Assessing the Growth and Trends of Smart Packaging: A Case of Food Distribution

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Abstract

Smart packaging plays a pivotal role in food distribution by integrating innovative technologies to enhance product safety, quality, and efficiency throughout the supply chain. Leveraging smart packaging minimizes waste, reduces spoilage, and enables real-time monitoring. However, producers face a few challenges with smart packaging, including high initial investment costs, compatibility issues with existing infrastructure, and regulatory

hurdles concerning data privacy and safety standards. Additionally, ensuring widespread adoption and addressing consumer acceptance pose significant challenges and the need for continuous innovation to keep pace with evolving market demands and technological advancements. Therefore, this study aims to identify the current landscape of smart packaging within food distribution, outline the main themes within this field, highlight potential areas for further study, and provide a roadmap for future research endeavors. To fulfill this aim, a comprehensive bibliometric analysis was undertaken, utilizing data extracted from the Scopus database. A total of 1,094 documents relevant to the chosen keywords were successfully gathered for analysis. Frequency analysis was conducted using Microsoft Excel, while citation metrics and further analysis were performed utilizing R package software. The outcomes of this investigation are presented using standard bibliometric metrics, encompassing publication year, authorship, subject area, document type, source title, citation analysis, keyword analysis, active institutional participation, geographic distribution, and language. The analysis revealed a significant increase in publications concerning smart packaging within food distribution since 1990. This upward trend underlines the crucial role of technology in the food industry, potentially impacting the environment, economy, and societal dynamics.

Keywords: Smart Packaging, Food Distribution, Sustainability, Research Trend Analysis

Introduction

In food distribution, the role of packaging extends far beyond mere containment. It serves as a critical interface between producers, distributors, retailers, and consumers, ensuring the safe and efficient delivery of food products (Vasile & Baican, 2021). However, traditional packaging solutions often fall short of addressing the evolving challenges of modern food supply chains, including issues such as spoilage, contamination, and transportation inefficiencies. In response to these challenges, smart packaging technologies have emerged as a transformative solution, leveraging advancements in materials science, sensor technology, and data analytics to enhance the safety, quality, and sustainability of food distribution processes (Yousefi et al., 2019).

One of the primary drivers behind the adoption of smart packaging in food distribution is the pressing need to ensure food safety and quality throughout the entire supply chain. With the global nature of food production and distribution, ensuring the integrity of food products from farm to fork presents a formidable challenge (Ling & Wahab, 2020). Smart packaging offers real-time monitoring capabilities, allowing stakeholders to track crucial parameters such as temperature, humidity, and freshness, thereby mitigating the risk of contamination and spoilage. By providing actionable insights into the condition of food products, smart packaging not only enhances food safety but also extends shelf life, reducing food waste and enhancing economic efficiency. Moreover, smart packaging holds immense potential in addressing consumer demands for transparency and traceability in the food system (Yousefi et

al., 2019). In an era marked by growing concerns over food authenticity and origin, smart packaging technologies enable the seamless tracking and authentication of products, fostering trust and confidence among consumers. From blockchain-enabled QR codes to near-field communication (NFC) tags, these innovative packaging solutions empower consumers to access detailed information about the journey of their food, including production methods, sourcing practices, and environmental impact (Sadeghi et al., 2022).

Furthermore, smart packaging plays a pivotal role in driving sustainability initiatives within the food industry. By optimizing packaging materials, reducing resource consumption, and minimizing food waste, these technologies contribute to the broader goal of creating a more resilient and environmentally conscious food system (Kalpana et al., 2019). As the global population continues to expand, and pressure mounts on finite resources, the adoption of smart packaging represents a strategic imperative for ensuring the long-term viability and resilience of food distribution networks. Hence, smart packaging stands at the forefront of innovation in food distribution, offering a convincing blend of safety, transparency, and sustainability (Ganeson et al., 2023). By harnessing the power of technology, these transformative packaging solutions hold the promise of revolutionizing the way we produce, distribute, and consume food, ultimately advancing the cause of food security, public health, and environmental stewardship on a global scale.

Today, great efforts are being devoted to the usage of smart packaging in food distribution. These efforts are even relevant in recent years whereby enhancing safety, quality, and efficiency throughout the supply chain, ensuring freshness, reducing waste, and improving consumer satisfaction is crucial (Bhardwaj et al., 2022). Hence, the goal of this paper is to present the pattern of the earlier study on smart packaging in food distribution and visualize it with the global development of the field. This article aims to answer the following research questions:

1. Is there an increase in the number of publications in smart packaging and food distribution-related studies each year?

2. Who are the leading researchers in the field of smart packaging-food distribution-related studies?

3. Which articles in smart packaging-food distribution-related have the most citations?

4. Which scientific journals are widely published in the field of smart packaging-food distribution-related field?

5. What are the most prominently used author keywords in the field of smart packaging-food distribution-related field?

6. Which countries have ranked top in smart packaging-food distribution-related articles and publications?

Addressing the research questions outlined has significant implications for both academia and industry in the field of smart packaging and food distribution. Academically, analyzing the increase in publications over time provides insights into the growth and maturity of research in this interdisciplinary domain, shedding light on emerging trends and areas of interest. Identifying leading researchers and highly cited articles not only acknowledges the contributions of key individuals and seminal works but also facilitates collaboration and knowledge exchange within the academic community. Understanding the distribution of publications across scientific journals informs researchers about the most reputable and influential platforms for disseminating their work (Ahmi, 2022).

From an industry perspective, insights into the most prominently used author keywords offer valuable intelligence for companies involved in smart packaging development and food distribution. It enables them to align their research and development efforts with prevailing themes and priorities in academia, thereby enhancing the relevance and impact of their innovations. Moreover, knowing which countries have ranked top in publications provides valuable market intelligence for industry players, guiding investment decisions, strategic partnerships, and market expansion efforts (Rajendran et al., 2023). Overall, addressing these research questions contributes to bridging the gap between academic research and industry practice, fostering innovation and advancement in smart packaging technologies for food distribution.

The subsequent sections of this article are structured as follows. First, an overview of the bibliometric analysis is discussed, followed by a review of similar studies focusing on articles related to smart packaging and food distribution. Next, an analytical map depicting publication trends for the past 19 years is presented offering compelling insights and potential avenues for future research. Subsequently, the methodologies employed in this study are described in the third section. The subsequent section presents the results derived from documents sourced from the Scopus database. Lastly, the conclusion section addresses a summary of findings, limitations, and recommendations for prospective research endeavors.

Literature Review

Bibliometric analysis serves as a crucial tool for understanding the scholarly landscape surrounding smart packaging in food distribution. Past studies have highlighted the growing importance of smart packaging technologies in addressing the multifaceted challenges of modern food distribution systems (Ganeson et al., 2023). However, to effectively navigate this complex and dynamic field, researchers and industry stakeholders require comprehensive insights into the existing body of literature, including publication trends, influential authors, highly cited articles, scientific journals, the most commonly used keywords, and countries that publish the most. Herein lies the necessity of bibliometric analysis.

Firstly, bibliometric analysis facilitates tracking the temporal evolution of research activity in the field. By examining the increase in publications over time, researchers can determine patterns of growth, identify key milestones, and gauge the maturity of research in smart packaging and food distribution. This temporal perspective is essential for understanding how the field has evolved, where it currently stands, and potential future trajectories (Batistič & van der Laken, 2019).

Secondly, identifying leading researchers in the field provides valuable intelligence for collaboration and knowledge exchange. By recognizing individuals who have made significant contributions, bibliometric analysis enables researchers to connect with experts, form interdisciplinary partnerships, and leverage collective expertise to address complex challenges in smart packaging and food distribution (Donthu et al., 2021). Furthermore, analyzing highly cited articles sheds light on seminal works and foundational concepts that have shaped the discourse in the field. Understanding which articles have garnered the most citations provides insights into the intellectual impact and enduring relevance of specific research contributions. This knowledge can guide researchers in building upon existing knowledge, identifying gaps in the literature, and generating new insights through empirical research or theoretical synthesis (Yan & Zhiping, 2023).

Moreover, assessing the distribution of publications across scientific journals offers insights into the dissemination channels and publication preferences within the academic community. Researchers can identify high-impact journals that are widely recognized and respected within the field, enhancing the visibility and credibility of their own research outputs (Dmytriw et al., 2021). Thus, bibliometric analysis plays a pivotal role in synthesizing and contextualizing the vast and diverse body of literature on smart packaging in food distribution. By providing comprehensive insights into publication trends, influential authors, highly cited articles, scientific journals, the most commonly used keywords, and countries that publish the most, bibliometric analysis empowers researchers and industry stakeholders to navigate the scholarly landscape effectively, fostering collaboration, innovation, and advancement in the field.

Methodology

De Oliveira et al. (2019) emphasized the essential role of statistical tools in conducting bibliometric analyses, which involve quantitative assessments of scientific outputs, such as academic articles within specific fields of study. Bibliometrics encompasses various descriptive statistics applied to citation data and employs network analysis techniques to examine authors, journals, universities, countries, and keywords based on citation frequency. This methodology facilitates the exploration of research clusters, offers insights into current research trends, and reveals emerging topics within a discipline. Furthermore, they emphasized the effectiveness of bibliometric reviews as a novel approach for implicitly

evaluating recent developments and establishing interconnected networks among publications (Bhandari, 2023).

The process of analyzing and mapping bibliographic data typically involves four key steps. Initially, it begins with data collection via systematic literature searches and comprehensive field evaluations. Subsequently, bibliometric citation analysis and network analysis are performed to discover the publication year, authorship, subject area, document type, source title, citation analysis, keyword analysis, active institutional participation, geographic distribution, and language. Finally, the synthesis of findings occurs, revealing potential research directions. Figure 1 illustrates the methodological flowchart for conducting a bibliometric review.
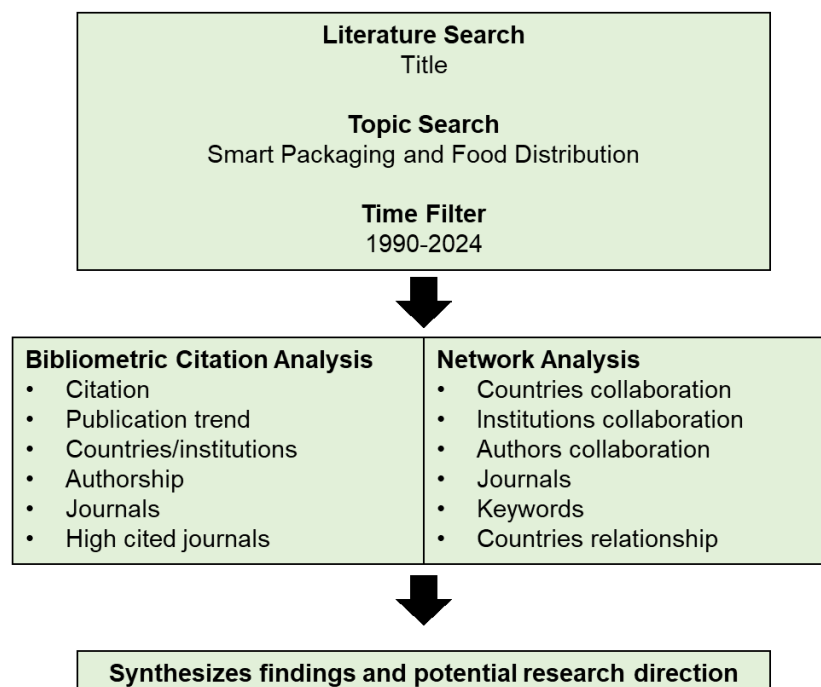

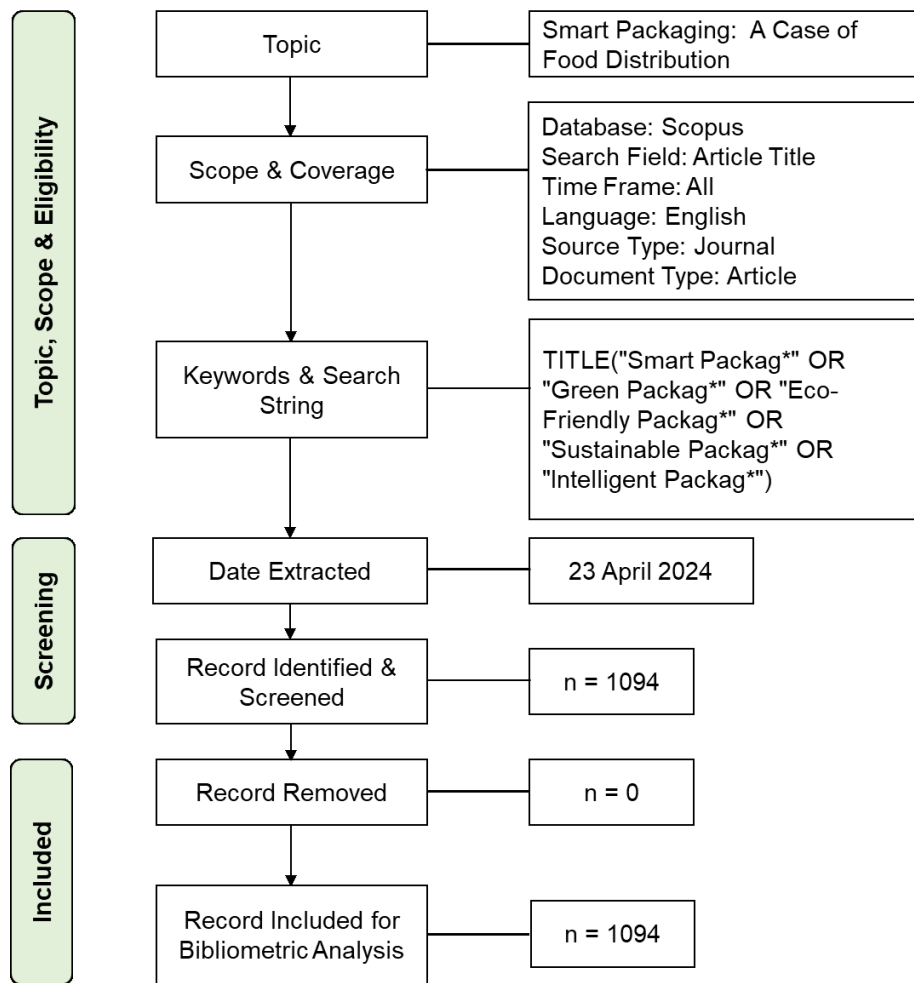**Figure 1. Methodological flowchart**

Figure 2. Search strategy flow diagram

The data for this study come from the Scopus database as of April 2024, encompassing a time frame extending from 1990 until 2024. This study employs a thorough bibliometric analysis to investigate the evolution and advancement of smart packaging in food distribution over a 33-year period. The selection of 1990 as the base year aligns with the publication of the first roadmap of smart packaging by Liu (1990). Scopus was used as a bibliometric analysis resource in our analysis because it is regarded as the largest citation database containing abstracts of peer-reviewed literature by many researchers, compared to other databases (Schotten et al., 2017). The keywords "smart packaging," "green packaging," "eco-friendly packaging," "sustainable packaging," and "intelligent packaging" were used to find relevant articles about smart packaging. The authors concentrate on the titles of the articles since they represent the specific topic relevant to the field of study and the scope of the research. Past researchers have stressed that the title of an article includes information that could be used to capture the interest of readers, as it is the first thing they will notice (Hong et al., 2020).

A total of 1,094 documents were acquired for the bibliometric analysis based on a Scopus database search, as shown in Figure 2. In this bibliometric study, all 1,094 documents in the record were screened and included for further analysis. Tools like Microsoft Excel and R-

package were utilized to examine the bibliometric analysis. Microsoft Excel was used to determine the frequencies of published materials and to create the appropriate charts and graphs, while R-package software was utilized to generate citation metrics and other frequency analyses.

Results

Bibliometric attributes such as publication year, authorship, subject area, document type, source title, citation analysis keyword analysis, active institutional participation, geographic distribution, and language were analyzed using data from the Scopus database. Most of the results and discussions are described as percentages and frequencies. VOSviewer is used to map the co-occurrence of the author's keywords, as well as report citation analysis, to identify the top ten most referenced publications in smart packaging.

Main information

The authors analyze the documents in the Scopus database by document type, source type, and source title. The type of document can be an article, conference paper, review, book chapter, note, short survey, conference review, editorial, erratum, book, report, letter and retracted. Figure 3 represents the document-type analyses from this study. A review paper represents (47; 36.4%) of the total documents published in smart packaging in food distribution followed by articles (42; 32.6%), and book chapters (27; 20.9%). The other document types listed are conference paper (9; 7%), note (3; 2.3%), and erratum (1; 0.8%).
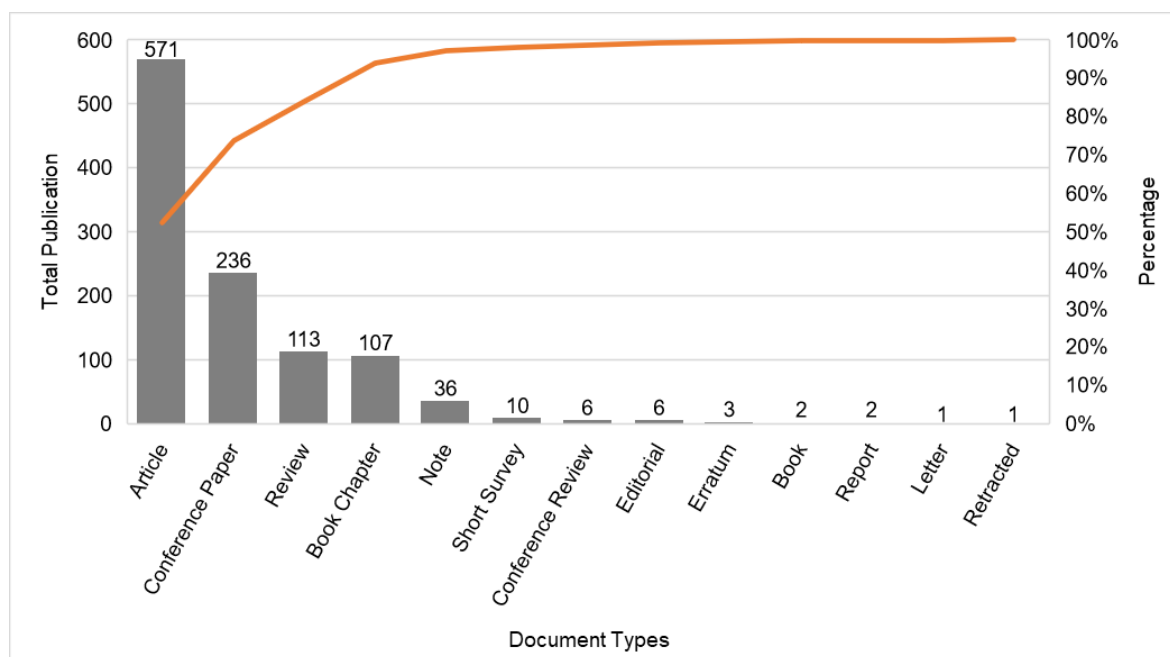

Figure 3. Document type of the published articles from 1990 till 2024

Table 1 contains more general information about the collection of selected articles gleaned from Harzing's Publish or Perish tool.

Table 1. Selected article's main information

Description Main Information About Data	Results
Timespan	1990:2024
Total papers	1094
Total citations	24739
Total citations per year	727.62
Total citations per paper	22.61
Total citations per author	7562.36
Total papers per author	457.63
Total authors paper	3.55
Total citations per author per year	222.42

Annual publication trends

The number of articles published on smart packaging has increased at a rate of 3.03% per year. The first five years (1990-1994) produced 6 publications, compared to 585 in the last five years (2020-2024). Figure 4 depicts the year-to-year publication trend. This demonstrates a growing interest in smart packaging in the food distribution industry. Further analysis has shown that articles published in the early years between 2002 to 2024 mainly focused on the application and potential of smart packaging in the food industry. As smart packaging advances, topics such as smart packaging for food distribution, food safety, food production, and food processing have been investigated in the last five years. A closer analysis of articles published from 2017 to 2024 showed that topics incorporating smart packaging in food distribution, such as smart packaging innovation in food product development, future food production, and food packaging had been examined. Apart from these, areas such as the application of smart packaging to mitigate food safety risks, food security and sustainability of smart packaging in the food sector have been examined. This increasing trend in smart packaging publication topics implies the development of smart packaging in food distribution for future food distribution. It captures the interest of a variety of experts, researchers, practitioners, and academics.
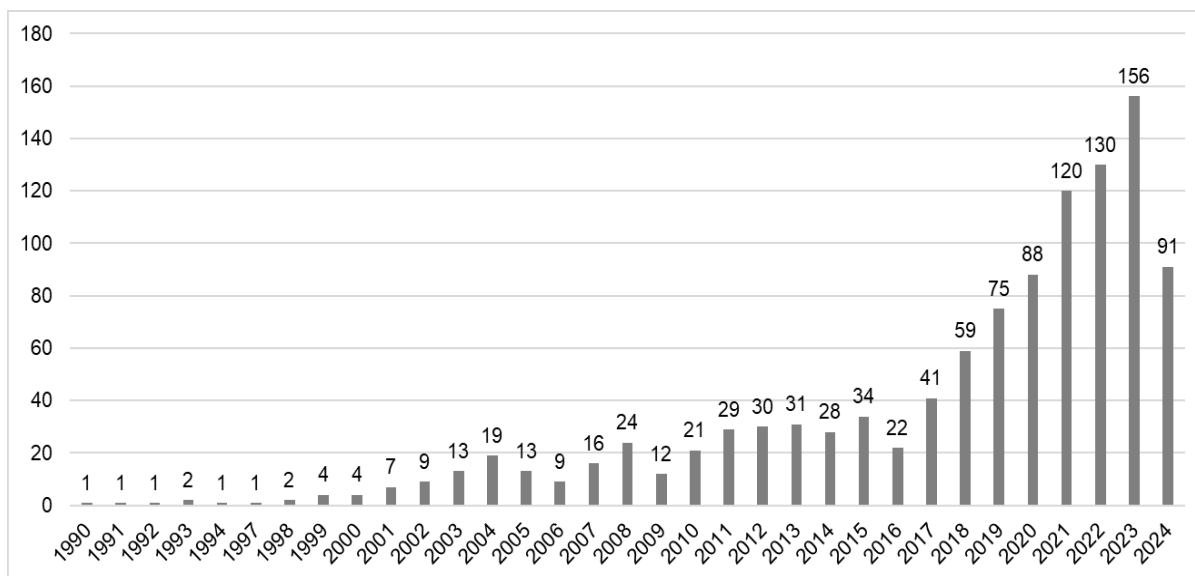
Figure 4. Year-to-year publication trend

Most productive authors

Looking at the most productive authors in smart packaging and food-related research, the current study discovered 32 authors who had jointly published a total of 180 articles. A thorough examination revealed that Liu ranked as the top author, with a total of 11 articles. The next contributing authors are Dirpan and Rhim with 10 publications, respectively. Furthermore, the number of works authored by the most contributing authors is listed in Figure 5. This output is very important for scholars who are looking for references or collaboration opportunities.
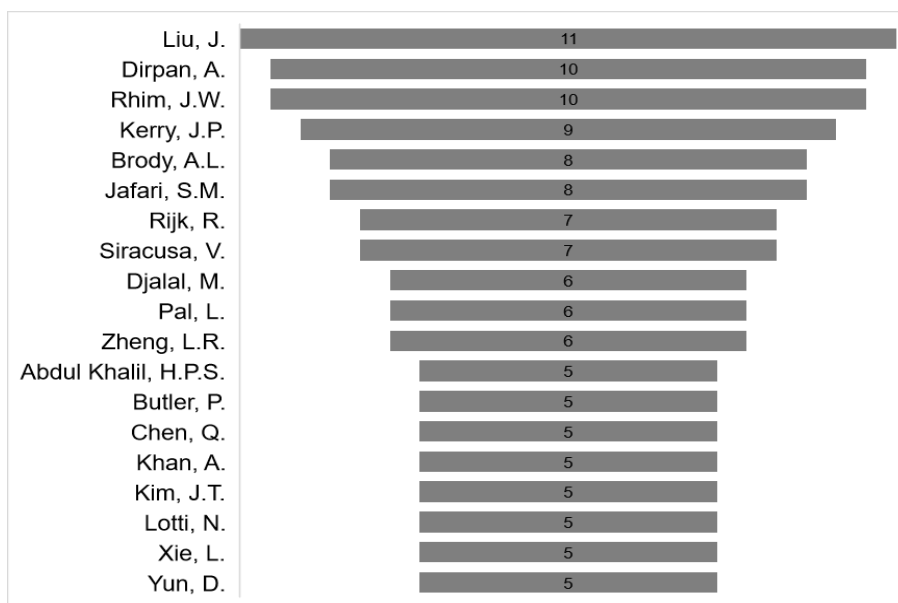

Figure 5. Most productive authors

Most cited papers

The 20 most cited articles were also examined, as presented in Table 2. In terms of the most cited sources on the subject of smart packaging, it is shown that the article produced by Kerry et al. (2006) obtained the highest number of 651 citations. The next article is by Yam et al. (2005), which gathered a total of 609 citations. Following this is the article by Yang et al. (2014), which received 558 citations. Next, the article by Biji et al. (2015) received 472 citations, while the article by Fang et al. (2017) gathered 420 citations. The remaining fifteen articles had accumulated a total of 4,606 citations. Those articles were authored by Realini and Marcos (2014), Ghaani et al. (2016), Restuccia et al. (2010), Prakash and Pathak (2017), Ahmed and Varshney (2011), Wu et al. (2021), Pacquit et al. (2007), Kuswandi et al. (2011), Kalpana et al. (2019), Rokka and Uusitalo (2008), Ezati and Rhim (2020), Moustafa et al. (2019), Rabnawaz et al. (2017), de Abreu et al. (2012), and Qin et al. (2019).

Table 2. Top 20 articles with high citations

No.	Authors	Title	Total citations	Citation per Year
1	Kerry et al. (2006)	Past, current and potential utilisation of active and intelligent packaging systems for meat and muscle-based products: A review	651	36.17
2	Yam et al. (2005)	Intelligent packaging: Concepts and applications	609	32.05
3	Yang et al. (2014)	A Health-IoT platform based on the integration of intelligent packaging, unobtrusive bio-sensor, and intelligent medicine box	558	55.8
4	Biji et al. (2015)	Smart packaging systems for food applications: a review	472	52.44
5	Fang et al. (2017)	Active and intelligent packaging in meat industry	420	60
6	Realini and Marcos (2014)	Active and intelligent packaging systems for a modern society	416	41.6
7	Ghaani et al. (2016)	An overview of the intelligent packaging technologies in the food sector	396	49.5
8	Restuccia et al. (2010)	New EU regulation aspects and global market of active and intelligent packaging for food industry applications	368	26.29
9	Prakash and Pathak (2017)	Intention to buy eco-friendly packaged products among young consumers of India: A study on developing nation	363	51.86
10	Ahmed and Varshney (2011)	Polylactides-chemistry, properties and green packaging technology: A review	347	26.69
11	Wu et al. (2021)	Challenges and new opportunities on barrier performance of biodegradable polymers for sustainable packaging	335	111.67
12	Pacquit et al. (2007)	Development of a smart packaging for the monitoring of fish spoilage	303	17.82
13	Kuswandi et al. (2011)	Smart packaging: Sensors for monitoring of food quality and safety	290	22.31
14	Kalpana et al. (2019)	Intelligent packaging: Trends and applications in food systems	289	57.8

15	Rokka and Uusitalo (2008)	Preference for green packaging in consumer product choices – Do consumers care?	284	17.75
16	Ezati and Rhim (2020)	pH-responsive chitosan-based film incorporated with alizarin for intelligent packaging applications	253	63.25
17	Moustafa et al. (2019)	Eco-friendly polymer composites for green packaging: Future vision and challenges	246	49.2
18	Rabnawaz et al. (2017)	A roadmap towards green packaging: The current status and future outlook for polyesters in the packaging industry	244	34.86
19	de Abreu et al. (2012)	Active and Intelligent Packaging for the Food Industry	239	19.92
20	Qin et al. (2019)	Preparation and characterization of active and intelligent packaging films based on cassava starch and anthocyanins from Lycium ruthenicum Murr	233	46.6

Most productive journals

The 171 selected articles were published in 10 different journals. Further analysis was carried out to identify the most productive journals on smart packaging-related research. The journal "International Journal of Biological Macromolecules" appears to be the most productive, with 39 publications. The second most productive was the "IOP Conference Series: Earth and Environmental Science," with 20 articles. Table 3 explains the top 10 most productive journals on smart packaging-related research. "Journal of Cleaner Production" is the third highest in total number of publications, with 18 articles.

Table 3. Most productive journals

No	Source Title / Publisher	Total Publications	Percentage	Cite Score	SJR 2022	SNIP 2022
1	International Journal Of Biological Macromolecules (Elsevier)	39	3.56%	14.5	1.187	1.518
2	IOP Conference Series Earth And Environmental Science (IOP Publishing Ltd.)	20	1.83%	0.8	0.197	0.255
3	Journal Of Cleaner Production (Elsevier)	18	1.65%	18.5	1.981	2.379
4	Packaging Technology And Science (Wiley-Blackwell)	18	1.65%	4.3	0.461	0.964
5	Foods (MDPI)	15	1.37%	5.8	0.771	1.302
6	Polymers (MDPI)	14	1.28%	6.6	0.72	1.167
7	Sustainability Switzerland (MDPI)	14	1.28%	5.8	0.664	1.198
8	Food Packaging And Shelf Life (Elsevier)	12	1.10%	12.9	1.338	1.536
9	Critical Reviews In Food Science And Nutrition (Taylor & Francis)	11	1.01%	23.6	1.862	2.751
10	Carbohydrate Polymers (Elsevier)	10	0.91%	18.9	1.726	1.862

Most frequent keywords

For the keyword analysis, this study used VOSviewer to construct a word cloud for the author's keywords. The top 100 words (or parts of keywords) used in the published article about smart packaging are shown in Figure 6. The total number of occurrences for the keywords is shown by the size of each word. It is important to highlight that all of the words generated are the trending words used along with the smart packaging and food distribution research. Thus, the authors can predict that future research on smart packaging can be focused on these keywords. The word cloud depicts various rising keywords such as intelligent packaging, smart packaging, sustainable packaging, food safety, food quality, food waste, and sustainable development, in addition to the keywords that were used to search the title of the paper. Another keyword is the fact that the words have been utilized to accommodate the issue of smart packaging and food distribution research, despite their modest size. Table 4 lists the top ten most often occurring keywords.
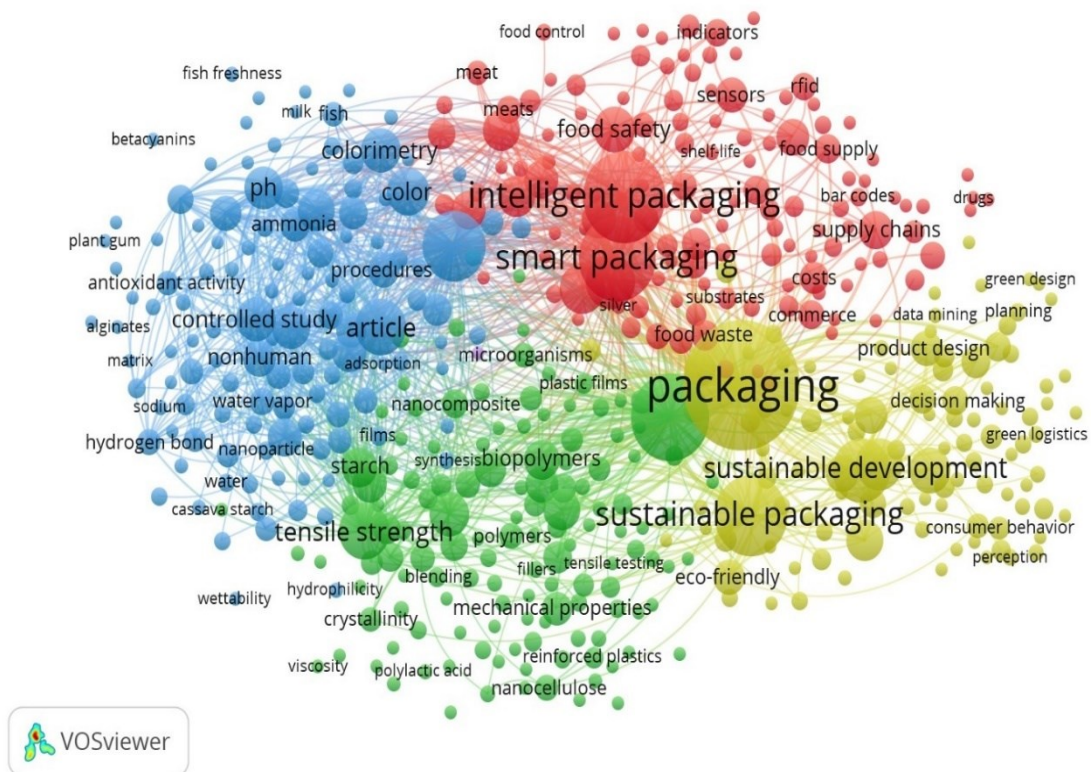

Figure 6. Word cloud of the author keywords

Table 4. Most frequent keywords

Keywords	Total Publication	Percentage
Packaging	437	39.95%
Intelligent Packaging	219	20.02%
Packaging Materials	196	17.92%
Smart Packaging	193	17.64%
Sustainable Packaging	169	15.45%
Food Packaging	129	11.79%
Sustainable Development	108	9.87%
Tensile Strength	84	7.68%
Article	83	7.59%
Packaging Machines	77	7.04%
Green Packaging	73	6.67%
Active Packaging	66	6.03%
Color	60	5.48%
Sustainability	56	5.12%
Food Safety	54	4.94%

Country publication trend

Table 5 outlines the countries that have explored the intersection of smart packaging in food distribution. Topping the list is China (186), closely followed by the United States (137), India (105), Italy (50), and United Kingdom (47). Similarly, Iran, South Korea, Indonesia, Spain, and Malaysia are among those countries showing higher contributions to this field (as indicated by the grey shading in Figure 8). These findings suggest that research on this topic spans nations with established technological capabilities as well as those emerging in smart packaging's applications in food distribution. It exemplifies international attention and collaboration among countries.

Table 5. Total of articles in the country

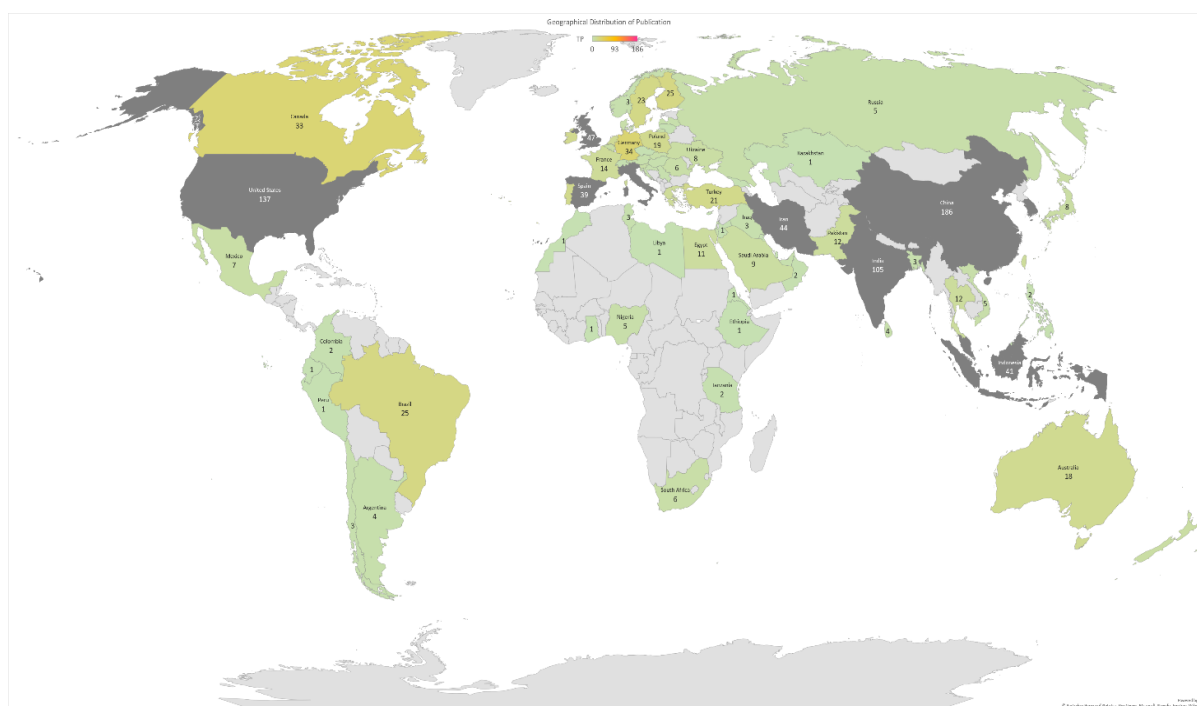| No	Country	Total Publication
1	China	186
2	United States	137
3	India	105
4	Italy	50
5	United Kingdom	47
6	Iran	44
7	South Korea	43
8	Indonesia	41
9	Spain	39
10	Malaysia	38

Figure 7. Country publication trend

Discussion

Numerous authors have explored the research stream of smart packaging and its application for food distribution, with a focus on prominent journals highlighted in this study. The top three prestigious journals identified are the International Journal of Biological Macromolecules, the IOP Conference Series: Earth and Environmental Science, and the Journal of Cleaner Production. While papers in Food Packaging and Shelf Life, Trends in Food Science and Technology, and Food Manufacture delve into food packaging, emerging technologies, and human nutrition, the latter journal encompasses research on smart packaging's role in both agricultural and food distribution. Through bibliometric analysis, the authors gained valuable insights into this interdisciplinary field. Based on the analysis conducted in this study, it's evident that only a limited number of studies have delved into the intersection of smart packaging and food distribution. Given the escalating concerns regarding food safety, quality, and security within society, there is a pressing need for further exploration of the relationship between smart packaging and food distribution in the future. Therefore, researchers should prioritize examining how smart packaging can contribute to enhancing food distribution, facilitating the sustainable transformation of food delivery within industries, and addressing the growing demand for both high-quality and sustainable food products. Additionally, there appears to be a dearth of discussion regarding the integration of Sustainable Development Goals (SDGs) and their significance in fostering long-term awareness and improvement in food distribution safety, quality, and security.

Consequently, researchers are encouraged to align their efforts with the core objectives of SDG 9 and SDG 12, focusing on industrial innovation and infrastructure, as well as responsible consumption and production. This alignment can aid in exploring the critical role of food distribution in ensuring long-term food distribution safety, quality, and security. Furthermore, the insights gleaned from this study unveil a nexus between food distribution and pivotal elements of smart packaging advancement. Sadeghi et al. (2022) underline the positive impact of technological innovation in food distribution on firm performance and sustainability, while Drago et al. (2020) emphasize the imperative of technological innovation within food distribution. Consequently, it is evident that the research frontier of smart packaging and food distribution is steadily emerging.

Conclusion

The rapid expansion of smart packaging within food distribution emphasizes its potential for enhancing various aspects of food handling, packaging, quality and safety throughout the supply chain. While many applications of smart packaging in the food supply chain are still undergoing research and development, its significance has prompted a bibliometric analysis to investigate its role in food distribution. This study scrutinizes 1,094 journal publications within the smart packaging and food distribution research domain, revealing valuable insights. The analysis categorizes information into five main areas: smart packaging, green packaging, eco-friendly packaging, sustainable packaging, and intelligent packaging. Furthermore, employing quantitative methods, the study derives primary bibliometric indicators. Over the 34-year period examined, the authors identify 160 contributors discussing smart packaging and food distribution, indicating potential collaborations among authors, countries, and institutions.

This study carries significant implications for both academics and practitioners alike. Identifying a robust connection between smart packaging applications within food distribution prompts further exploration into their relationship with sustainability within the framework of the SDG agenda. The method employed holds substantial theoretical implications, offering a well-structured methodology that can be directly applied to the smart packaging and food distribution sectors. Moreover, it highlights that smart packaging in food distribution transcends mere technological innovation adoption, evolving into a driver of innovative technology itself. Practitioners in the food industry stand to benefit from the insights provided by this study, leveraging its findings to enhance food distribution services in their facilities and foster sustainability as a source of innovation.

The study's findings serve as a foundational resource for food distributors and stakeholders within food systems, offering insights into the implementation of technologies to enhance supply chain visibility, food delivery, tracking and traceability, and food integrity within their distribution systems. Additionally, researchers stand to benefit from easy access

to a wealth of information regarding various trends, themes, and research streams pertaining to smart packaging in food distribution, facilitated by this study's contributions. Nevertheless, several limitations warrant consideration. Primarily, the research solely examines bibliometric data from papers, rather than delving into the complete content. While the employed keywords are expected to represent the core substance of the documents, there exist inherent limitations in this approach. Hence, integrating this type of literature review with a traditional approach would enhance the overall value of such investigations. Additionally, while the authors conducted independent coding of sample articles during cluster analysis, the reliance solely on Scopus as a research database may introduce bias in paper assignment to clusters. Thus, future studies should consider utilizing other journal databases to mitigate potential biases. Furthermore, the limitation of the database search to English-language publications excludes contributions from other languages, indicating a need for future research to encompass a more diverse linguistic scope. Despite these limitations, this study furnishes valuable insights into the current state of knowledge regarding smart packaging in food distribution. Consequently, the authors foresee that this contribution will enable scholars to direct intellectual capital towards future research endeavours with significant impacts, particularly in the area of sustainable food distribution development.

Acknowledgements

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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