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Retraction

Retracted: Machine Learning and Artificial Intelligence in the Food Industry: A Sustainable Approach

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope

(2) Discrepancies in the description of the research reported

(3) Discrepancies between the availability of data and the research described

(4) Inappropriate citations

(5) Incoherent, meaningless and/or irrelevant content included in the article

(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] R. Kler, G. Elkady, K. Rane et al., "Machine Learning and Artificial Intelligence in the Food Industry: A Sustainable Approach," *Journal of Food Quality*, vol. 2022, Article ID 8521236, 9 pages, 2022.

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Research Article

Machine Learning and Artificial Intelligence in the Food Industry: A Sustainable Approach

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The goal of this research was to look into how artificial intelligence (AI) and machine learning (ML) techniques are being used in food industry and to come up with future research directions based on that. This study investigates the articles available on several scientific platforms that link both AI and supply chain from one side and ML and food industry from the other side, using a systematic literature review methodology. The findings of this research stated that although AI and machine learning technologies are yet in their beginning, the prospective for them to enhance the performance of the food industry (FI) is quite promising. Various investigators created AI and ML-related models that were verified and found to be effective in optimising FI, and so the use of AI and ML in FI networks provides competitive advantages for improvement. Other academics suggest that AI and machine learning are both now adding value, while others believe that they are still underutilised and that their tools and methodologies can harness the overall value of the food business. According to the findings, AI and machine learning have the potential to reduce economic losses, thereby supporting the food industry's efficiency and responsiveness.

1. Introduction

Artificial intelligence is particularly beneficial for making complex decisions that are either too sophisticated for traditional programming or would need a significant amount of manual labour and cost. Artificial intelligence, for example, can be used to execute data and workforce analytics, both of which are important parts for businesses to work with in order to stay competitive and in a better position [1]. Working more successfully using workforce analytics can result in managers and leaders in firms being able to fulfil their strategic and operational goals more efficiently, according to latest research collection [2, 3]. Food processing and handling is the most important manufacturing business in the world, with the greatest number of job prospects. The human labour is critical to the effective execution of food product manufacturing and packing [4, 5]. Working with data and analytics could be a

key component of how to optimise management in the food sector, possibly using artificial intelligence, because artificial intelligence technology can leverage existing data to produce even more accurate forecasts.

The food business requires a comprehensive method to organising, analysing, integrating, and drawing conclusions that may be used to standard and path key performance indicators (KPIs) linked to food safety and quality [6, 7]. As a result of human involvement, the food business is deteriorating to tolerate the demand-supply cycle and is also inadequate in food safety [8]. The most effective technique for solving these issues in the food business is operational automation. To automate everything, artificial intelligence (AI), machine learning (ML), and deep learning (DL) technologies are applied [9, 10]. Machine learning and artificial intelligence (AI) can be used to transform food safety and quality data management. AI can provide a feedback loop for existing food safety and quality programmes to determine whether they are fulfilling the goals and expectations of business quality assurance management [11]. It also contributes significantly to the growth of the national and global economy. Thus, the product quality and safety in the food sector, as well as effective distribution, are crucial. In recent decades, newly developed technology such as artificial intelligence (AI) has shown favourable results in terms of attaining the desired aims [12, 13]. Other benefits of using AI in this way include providing a numerical system to validate asset in a firm's food safety and quality programmes [14].

Artificial intelligence-based systems, often known as autonomous systems, are widely employed in practically every element of technology. It enables the globe to efficiently solve problems, computerise the food industry, and revolutionise food industry goods [15, 16]. To limit the risks, predicting dangers, peril evaluation, and deterrence connected to food safety require an easy and capable empirical prediction method such as BDA. Identifying food safety outbreaks and determining potential causes require the collaboration of public and private sector partners [17–19]. Food industry must establish high-standard grading procedures that are more trustworthy in controlling product quality. The industry, on the other hand, features a diverse nonlinear action plan that may be rectified using an autonomous and trustworthy approach like AI and traceability [20]. AI is a mathematical technique that depicts spiritual capacity and brainy solutions to many food business difficulties [21, 22].

The industry may use a computerised system to analyse and guarantee that the most ideal conditions, such as crop cultivation, precision agriculture, watering, and temperature monitoring, are improved, resulting in excellence within food sector goods. AI's uses are not limited to these [23, 24]. This study is focused with the outcomes and investigation of the created automation technology leading AI and ML in the food sector [25, 26]. Furthermore, it emphasises the current automation accessible in various food processing businesses [27]. Combining automated technologies with expert machines has several advantages, including decreased error and greater accuracy in judgement, prediction, enhanced efficiency, decreased time consumed, and lower costs.

Big data is crucial in the assurance of food quality. A good example is a cold supply chain during delivery. Temperature-sensitive products, such as vegetables, fruits, milk, and ice cream, necessitate exact climatic conditions and may be affected by temperature fluctuations. Specific IoT-driven sensors that process, analyse, and transmit data in real time to all stakeholders, allowing for full supply chain cycle monitoring, are the right solution. It is possible to use big data to replace damaged products with new ones in a timely way or to take preventative measures.

Big data enables us to boost any type of organisation and employ innovative approaches depending on information obtained. Farmers may obtain weather forecasts, shippers can obtain transportation information, and restaurants can obtain consumer feedback and prices. Big data in restaurants has enormous potential for restaurant managers, allowing them to compare collected data and choose the most efficient plan. Furthermore, big data enables the identification of profitable and desired commodities in specific regions, which can subsequently be identified for interested parties. The farming business is only now beginning to use big data, but the results are already remarkable. Because agriculture serves as a sort of foundation for all food industries, it is vital to leverage big data here.

The remainder of the paper is organised as follows. Section 2 gives brief challenges of FI. Section 3 discusses about the role of AI and ML in FI. Section 4 highlights the approach to achieve the sustainable goal in FI. Findings of this research are discussed in Section 5. Section 6 highlights the findings and end with the discussion. The conclusion of this research is done in Section 7.

2. Food Industry Current Problems

The food industry facing different problems are stated in this section of the research paper.

2.1. Food Waste. One of the most serious problems in the food sector is that one-third of all food produced each year is wasted. Globally, food waste is predictable to be 1.3 billion tonnes per year, worth $1 trillion (UN, 2020). Food waste is described as a decrease in the quantity and quality of food as a result of restaurant work, retailer, or customer activities or decisions [28]. Food waste could be linked to every market in the food business, as it occurs along the whole supply chain, from agricultural production to customer consumption. Transportation, food harvesting procedures, and food that end up in bins or merchants by customers are the primary causes of waste [29]. Food waste accounts for a third of all food produced and are a problem at every level of the supply chain, most notably during transportation, harvesting, and by consumers, indicating that there is a chance to save food by collaborating on food waste prevention solutions [30].

2.2. Food Scarcity. At the same time as food waste is a major concern, 2 billion people are expected to be hungry around the world (The United Nations, 2020). The problem of hunger is referred to as food insecurity in the food industry,

and it is divided into two categories: severe and moderate. Severe malnutrition results in starvation, which affects 9.2% of the world's population, or 700 million people, while moderate malnutrition refers to a lack of regular access to nutritious and sufficient food, which affects 17.2% of the world's population, or 1.3 billion people [31–35].

Because food insecurity is essentially tied to food, it is a problem for which the food sector may have responsibility. According to projections, if "business-as-usual" investment patterns continue to develop, food access will not improve at all by 2030. Although the geographical distribution varies, food insecurity is more prevalent in lower-middle-income countries. Food insecurity is most prevalent in continents such as Africa and Asia, according to statistics from the International Food Policy Research Institute. It is least prevalent in North America and Europe [36, 37].

2.3. Impact on Environment. Finally, present issues in the food sector include global food consumption, as well as the associated production, use, and waste management, which are the primary causes of environmental effects. Food, together with housing and transportation, is responsible for 70% of all environmental consequences [38, 39]. The focus in food is meat and dairy. As a result, the food industry's contribution to environmental effects demonstrates the need to reverse bad trends and establish long-term food solutions for future generations. According to the categories of food in the typical food intake in Europe, agriculture, logistics, and food processing have the greatest environmental impact on the food supply chain [40].

Figure 1 shows the challenges faced by the food industry. The problem associate with each key point is shown in the figure. The food waste can be minimising by awareness. But the waste of food is due to lack of planning in the system and also due to industrial process. In similar manner, food scarcity may lead to poverty, malnutrition, and social discrimination. Due to traditional food industry energy loss is present, it also have large carbon foot prints.

3. AI and Ml Role in Food Industry

Sustainable work is critical to overcoming present concerns, anticipated challenges (The United Nations, 2015), and meeting the consumer demand for sustainability in the food business (The United Nations, 2015). The future of food and agriculture, which argues for the premise in this paper by focusing on how "sustainable food and agriculture systems cannot be realised without major additional efforts," supports the demand for sustainability [41]. Because customers play such an important part in change, and most sustainable solutions will fail without market acceptance, the consumer's perspective can be seen as a barrier to enterprises in the food industry pursuing sustainable development. Table 1 shows the area where AI and ML can be implemented in food industry for enhancing the food quality while keeping in the food industry problems.

The uses of AI are not limited to simply these. Food processing, storage, and transportation can all benefit from it. Intelligent technology, such as robots and intelligent drones, can also help to reduce packaging costs [42]. It will also help with food delivery, work fulfilment in hazardous areas, and the provision of high-quality items.

Regardless of whether AI is employed, it is important to discuss the current structure and state of food safety and quality data at this stage. Internal and external data on food safety and quality fall into two groups [43]. External data, such as product recalls, food-borne outbreaks, pertinent electronic health records, and final product testing, aid in the formation of a more complete picture and are actively collected by a variety of nonprofit and government groups.

The findings of this article will serve to fill up the gaps in the literature stated in the literature review summary of this paper, as well as advise practitioners about the need for further crucial measures and changes [44]. This area has not been explored with objectives directed towards the food industry, so in order to ensure the reliability of this research, we will use current research, which includes both empirical and theoretical studies from secondary sources, that has been raised on a global scale regarding the food industry, sustainable management, and artificial intelligence, and analyse those in comparison with the food industry, by collecting insights on a micro scale [45].

It should come as no surprise that the food industry is the most important segment of the global economy. We want our food to be fresh, clean, and healthy, and as stakeholders, we want to identify efficient outputs for food manufacturing, food discovery, customer problems, consumer preferences, supply chain management, and so on. It has no surprise, then, that data science and big data are exploding in numerous fields due to their vast uses. As a result, numerous FoodTech businesses are using machine learning and artificial intelligence (AI) to solve difficulties. Tools for data analytics can also aid in the improvement of your marketing activities. You may alter how you promote your brand and discover client pain points that you can utilise to your advantage by taking a deeper look at audience habits. You may learn what things are selling well and why customers prefer them over other items on your menu by studying sales data. Either you can introduce and promote new things from there or you can highlight ones that demand more attention. This approach pairs nicely with AI-powered contactless menus, which have grown in popularity since the outbreak began.

Food processing is a demanding task. Sorting farm food and raw materials, as well as maintaining machinery and various forms of equipment, are all part of the job. Finally, when a product is ready to ship, people evaluate it for quality and assess whether it is fit for shipment. However, AI is automating this procedure in many food processing companies. The top five AI applications for food processing companies that have an immediate impact on revenue and customer experience are given below.

(1) Sorting products and packages: the first operational challenge that food processing companies face is the sorting of feedstock. Every potato, tomato, orange, and apple is different, demanding careful sorting. To

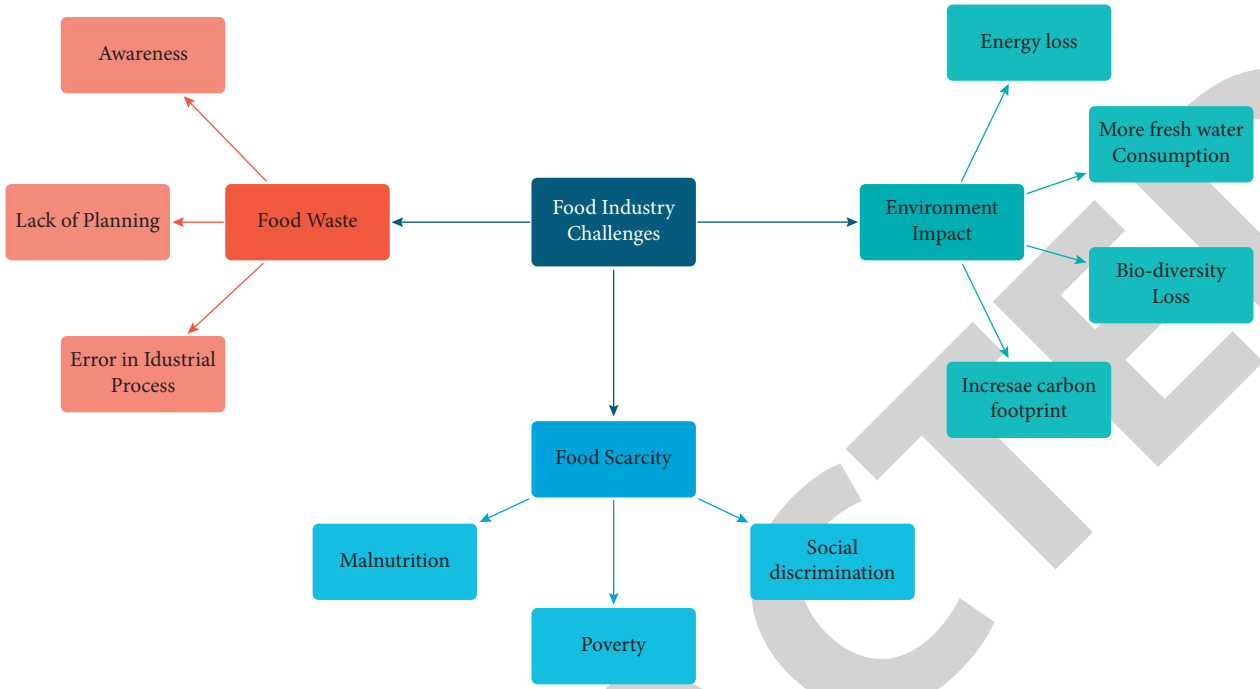

Figure 1: Food industry challenges.

be competitive, every food processing company must maintain a certain degree of quality. If not automated with AI and other modern technologies such as IoT, this method requires a significant amount of human effort.

(2) Food safety compliance is a big issue in the food processing sector. Even the smallest amount of contamination in food can be lethal. Factories have begun to deploy AI-based cameras to determine whether or not an employee is adequately suited.

(3) Maintaining a clean environment: in food processing plants, cleanliness is a crucial issue. Many companies claim to be as pure as ice since all of their processes are automated and undisturbed by human interaction.

(4) Assisting customers with decision-making: artificial intelligence, like food processing corporations, assists customers in making more informed purchasing decisions. Kellogg's introduced Bear Naked Custom, which allowed customers to create their own granola from a menu of more than 50 ingredients and many more use of AI and ML in food industry.

Table 1: Application of AI and ML in FI.

Area	AI and ML techniques
Food security management	(i) ANN (ii) Data mining (iii) Data analysis (iv) Intelligent optimisation techniques
Food quality management	(i) Genetic algorithm (ii) Predictive models (iii) Tree decision-making
Food production	(i) ANN (ii) Decision tree (iii) Gaussian mixture models (iv) Data mining
Food logistics	(i) ABS techniques (ii) Robot programming (iii) Simulated annealing (iv) Automated planning
Food supply chain	(i) Bayesian network (ii) Stochastic simulation (iii) ANN (iv) Fuzzy logic
Food processing industry	(i) Decision-making data analytics (ii) Predictive models (iii) Forecasting models of AI and ML

4. Approach toward Sustainable Development in Food Industry using AI and ML

In this research work, to collect data and execute analysis, a systematic process is used. In the first phase, data collection is done. A pilot search is conducted in the second phase to better grasp the existing state of affairs in the area. These study data were gathered from a variety of sources using precise keywords, titles, and abstracts, as well as a certain time frame. This information will be compared in order to discover links and opportunities for growth in the direction of a more sustainable industry. Furthermore, we will make recommendations based on the findings of a thorough investigation, as well as reasonable arguments based on the current state of the food market.

4.1. Data Collection using Different Research Platform. To understand the present uses of AI and ML in food industry, we have collected data from the research publication platforms such as IEEE explorer, Elsevier, and Springer, which are taken into consideration. Figure 2 shows the various publications based on the uses of AI and ML in food industry topic. The data base platform has more research than shown, but only those are considered which are related to our research topic.

4.2. Through Abductive Methodology. This paper's methodology is examined and investigated using abductive research methodology, which is a systematic technique to developing new theories based on a combination of diverse components of the research and data gathering process, including both theoretical and empirical research. Before performing knowledge for the existing status of the topic, the abductive approach was used to be able to find general ideas and principles without making assumptions about where the article should start.

Furthermore, the method is to examine from several angles, with a focus on food industry segmentation and artificial intelligence, with a selection made by examining the prospective strategic aim, qualitative data, and theoretical generalisation. To be clear, the selections are divided into sections in order to achieve a holistic knowledge as well as to build concepts and theories. Existing research and theories are compared to how well they could support the paper's hypothesis in terms of adoption. Like in the previous section, we use research article to collect data, through abductive methodology we yearly digitalisation data in food industry as shown in Figure 3.

From Figure 3, it is clear that the % of digitalisation in the food industry has been increased. This digitalisation process is going to lay a platform for new-generation approach like AI and ML.

4.3. Data Mapping. In this research, we used data mapping to analyse in which sector of the food industry can be linked with that technique. By mapping, the exact method can be link with the need of the food industry as shown in Figure 4. It shows the different stages in the food industry and which technique it can use to get the best results. Like, for the demand forecasting ANN, moving average can be used as AI and ML tool for forecasting category.

All approaches stated in Section 4 are used in Section 5, and these are used to state the findings of this paper.

5. Finding of This Research Paper

The current research revealed that the food business could benefit from artificial intelligence in a variety of ways. As a result, this article will raise awareness of how artificial intelligence could help food industry practitioners become more sustainable, without a promise of improvement, but with qualitative research that can help move the topic closer to creation and implementation of solutions. Artificial intelligence technology consists of possibilities that might maintain a massive technical knowledge base to expand;

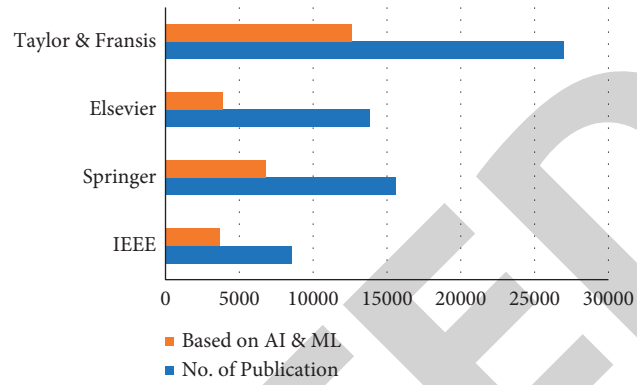

Figure 2: Research publication on different data bases.

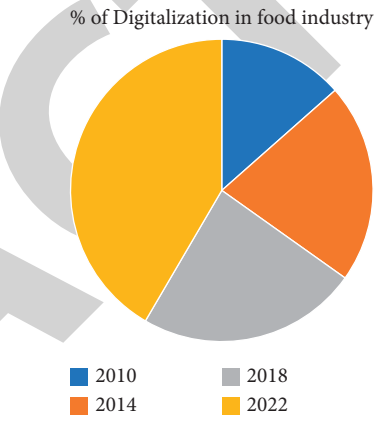

Figure 3: Digitalisation in food industry.

thus, we are focusing on possible solutions rather than execution. To be clear, the knowledge that this study promotes is merely a starting point, but it will pave the way for further investigation. Furthermore, according to the conclusions of the literature analysis, the features of artificial intelligence that could contribute to the sector include areas from both the managerial and operational viewpoints.

Through the data collection and analysis, we divide the food industry in 4 categories as shown in Figure 5. The first category is smart farming. AI has various major uses in the food business, such as soil monitoring, robocropping, and predictive analysis.

Smart transportation is the second category. Artificial intelligence is transforming the transportation business. It has already been employed in a number of sectors, including helping automobiles, trains, ships, and planes, as well as smoothing traffic patterns. It has the potential to transform all modes of transportation, as well as the food industry, safer, greener, smarter, and more efficient. Artificial intelligence-assisted autonomous mobility may, for example, help to remove the human mistakes that cause so many traffic accidents. These possibilities, however, come with real hazards, such as unintended consequences and abuse, such as cyberattacks and distorted transportation decisions. There are further employment consequences, as well as ethical questions concerning artificial intelligence's liability for decisions made in the absence of humans.

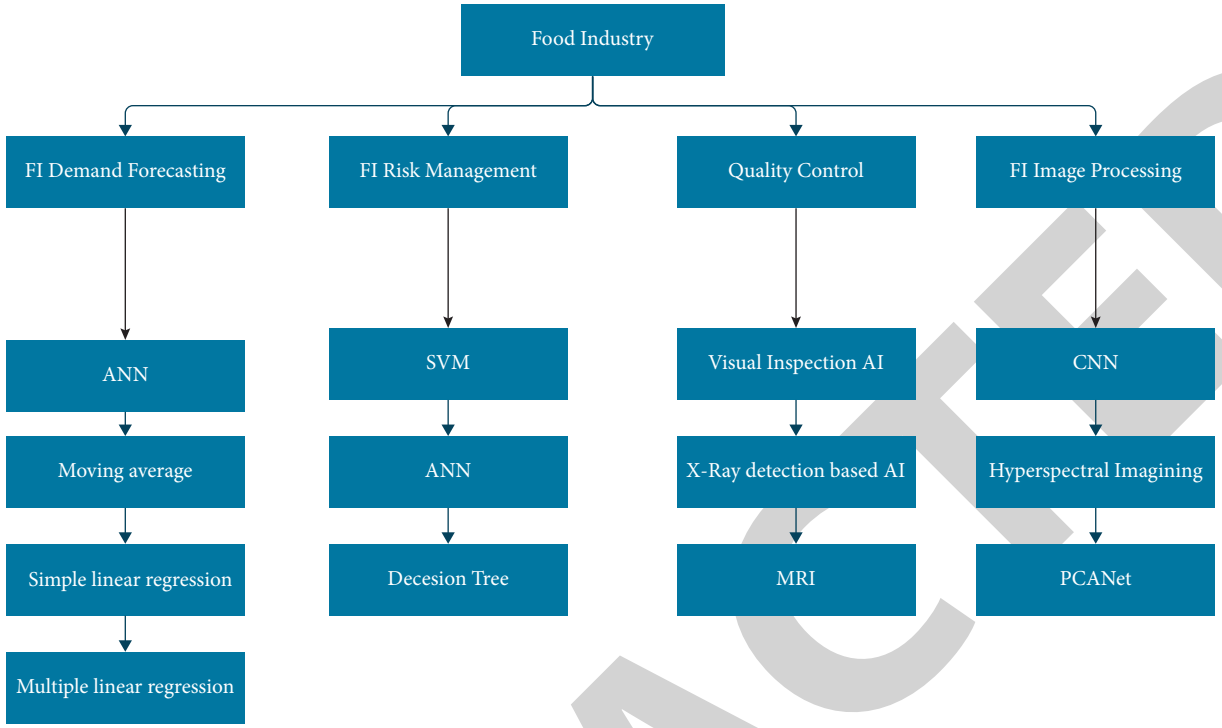

Figure 4: Mapping of different AI and ML techniques.

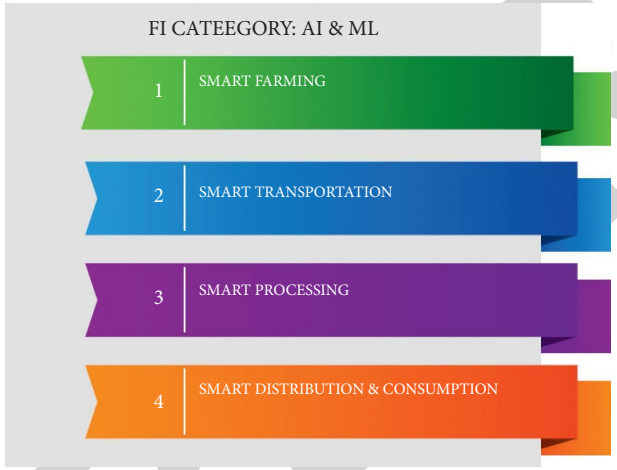

Figure 5: Categorisation of FI.

The third category includes smart processing. Artificial intelligence (AI) is attracting the attention of enterprises across a wide range of disciplines and industries, including food processing and handling (FP and H). AI has a direct and indirect impact on the FP and H business. Indirectly, it aids farmers with weather forecasting, which in turn aids farmers in producing high-quality raw materials for food processing industries, allowing them to save money on product sorting. AI also assists transportation firms in lowering shipping costs, resulting in lower transportation costs for food processing companies. In either case, it aids FP and H firms in reducing revenue.

The last category of FI is smart distribution and consumption. The name itself indicates the end use of the farming product in FI. Machine learning (ML) can assist in efficiently solving problems such as determining delivery routes, supplying raw materials, forecasting demand for specific food items, and logistics planning. Distribution way problems can be resolved with ML by optimising the place of the delivery agent in relation to present or upcoming traffic conditions and then notifying them about the best route in a synchronous manner. There are numerous apps in the food service industry nowadays that assist in anticipating the amount and kind of food orders, as well as the relevant inventory. These data can be used to do statistical analyses of visitor traffic and the food products that will be required over time. These data are compiled by combining information from previous interactions with consumers, such as their meal preferences, habits, and complaints, as well as the supply of essential commodities during that time period.

According to the data collected and analysis, we find out that the smart farming market is increasing day by day. Investors are investing lots of money to make the farming process more effective. Figure 6 shows the growth predicted growth of smart farming in next coming years.

In similar manner, Figure 7 shows the other three category investments.

6. Result and Discussion

6.1. Result of the Research Work. Following a review of the literature in the food business, it is clear that the food processing and manufacturing industry requires a large amount of investment. System-based AI can more easily diagnose numerous faults in food production than human-based systems. It has also been noted that researchers are

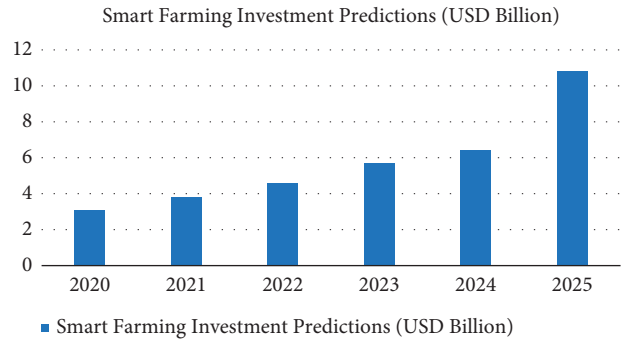

Figure 6: Prediction of smart farming investments.

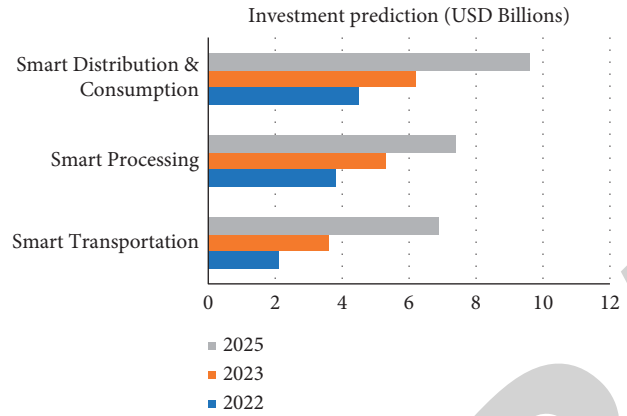

Figure 7: Future investment prediction in FI.

heavily involved in this field. Globalisation presents hurdles in food processing chains, resulting in several impediments due to a lack of automation, taking health and safety as one of the primary issues into consideration.

Once sensors are attached to the microcontroller, output spikes are produced by the microcontroller, resulting in a low-cost and user-friendly platform for a range of artificial neural robotics applications. It has the potential to be extremely beneficial in the food industry. In the agro-based business, AI-based sensors that focus on agricultural production, yield forecasting, detection of diseases, and features that are available have integrated machine learning and big data to give better information for decision-making and movements.

So, categorising the FI according to the category defined in Section 5 and focusing individual using AI and ML integrated system, the output will increase drastically. Figure 8 shows the accuracy, efficiency, and reduction in waste that can be achieved using AI and ML applications in all four categories of FI stated in Section 5.

For many sectors, artificial intelligence and machine learning technologies offer several opportunities to streamline and automate processes, save money, and eliminate human error. Restaurants, bars, and cafes, as well as food manufacturers, can profit from AI and machine learning. These two divisions offer a lot of frequent application cases for AI in the food industry. Because customer and market expectations are rapidly evolving, staying one

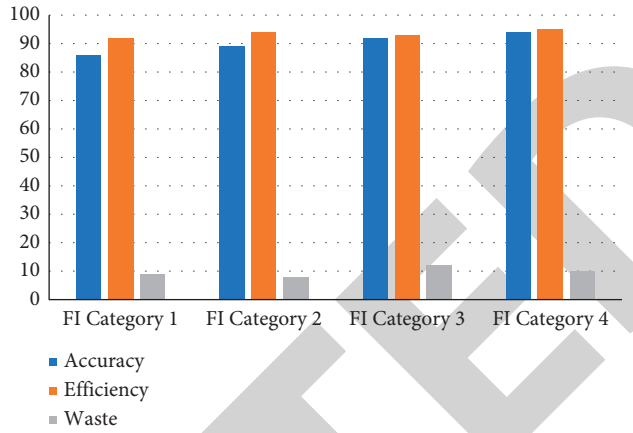

Figure 8: AI and ML category-wise possibilities for enhancing the FI.

step ahead of the competition has never been more crucial. The most valuable thing for a food business owner or a food maker is to define the most prevalent tastes and preferences. The latest food tech trends, for example, are tied to a slew of healthy lifestyle devotees. Machine learning uses data collection and classification methods to determine that food tech solutions will be the most popular in the near future in order to detect them.

Every online meal ordering platform has a wealth of data on customer preferences and ordering habits. Machine learning algorithms can aid in the dispatching of food delivery drivers in a more effective, cost-effective, and time-effective manner. Although data science is still in its infancy in this area, it is already providing businesses with some viable opportunities to gain market share.

6.2. Discussion. From the reviews and present practices, it is clear that global challenges like food waste and environmental damage are pressuring businesses to take action. On the contrary, the challenges from a micro perspective show that there are some existing barriers preventing local industry from responding to global demand to the extent that it should, both in terms of more profitable business solutions, external stakeholders, and the global socioeconomic and environmental challenges that humanity is confronted with. Artificial intelligence, as this thesis has already mentioned, is a technology with a wide range of prospective solutions that could help to meet the current demand in the local food industry for sustainable development.

Following a thorough examination of the literature, we identify a few topics that merit additional investigation. On an applicability basis, certain less well-known AI methods can be evaluated for enhanced supply chain, safety, cleanliness, among other things.

Furthermore, AI and ML applications have various obstacles, such as lowering the workforce, which results in unemployment. Its execution necessitates both financial commitment and a competent team. There are social problems in BDA, for example, worker implementation and a deficiency of decision support tools. For this study, we

looked at a small number of publications over a short period of time; therefore, the analysis and conclusions are based on the information we obtained.

7. Conclusion

This paper shows the reader how to move from a conventional approach to the most up-to-date and innovative automated process in the food sector. Regardless of the fact that a variety of techniques have been established to meet the challenges that have emerged in the food sector, AI and machine learning have provided real-world opportunities to experience cutting-edge technology. Various multidisciplinary systems are governed by AI to assess many metrics depicting quality, appearance, texture, overall consumer acceptability, and so on. This unique strategy entailed studying data patterns and adjusting the process to provide output that is correct, reliable, takes fewer humanoid incomes, is competent, and helps the operator forecast upcoming circumstances over time. These techniques can be considered as a blessing in terms of filling the hole left by the ever-increasing number of flaws in the food sector. Drone technology would become a great milestone in the food supply chain management over time. Sensors are becoming an increasingly significant part of the food preparation process. The food industry has indeed been able to achieve better, more efficient, and actual outcome of AI and big data.

The use of AI and ML in food production and restaurant operations is already putting AI in charge of food safety. Artificial intelligence has taken the food safety industry to a new level by reducing human errors in manufacturing and, to a lesser extent, unused goods. It provides lower packing and delivery costs, more customer satisfaction, faster services, voice searching, and more personalised orders. Large food companies can also profit from these business advantages, which will provide a clear gain in the long run.

Data Availability

The data used to support the results of the study may be obtained from the corresponding author.

Conflicts of Interest

The authors state that the publishing of this work does not include any conflicts of interest.

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