reduce information asymmetry and health risks in retail contexts | 2015 | Information and Management | 23 |
| 5 | Song H., Ruan W.J., Jeon Y.J.J., | An integrated approach to the purchase decision making process of food-delivery apps: Focusing on the TAM and AIDA models | 2021 | International Journal of Hospitality Management | 13 |
| 6 | Egelyng H., Romsdal A., Hansen H.O., Slizyte R., Carvajal A.K., Jouvenot L., Hebrok M., Honkapää K., Wold J.P., Seljåsen R., Aursand M., | Cascading Norwegian co-streams for bioeconomic transition | 2018 | Journal of Cleaner Production | 13 |

| | | | | | |
|----|---|--|------|---|----|
| 7 | Jayakrishnan M., Mohamad A.K., Azmi F.R., Abdullah A., | Adoption of business in- telligence insights to- wards inaugurate busi- ness performance of Malaysian halal food manufacturing | 2018 | Management Science Letters | 12 |
| 8 | Bonomi S., Ricciardi F., Rossignoli C., | Network organisations for externality chal- lenges: How social en- trepreneurship co- evolves with ICT- enabled solutions | 2017 | International Journal of Knowledge- Based Develop- ment | 11 |
| 9 | Jayakrishnan M., Mohamad A.K., Azmi F.R., Abdullah A., | Implementation of busi- ness intelligence frame- work for Malaysian halal food manufactur- ing industry towards ini- tiate strategic financial performance manage- ment | 2018 | Management Science Letters | 10 |
| 10 | Zvezdov D., Hack S., | Carbon footprinting of large product portfolios. Extending the use of En- terprise Resource Plan- ning systems to carbon information manage- ment | 2016 | Journal of Clea- ner Production | 10 |

Table 2. Most cited papers

The first most cited paper aims to investigate the intention to participate in a Halal traceability system based on blockchain through a combined model that consists of Halal orientation strategy, institutional theory and dissemination of innovation theory.

The second most cited paper has the scope to construct a new approach that concurs the flexible modelling and the resolution of the problems of management of the food supply chain (FSCM).

The third most cited paper aims to enable new types of efficient and responsive logistics networks with flexible tracking and traceability systems that include chain and decision support based on such information.

The fourth most cited paper has developed a thrifty model of technology acceptance for food traceability systems.

The fifth most cited paper provides an understanding of the process of consumers accepting a food delivery app on demand and to establish the effect of marketing communication on results related to consumer behaviour.

The sixth most cited paper creates bioeconomic transition options in Norway and presents the results of a transdisciplinary investigation into the cases of the Norwegian food industry cases involving processing of fish, meat, fruit, and vegetable co-streams aiming to capture or even increase use and value of residues from processing.

The seventh most cited paper aims to bring out the knowledge from the BD organization and to use the BI together with the perception of the MIT90 framework and environmental factors for the analysis of the decision-making process of halal food producers in Malaysia.

The eighth most cited paper aims to investigate how forms of organization networks, information technology enabled solutions, as well as their institutional context, co-evolve in social entrepreneurship.

The ninth most cited paper aims to develop a BI framework to provide data analysis and action plan to help Malaysian Halal Food Manufacturing Industry (MHFMI) strategize financial performance.

Finally, the 10th most-cited paper sheds light on the requirements of a comprehensive carbon information management system and discusses the contribution of ERP systems to carbon information management for large product portfolios.

From the reading of the most cited papers before and of all the other papers then, two great lines of research have been identified: a first strand that concerns the use of technology for the sustainability of organizations in the food sector and a second strand that instead concerns the use of technology to support performance. These two strands of research will be investigated in more detail in the next paragraph.

4 Main topics analyzed

Once carried out the descriptive analysis of the selected papers showing the publication trends in this specific field of research, this section provides a review of the main topics investigated. After the autonomous reading of the papers, the authors identify two main topics able to synthesise the main research streams.

4.1 Technologies and Information Systems to support food sustainability

During the pandemic crisis resulting from Covid-19, consumers have become more aware of the sustainability not only of food production but also of packaging: consumers, in fact, are aware of the seriousness of the environmental situation of our planet and sustainability is the main driver of choice in food shopping for families. Sustainability is synonymous with controlled supply chain, local production linked to the

territory, completeness and clarity of food labels (Source: Nomisma Sustainability Observatory).

The food sector faces specific challenges, including product traceability, and one of the main challenges is the development of information systems that support such food traceability [16]. Canavari et al. [17] noted that product traceability is one of many information processes supporting a general goal of safe and quality food supply. Even sovereign states can introduce and adopt food standards to improve food security and protect their citizens from any risk associated with food protection [18,19]. Such protection can be provided by improving the provision of food information through mandatory or voluntary labelling measures [20]. Previous studies have shown that there may be an information asymmetry between sellers and consumers and that certain types of information systems may play an important role in reducing this asymmetry [21]. The development of Internet-based information systems promises to overcome these shortcomings, but it is widely accepted that the Internet faces a number of shortcomings regarding data processing, storage and transmission and control [22]. Future Internet infrastructure is expected to exceed these limits [22-24]. The opportunities of Future Internet technologies to address the specific demands of information systems for logistics in the food industry and the goal is to introduce the Future Internet for intelligent agri-food logistics information with the advantage of produce less food waste, to improve the safety of agri-food products, the better use of logistics capacity [25].

4.3 Integrated Information Systems with digital technologies to support performance

An issue relevant for researchers is related to the role of digital technologies and information systems to improve food companies' performance. In particular, many Scholars [26-28] assert that demonstrating the impact of IS on performance is important to foster the use and acceptance of Agricultural Information Systems (such as also food-delivery apps) among food companies' managers and farmers. Several studies, such as the one of Qataweh [29] and, are aimed at examining the influence of data mining (information and communication technologies, knowledge management, data warehousing, and data mining on performance and outcomes of accounting information system application through a mediating role of information technology infrastructure in the food sector.

Other studies [30,31] tested - also with quantitative methodologies - the effect of integrated information systems on reverse logistics performance considering costs and process performance. Actually, in the actual global competitive market, to try to compete, to improve business functions and gain a competitive advantage, it is necessary to use and apply integrated information systems to manage human resources, operational and production functions [11,32]. In this perspective, ERP systems have to be integrated with digital technologies, for example with Business Intelligence [33, 34].

Moreover, performance of companies operating in the food sector are affected by augmented reality retail applications used in both physical store and online shops that

are able to improve the retail settings and customer experience [35]. In fact, the development of Information Systems (IS) and Information and Communication Technologies is offering new opportunities for businesses to implement promotion strategies focused on customer attraction and retention [36].

5 Primary conclusion

It is now widely believed that during this century more and more companies must necessarily compete in the global competitive market in order to survive, and to do so they must improve their functions and processes to gain a competitive advantage partly through the use of information systems and information technology. In particular, food companies use information systems to improve the management of their functions and apply such systems in human resources, finance and accounting, sales and marketing, operational functions, and production [11].

The purpose of this research was to identify, through a systematic literature review, the state of the art of information systems and technologies in the digital world and how they affect organizations belonging to the food sector.

The analysis of the literature on papers investigating the different types of technologies and information systems that influence the industries of the food sector, together with the descriptive results (circulation of papers per year, publication of papers for journals, most commonly used keywords and more cited papers), have led to the identification of two main areas of research on this theme: the sustainability stream and the performance stream.

On the one hand, the sustainability papers have shown that consumers, especially in recent years, are increasingly interested in food traceability to understand where the food they buy comes from, to understand how it was produced, preserved and packaged and companies, to meet this need by consumers, are helped by the implementation of technology in the processes of logistics, production and packaging [i.e. 16, 22, 23, 25]. On the other hand, the papers belonging to the performance stream focus the investigation on the impacts of digital technologies and integrated information systems on food companies performance and also acceptance of the use of agricultural information systems that allow management to make better decisions for their company [i.e. 26, 27, 28, 33, 35].

The research work presents some limitations, linked in particular to the choice of the databases examined, which has limited the analysis to only a few areas of publication. Future research will expand the analysis using more databases, trying to build an interpretative framework based on the two streams of research already highlighted, and seeking to confirm our study of literature with a case study with a company operating in the food sector to understand what kind of technology it uses to carry out its work and to investigate the consequences it has both on the sustainability side and on the side of performance.

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