The Effects of Disruptive Thinking on the Food Industry*

Omotola Oluwakemi Dairo[1,2], Bernard Boamah Bekoe[2,3]

[1]Faculty of Business and Law, Anglia Ruskin University, Cambridge, UK
[2]College of Education and Liberal Art, Wilmington University, Delaware, USA
[3]College of Management Science, Hohai University, Nanjing, China
Email: Omotee.dairo20@yahoo.com

Abstract

This study aimed to understand disruptive thinking and how its ideas can change the food industry. This was achieved by identifying, studying, and understanding the impacts, current trends, and different disruptive ideas and innovations emerging in the food industry. The study was conducted through interpretive research philosophy by carrying out secondary data collection processes, where both qualitative and quantitative information was presented. Deductive approaches were also selected to apply existing theories and models, which were used to construct research hypotheses and present detailed findings. The study finds that, with disruptive thinking, enhancements in the product life cycle, new flavors, and improvements in food packaging have been possible. The supply chain, which is always considered a complex part of the food industry, has been streamlined, offering greater transparency and real-time tracking and improving quality control across distribution systems.

1. Introduction

According to Bongomin *et al.* [1], technology has the potential to help firms and organizations stay safe from the competition in the industry or sector. Disruptive innovations are considered highly revolutionary and discontinuous, capable of displacing existing technology and forcing the entire industry to adapt to new changes [1]. Disruptive thinking or Innovation creates new industrial sectors and markets with enhanced opportunities for early adopters. Industrial leaders

---

*An exploration of how innovative and unconventional ideas are reshaping the food industry.

often follow obsolete technologies based on suitability and needs, falling behind the competition [2]. Organizations that produce disruptive innovations build new opportunities and develop as industry leaders, involving Innovation in business models, products, and services to offer new solutions and alternatives to customers and stakeholders [1].

Disruptive thinking can change social practices significantly, influencing living standards, work practices, and interactions between customers and brands. The current pace of disruptive thinking and its application in the food industry is expected to accelerate, driven by millennials' fascination with food. As millennials graduate college and enter the job market, they will become the driving force of the economy, with higher incomes and spending habits driving up demand for the food and beverages industry. Organizations must develop new solutions and ways of producing, packaging, and marketing food products to meet millennials' demands and expectations [3]. While disruptive thinking and Innovation are still in their early stages, few players have adopted new solutions or disruptive ideas [4], presenting significant scope and development opportunities for existing players to reshape the food industry landscape [5].

Deloitte [5] highlights that the next decade in the food industry will witness significant changes due to disruptive Innovation. Entrepreneurs and technology are expected to be the major game changers, with rising environmental awareness, the need for nutritious ingredients, and product transparency driving changes in business operations [6]. Start-ups with new business models are likely to become the driving force in shaping the future of the food industry [7]. Prominent disruptive ideas already taking shape include artificial proteins, 3D food printing, food robotics, the internet of things applications, personalized nutrition, food waste, and food safety [8].

The study's primary aim is to understand disruptive thinking and ideas that shape the food industry. The research objectives are:
- To identify different disruptive ideas emerging in the food industry;
- To study the current trends of disruptive Innovation in the food industry;
- To understand the impact of disruptive thinking in the food industry.

The study will primarily utilize secondary data collection procedures, incorporating various journal articles and insights from industry experts, writers, and leadership team members of major players in the food industry. This research will have significant theoretical implications, shaping the view of organizations operating in the food industry regarding disruptive thinking and the creation of new solutions.

2. Literature Review

2.1. The Concept of Disruptive Innovation

Disruptive Innovation can be described as a technological implementation that significantly affects the process through which an industry maintains its business functions [9]. The Internet is one of the most compelling examples of disruptive Innovation in the modern Internet. The use of the Internet has altered the

process through which organizations run their businesses. However, the impact of the Internet was positive and negative on organizations, and the adverse effects were initially unwilling to adapt to the business process of that time [10]. Disruptive innovations are taken into account as they help take over a market share and are also effective for delivering opportunities related to growth for organizations that have adapted to such innovations, which further leads to bringing in new trends [4]. It can, therefore, facilitate both consumers and the current market competition by providing the respective organizations with cheaper and better products, which are comparatively more accessible than those of their market rivals.

Henceforth, it has been understood that disruptive Innovation can be considered as a process instead of a product or service. For instance, the time of launching innovative products helped the respective organization to draw the attention of customers to a greater extent [11]. Because of this, the organization may have been able to increase the rate of sales volume and the level of financial turnover [11]. The respective organization may have improved and developed its overall business operations through Innovation with this assistance. Disruptive Innovation can be categorized into two different parts, which have been identified as follows:

• New-market Disruption: This type of disruption indicates the organizational process of innovations leading the respective organizations to compete in the lowest margin against non-consumption throughout the industry [12].

• Low-end Disruption: This type of disruption refers to those organizations that serve their customers by coming to the bottom of their operating markets [3].

According to the Harvard Business Review, it has been determined that disruptive innovation theory illustrates a process through which a small-scale organization with a lower base of resources may have become able to impose large-scale challenges towards primarily established businesses [6]. Such a disruption can be termed as incumbent, which can be witnessed by coming from the bottom position of the operating market and continuing to move upwards. The entire process commonly takes place through a range of stages, which have been identified as well:

• Incumbent businesses are highly efficient in innovating and developing their products and services so that they can appeal to their profitable customers and highest demanding products [13].

• New entrants may have targeted such market segments that are ignored and also derived tractions by fulfilling their needs at a lower cost level than that offered by incumbents [2].

• Incumbent businesses are not responsive to new entrants in their operating markets. Instead, it can be seen that they continue to emphasize their stress on profitable segments to a higher degree [14].

New entrants may eventually move upwards in their operating markets by offering the best possible solutions, which appeal more to mainstream customers of incumbent businesses [15].

• After new entrants have begun attracting the mainstream base of customers of incumbent businesses, it can be seen that disruptions may have taken place in those new entrants [16]. (**Figure 1**)
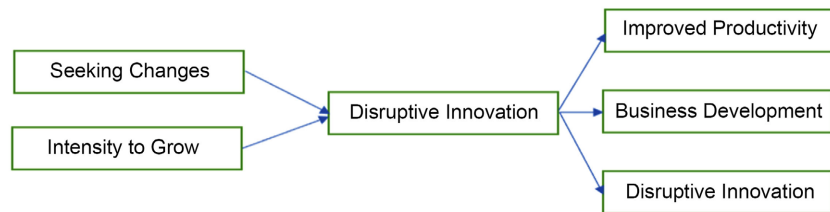
Figure 1. Conceptual framework (source: developed by the author). Note: Conceptual framework theory of disruptive innovation.

2.2. Positive Drivers

Agility can be determined to be more necessary than it has ever been. Food manufacturers may have been looking forward to modernizing their processes with effective Research and Development (R&D) activities [17]. This helped the respective manufacturers maintain the effectiveness of supply chain management, making them more responsive to fast-evolving market trends. Technological interventions may have imposed large-scale positive impacts on the respective companies and helped them step up to critical market challenges [6]. The following possible solutions can enrich challenges they may have experienced:

-Product lifecycle management: These solutions may have helped organizations participate in the market race with new products, flavors, and pathways for food packaging [18].

-Cloud-based solutions: These solutions provide organizations with fast deployment, making it easier to open new divisions and branches [19].

-Connected supply chain networks: These solutions may have helped respective organizations ensure on-time delivery of ingredients, managing their traceability [20].

• Quality control: This is crucial for organizations in maintaining taste consistency, freshness, and visual appeal.

When baby boomers read labels for information regarding fat grams and calories, millennials may have been interested in where food ingredients were grown [21]. Additionally, they may have been concerned about reducing the carbon footprint and ensuring the humane treatment of livestock [22]. Sustainability has been a top priority, with millennials well-informed about environmental issues and willing to support sustainable practices [18]. Excessive packaging, non-recyclable packages, and plastic containers are considered the most significant turn-offs regarding sustainability and creating low carbon footprints. Healthy food options blended with exotic tastes are considered a top priority, with unusual snacks gaining popularity [18]. For example, Coolhaus, an ice cream producer, plans to target the market by offering 13 vegan ice creams from brown rice, cocoa butter, and peas.

A global increase in demand for protein has been observed, leading to higher

prices for meat and other protein sources [10]. Lab-grown meats have emerged as a promising alternative when nearly seven tons of water produce up to 450 gms of beef, offering sustainable and ethical protein options [10]. In 2013, it was not considered to be affordable which affected the rate of prices for manufacturing protein around 140 gms of the total artificial meat to had further dropped to 959 Euro from 274.366 Euro at the end of 2017 [15]. Consumers progressively select food options according to their needs and preferences, encouraging organizations to develop cultured protein-based food options [15]. Additionally, organizations have been specializing in insect-based food, algae, and other substitute products, opening new market opportunities [9]. For example, Impossible Foods has created the Impossible Burger, mimicking the texture and taste of real meat [23].

3D food printing organizations have been using various types of liquid or powdered food materials to add extra nutritional value to customers' plates and generate additional income [20]. 3D food printers allow for precise, reproducible, customized nutrition tailored to individual needs [20]. Bio-printers, a specialized form of 3D food printers, have the potential to print living cells, offering fresh food options and potentially addressing hunger worldwide [6]. Natural Machines uses open capsules loaded with foodstuffs chosen by users to create savory and sweet cuisine [17].

2.3. Resisting Forces

Currently, consumers prefer in-home food delivery over dining out in restaurants, fueled by the proliferation of reality TV shows featuring cooking challenges and chefs [4]. Millennials, envisioning themselves as chefs, prefer preparing meals in their kitchens rather than in large-scale industrial plants for food processing [19]. This has increased the popularity of meal kits and ready-to-make meal options [21]. For example, Grainful produces whole frozen entrées featuring quinoa, whole oats, sorghum, proteins, sauces, and vegetables, claiming to be prepared by real chefs in real kitchens [14]. Similarly, Frozen Foodies partners with renowned Chicago chefs to bring restaurant-quality meals into homes, preserving texture and taste through cryogenic freezing [3].

Traditionally, most innovations in the food industry were driven by established players. However, new entrants are now the primary drivers of disruption within the industry [11]. Start-ups are influential in producing probiotics, ice cream, energy bars, and drinks infused with enzymes and vitamins [11]. For example, Halo Top, an ice cream brand marketed as "better for you," gained popularity for offering guilt-free indulgences [22]. These innovations often come from small-scale or regional brands leveraging technological implementations [13]. Large organizations often acquire these start-ups to expedite Innovation across specific product lines [13]. For instance, Coca-Cola acquired Honest Tea, Hormel acquired Applegate Farms, and PepsiCo partnered with small farmers in Ethiopia [13].

2.4. Positive and Negative Impacts

As defined by Hämäläinen and Inkinen, disruptive thinking focuses on innovative strategies aimed at enhancing business operations, ultimately leading to improved profitability [24]. Often characterized by "out-of-the-box" thinking, unconventional ideas leverage information technology to streamline data collection and processing for future enhancements [25]. Implementing disruptive innovations attracts customers and enables policymakers and business owners to explore new possibilities [3]. Technological adaptation, as emphasized by Savastano, Amendola, and D'Ascenzo, has revolutionized the business landscape, fostering manufacturing improvements that reduce pollution, enhance product quality, and lower operational costs [4] [26]. Additionally, cost-cutting measures through digital processes for marketing, manufacturing, and supply chain management contribute to profitability and quality enhancement [27]. The utilization of advanced information technologies, such as Manufacturing Value Modelling Methodology (MVMM), as highlighted by Demartini *et al.*, further enhances manufacturing efficiency and reduces processing costs [6].

Adopting disruptive innovations, primarily driven by information technology and artificial intelligence, can have adverse consequences despite its potential benefits. Environmental concerns and food recycling efforts, while aimed at cost reduction, may compromise food quality [28] [29]. Furthermore, the proliferation of self-sufficient technologies could lead to employee displacement, posing significant challenges in the future [30]. Failure to prioritize practical analysis and implementing innovative ideas may result in adverse business outcomes [31]. Moreover, advancements in supply chain management and manufacturing processes may inadvertently contribute to monopolistic practices due to the prohibitive costs and time associated with technology adoption [32]. Consequently, management, quality, cost, and employee-related issues may emerge as significant challenges in adopting innovative ideas [6].

3. Research Methodology

A comprehensive literature review using peer-reviewed publications including scholarly articles, industry reports, and case studies from sources like Harvard Business Review, Deloitte, and scientific journals was conducted. The search keywords include disruptive thinking, food industry, supply chain, lab-grown meat, and biotechnology providing the needed information for this research. This approach aided in the comprehensive investigation and evaluation of the subject matter from scholarly publications, research papers, reports, and other pertinent sources from the search.

The methodology included a thorough review and analysis of the identified literature, extraction of key findings, themes, and concepts, and synthesis of the data to develop a comprehensive understanding of the topic. Various aspects were examined, including market trends, consumer behavior, the positive and negative impacts of disruptive thinking, statistical data from the World Bank

and industry reports, and qualitative interviews and surveys with industry experts and food tech start-ups.

The research employed interpretivism as the research philosophy, focusing on small sample sizes and facilitating in-depth studies through qualitative and quantitative methods. Interpretivism was selected for its relevance and appropriateness, allowing researchers to gain meaningful insights and a diverse approach to understanding the influence of disruptive innovation in the food industry. It also employed a deductive approach to ensure that existing theories and models were followed.

3.1. Research Design

Research design is a crucial aspect of the research methodology, significantly impacting the comprehensiveness of the study and its findings [33]. Defining the study's structure influences the findings' overall construct. Generally, three types of methods are utilized: exploratory, explanatory, and descriptive. This study focuses on exploring various disruptive thinking ideas and technologies emerging in the food industry [34]. It is evident that millennials are driving Innovation in the food industry due to their specific expectations and demands. Consequently, various disruptive ideas have emerged, but they are still in their nascent stage. Many players in the food industry adhere to obsolete technologies, aligning with their business models.

Given the nature of the topic, an exploratory research design was selected to explore various factors, disruptive thinking ideas, and their impact on the food industry [35]. This design allows for exploring abundant sources and facilitates qualitative and quantitative analysis, which is beneficial for comprehensively understanding the topic at hand.

3.2. Data Collection and Analysis Method

Disruptive Innovation and thinking are prevalent topics in today's business environment, characterized by uncertainty, volatility, and complexity [36]. Focusing specifically on the food industry and highlighting various unique ideas with the potential to disrupt the entire sector necessitates abundant sources of information to provide an insightful view of the industry and the impact of disruptive Innovation. Therefore, a secondary data collection method has been chosen, utilizing books, journals, articles, online materials, and various other sources to conduct a detailed study of the food industry and disruptive innovation [36].

Effective data analysis techniques are crucial for accurately interpreting and presenting the collected information [37]. The researcher has ensured that all data and information related to the food industry and the impact of disruptive Innovation are comprehensively presented to enhance understanding. Both qualitative and quantitative analyses have been conducted to provide a broader perspective on the topic [37]. Despite secondary data collection, the study incorporates qualitative and quantitative information to illustrate how disruptive thinking is reshaping the industry landscape [37]. Major players in the industry

have already experienced significant changes due to evolving customer expectations, increasing awareness of environmental impacts, and rising demands. Therefore, Innovation and disruptive thinking are expected to drive further changes in the industry. The data analysis will be conducted efficiently to present critical qualitative and quantitative insights.

3.3. Sampling Technique

The sampling technique is considered highly important in this study as it involves selecting participants to get involved in the research process. This allows the researcher to collect information from industry experts, managers, or even customers at times [38]. Various sampling techniques and methods are available for selecting appropriate and relevant sampling populations, including probability and non-probability sampling techniques. Probability sampling techniques require methods where each individual in a group has an equal chance of getting selected. In contrast, in the non-probability sampling technique, the selection process requires bias towards certain groups or individuals [38]. In this study, the focus has been to collect information only through secondary sources.

4. Results and Findings

According to Deloitte [5], the food industry is the biggest industry on planet earth, as it comprises consistent and loyal customers of nearly 7 billion. According to the World Bank [39], food and agriculture comprise nearly of about 10% of the global GDP which means that food and agriculture was valued close to $8 trillion globally in the year 2019, where the global GDP estimates stood at $ 88 trillion. According to the statistics and reports, it has been analysed that the daily consumer spending on food and non-alcoholic beverages in the UK has increased consistently in the past 3 to 4 years. The value of consumer spending for food and non-alcoholic beverages stands at 26.7 billion British pounds in the year 2019, a slight increase from 26.3 billion in the previous year [40]. These numbers clearly highlight the huge size of the food industry.

However, it is important to note that despite the huge size of customer base and high consumer spending on food and beverages, the entire industry has been facing tremendous challenges ranging from production, meeting demands, managing regulation as well as changing consumer choices. Although, consumer demands and preferences keep changing every year, however, there has been an increased focus on sustainability, health and freshness that has put considerable pressure on the food industry to move towards disruptive thinking and innovation to sustain itself [40]. In the current section, focus has been laid on discussing key drivers of disruptive thinking, what changes have been observed in the food industry, a conceptual model for disruptive thinking and technology development in the food industry.

4.1. Food Ecosystem

In the past, the food ecosystem operated with distinct and independent players,

following a linear process from farmers to consumers. However, recent years have witnessed a dramatic increase in technology's involvement, transforming this linear process into a dynamic landscape. The food system's major components—producers, processors, wholesalers, restaurants, grocers, and consumers—have become interconnected and interdependent. New technologies and platforms have facilitated better connectivity between food businesses and consumers, creating a diverse food ecosystem within the linear process. Online-only players now offer convenient food at lower prices, blurring the differences between traditional players as grocers offer prepared meals to consumers. These trends and evolving consumer preferences have increased the value and interconnectedness of the current food ecosystem [41].

Every player in the food ecosystem plays a crucial role, and their relationships and interactions contribute to consumer satisfaction and sustenance. With billions of people needing to eat multiple times a day, there is a significant opportunity for disruptive thinking to transform the food ecosystem, from novel ingredients to improved diet and advancements in food distribution, preservation, and access [41]. (Figure 2; Figure 3)
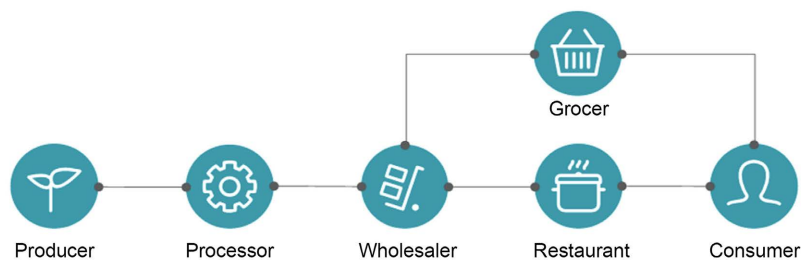

Figure 2. Interconnected food ecosystem (source: Deloitte, 2021). Note. The figure illustrates the past state of play in the food ecosystem.
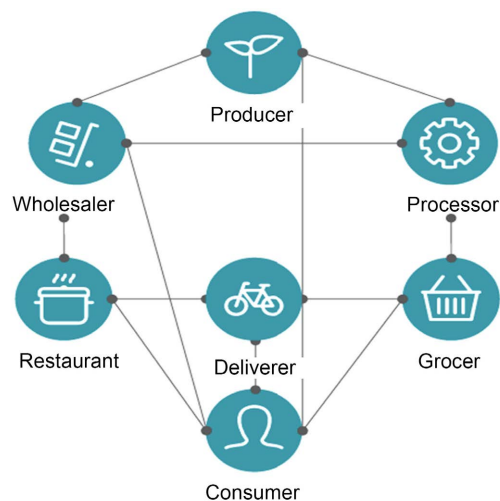

Figure 3. New food ecosystem (source: Deloitte, 2021). Note. The figure illustrates the current state of play in the food ecosystem. While each player may face challenges and uncertainty in adapting to changes in the food industry landscape, new growth opportunities are emerging.

According to Deloitte [5], food is an integral part of everyday life, with approximately 7.7 billion people consuming nearly 14.7 million tons daily. The food industry is enormous and evolving, with food being produced on farms and often reaching consumers' plates through various intermediaries, including manufacturers, grocers, and restaurants.

4.2. How Disruptive Thinking Is Changing the Food Industry?

The transformation of the food industry through technological advancements is a compelling topic, exemplified by various examples. Food technology encompasses various technological applications, including agri-tech and food tech. Agri-tech encompasses precision agriculture, breeding techniques, aquaculture, biotechnology, and the production of new protein sources. Meanwhile, food tech involves robotics, data technology, novel processing, nanotechnology, and cell technology [42].

Over the past few years, the food industry has finally overcome hurdles in including robotics as an important part of it. With robotics, food industry has witnessed automation across production processes. As of now robotics is finding applications in the food industry and its overall demand and sales are increasing widely in Europe as well as worldwide. With robotics, use of technologies like image recognition and gripper technology has been implemented increasingly. This has improved the capabilities such as handling diverse and delicate products, functioning in challenging work environments, as well as following strict food safety laws. It has been noted that robotics is being used widely across various restaurants as well as for improving every task and production facilities and processing plants. (**Figure 4**)

Robots sales to the food industry are increasing
New robots sold to the food and beverage industry, per year

In Europe
2013: 2480 | 2014: 3192 | 2015: 2772 | 2016: 3412 | 2017: 3766

Worldwide
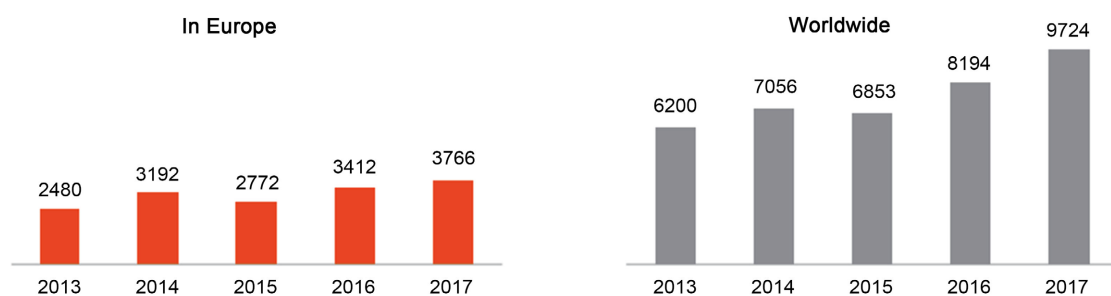2013: 6200 | 2014: 7056 | 2015: 6853 | 2016: 8194 | 2017: 9724

Figure 4. (Source: Ingwb, 2021). Note. The figure illustrates the escalating demand and sales of robotics in the food industry, both in Europe and worldwide.

In the year 2016, JBS, which has one of the largest meat processing plants, started trying robot butchers to cut different sections of the meat. Robots have created a safe environment as well as reduced overall injuries caused to human resources. One of the major reasons behind the use of robots across the food industry is the rising costs involved with labour as well as staff shortages. It has

been noted that robots can do much more than stacking boxes together, for instance, they have high capabilities to manage operations in the production process where defined applications across logistics, quality control, processing, pick and place and packing. (Figure 5)

Robots do much more than just stack boxes
Examples of robot operations by degree of difficulty and their place in the production process
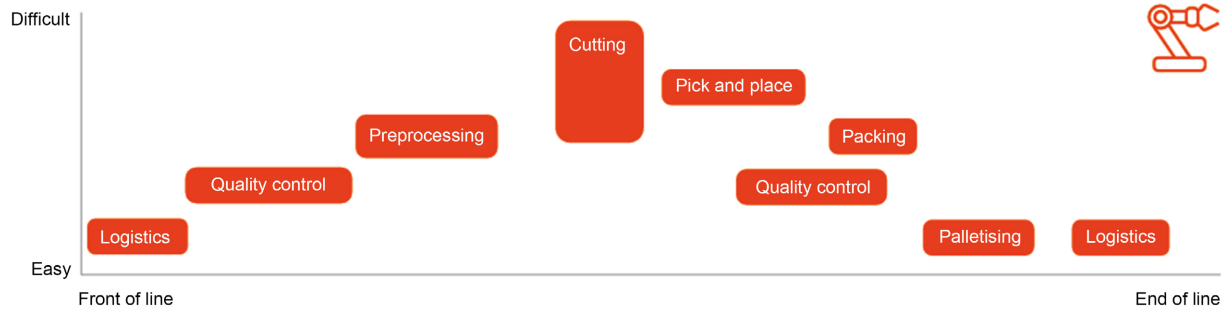

Figure 5. (Source: Ingwb, 2021). Note. This image illustrates the high capabilities of robots in managing operations within the food industry production process.

Different reports have highlighted that the use of robots differs from country to country. In the year 2017, nearly thirty-one thousand robots were used in the European Food Industry. Therefore, Europe, particularly Germany and Italy, has adopted robotics within the food industry, accounting for half of the world's robot supply. Countries like Sweden and Denmark, which have high labor costs, exhibit the highest robot density per 10,000 employees. Conversely, the UK has a lower adoption rate of robots due to lower labor costs [42]. (Figure 6)

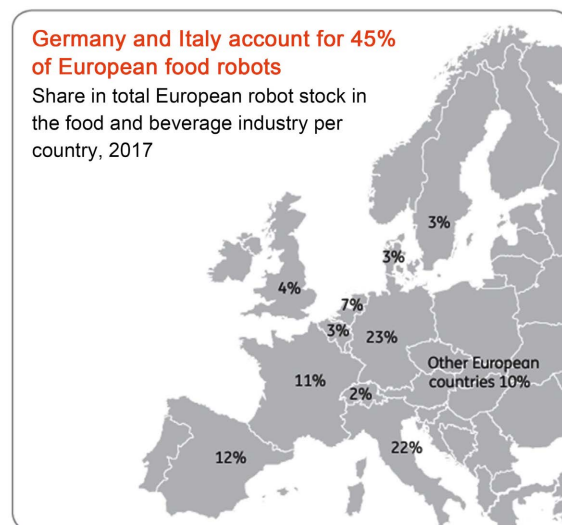

Figure 6. Robot stock is concentrated in Germany and Italy (Source: Ingwb, 2021). Note. Reports in 2017 emphasized the utilization of robots in European countries.

Technological solutions like data technology have enabled better control and

optimization of production lines, enhancing transparency from farm to fork [42]. Novel processing techniques have blurred the boundary between processed and fresh food, producing fresh-quality processed products like pasta, soup, and fresh juices. These techniques also have applications in sterilizing and pressurizing products such as meat and spreads [42].

Companies like WestFort Vleesproducten have invested in robotics for meat processing, improving food safety and work conditions—data technology aids in predicting the value extracted from livestock and optimizing production. Similarly, companies like Ardo use camera technology and robotics to meet quality demands for fresh frozen products [42].

Artificial intelligence (AI) solutions play a crucial role in managing data and optimizing operations in the food industry. AI enables real-time forecasting of staff demands and product tracking in cafes and restaurants, enhancing efficiency. Additionally, the Internet of Things and blockchain technology are emerging as transformative technologies, improving supply chain efficiency and transparency [43].

In summary, technological innovations are revolutionizing the food industry, driving automation, enhancing quality, and improving efficiency across various processes, from production to distribution. These advancements are essential for meeting evolving consumer demands and ensuring the sustainability and competitiveness of the food industry [43].

4.3. Conceptual Model for Innovative Technology Development in the Food Industry

Scientific progress often outpaces practical application, particularly in the food industry, where new findings need more frameworks for technological implementation [44]. Consequently, there is a pressing need to develop conceptual models to facilitate the transition of scientific knowledge into new technologies [44]. These models aim to provide a structured approach for transferring ideas to entrepreneurs, industrial associations, and regional organizations.

Biotechnology plays a crucial role in agriculture, spanning crop production, molecular breeding, the creation of transgenic animals, and agricultural waste processing [44]. It also encompasses dietary proteins, functional foods, and food ingredient development [44].

Nanotechnology holds immense potential to revolutionize the food industry, enhancing nutritional properties, food safety, and molecular synthesis of new products [20]. Its primary focus is improving food safety, nutrient absorption in plants, optimizing food delivery, creating functional foods, and enhancing food storage and transportation's environmental and economic efficiency [44].

Information and Communication Technology is vital for DNA and protein sequence analysis, accelerating Innovation in life sciences and food technology [44]. Information and communication technology (ICT) is instrumental in reducing the cost of exploring, testing, and predicting properties of new nanostructures [44]. Cognitive technology in the food industry involves developing func-

tional foods influencing human cognition and psychophysiology [44].

Cognitive Technologies also has its roots in computer technology. The term cognitive has undergone various transformations and it is broadly seen as connotation of knowledge and intelligent being [44]. This technology plays an important role in the food industry because it allows testing of products from psycho and physiological characteristics of humans. In applying this particular technology to the food industry, the best example includes the development of functional foods that can influence human cognition and psycho-physiology.

It is important to note that the technology discussed above has wide applications in food science and technology. It has been noted that the design of nano-materials can help in manufacturing properties of plants as well as it can be used for self-assembling and selling healing. Nano sensors and Nano biosensors can play a significant role in quality control and food safety. For making improvement in the area of processing of food nanofabrication, Nano filtration can play an important role. (Figure 7)
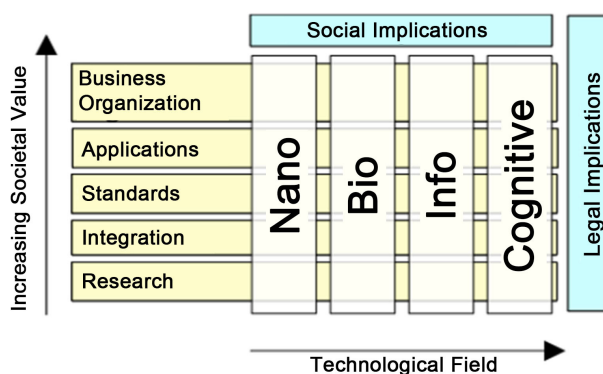

Figure 7. (Source: Khramtsov *et al.*, 2014). Note. It is important to note that the food industry is expected to transform on these four pillars of modern progress. With the integration of these four technologies, as per the architecture shown in the above figure, it can be said that the food industry will develop rapidly while involving solutions and products for billion consumers.

4.4. Discussion

Technology is disrupting the food system, which is a well known fact across the world. With the use of more and more technology, each area of the food industry is becoming more integrated with every other part. There has been acceleration in the adoption rate of existing technologies as well as new wave technologies have been emerging which are opening opportunities as well as challenges for food companies and start-ups. It has been analysed that use of data analytics as well as various kinds of digital platforms have become a new trend among businesses as they offer better opportunities to understand customer choices as well as their needs. Traditionally, these platforms were never available for businesses to connect more extensively with consumers, therefore, wide use of digital

platforms is one area that is helping businesses to fulfil consumer preferences in an effective manner as well as offering personalized catering services. It is important to note that complex consumer requirements are a major challenge that food processing companies have to deal with. Simultaneously, it has been argued that the use of mobile apps and health trackers has made people highly conscious about what they consume and the quantity as a quality [20]. These new trends among the consumers are changing their preferences thereby consumers are asking businesses to put higher nutritional value and protein content as well as ensure high convenience in terms of accessibility. Therefore, businesses are bound to use disruptive thinking and ideas to revolutionize their supply side. The Food Industry is witnessing transforming and not just what consumers eat but also so on how foods are produced, supplied and packaged. Starting from 3D printers as well as synthetic meat, technology is disrupting the food ecosystem.

Different studies have highlighted that control systems are being used by local food production plants to increase their productivity and lower their costs [44]. Another major innovation that has evolved in the food industry is the use of vertical farms as well as greenhouse or warehouses where food is being produced with the use of high tech urban indoor farms rather than agricultural land using soil. With the internet of things and block chain technology gaining momentum across the world, the Food Industry is also witnessing transformation in its supply systems due to this new technology. It is important to note that businesses are burdened with the pressure from consumers regarding transparency as well as providing real-time data and tracking features. Therefore businesses are adopting various next wave Technologies to deliver these aspects across their services. It is important to note that food Tech companies attract maximum investments from investors around the world as 7 billion consumers on earth are constant and all customers constantly need food to meet their nutritional requirements. Therefore, it can be said that in the coming decades, the Food Industry will vastly become revolutionise and come out of its traditional practices. It is difficult to clearly highlight the picture of the future Food Industry, however, it can be said that businesses ranging from start-ups to small enterprises and even large scale businesses having global footprint are bound to witness revolution in their food processing and production facilities, delivering, packaging, distribution and all other areas.

5. Conclusion

5.1. Summary

In the above study, disruptive Innovation is analyzed, involving the implementation of technology with tremendous potential to transform business functions. Various technologies have emerged and transformed the business world. However, mainly catering to the food industry, it has been identified that disruptive Innovation leads to improved productivity, better business development, and cost reduction. Various key drivers encourage disruptive thinking and ideas to

evolve and translate into business opportunities. For instance, it has been identified that technological intervention has a significant positive impact on production and processing units. With disruptive thinking, enhancements in the product life cycle, new flavors, and improvements in food packaging have been possible. The supply chain, which is always considered a complex part of the food industry, has been streamlined, offering greater transparency and real-time tracking and improving quality control across distribution systems.

With growing awareness among consumers, the demand for healthy, sustainable, and fresh products is rising, due to which food tech companies and start-ups are on the rise. With high investment available from around the world, companies are taking risks to develop new products like artificial proteins, dairy products, and better quality processed foods, as well as increasing the number of protein sources. New wave technologies like artificial intelligence, the Internet of Things, and robotics are being widely adopted by start-ups, cafes, restaurants, and food processing plants. Disruptive thinking has changed the food ecosystem, where grocery stores, wholesalers, and producers have become interconnected and come closer to consumers. However, there are certain drawbacks associated with it; it has been analyzed that the increasing use of technology across food processing and production has blurred the lines between fresh and processed food. New start-ups, along with innovative business models and the use of new-wave technologies, are disrupting the food industry, thereby challenging pre-established businesses. With disruptive thinking finding wide application in the food industry, it is evident that the entire food ecosystem and its landscape will transform in the coming one or two decades.

5.2. Linking with Objectives

Various disruptive ideas have emerged in the food industry, which has been illustrated in the above sections. It has been identified that 3D food printing is an emerging idea that is being adopted by various organisations. They are primarily using 3D printing methods to produce high nutritional food products providing customers with precise and customised nutrition to cater to individual choices and preferences. Bioprinter is one of the most effective specialised forms of 3D food printers that have been adopted. Along with this, artificial proteins or lab grown meat is widely translated into easily accessible products in the market. With the rising demand for high nutritional value and protein content, food companies are focusing on production of insect based food, plant based food as well as using algae to produce high protein foods that may soon become a new normal in the coming future. Along with this, disruptive ideas are also transforming how food is produced, for instance, nanotechnology and biotechnology are being widely used.

According to the current trends of disruptive innovation in the food industry, it has been studied that food tech companies and start-ups are the frontiers of innovation. Discussion about various examples highlighting names of different companies, which have done a remarkable job ranging from commercialising

alternative proteins, use of vegetarian versions of meat products as well as developing milk kit distribution. Industrial food tech has also been involved with the current trends. As consumer's demand for sustainable and healthy food products rises, several companies have come forward to develop technology regarding food quality, foreign object detection, reducing food wastage and improving nutritional labelling. At the current stage, the major change that has been observed is that consumers prefer more to the quality of food that they consume than the quantity. Therefore, various companies are preparing healthy food products using artificial intelligence.

It is important to note that new technologies like internet of thing have widely affected the entire food industry. Although, the implementation of disruptive thinking is currently at its early stage, however, several organisations are following the trend to optimise their production processes as per the customer needs and preferences to sustain their business. One of the disruptive thinking in the food industry is the widespread use of robotics. Earlier, it was noted that implementing robotics in the food industry was quite challenging. However, now the food industry and its stakeholders have overcome all hurdles in robotization. Robotics has found wide application in production facilities and processing plants, where they can be seen handling difficult and delicate tasks. The use of robotics has improved working conditions in the food industry companies, along with this, the use of data technology has provided better transparency and real-time data to consumers thereby, winning the trust of consumers as well as encouraging them to spend more on food and beverages. Lastly, it can be said that disruptive thinking has completely transformed the food ecosystem where all the participants including farmers, grocery stores, producers and wholesalers are better connected with the consumers.

5.3. Recommendations

It is important to note that the study has emphasized the use of robotics, its wide application across cafes, restaurants, and food processing plants, and how it has helped improve quality control and ensure a safe work environment. The study has primarily focused on highlighting the use of artificial intelligence and showcasing various examples of companies that have made a strong mark with innovative ideas and products. However, it is essential to note that disruptive thinking and technological implications in the food industry are still in their early stages. There are various new products and technologies still to be developed and commoditized. Therefore, there is tremendous scope for future studies and research. Primarily, future studies should focus on exploring the negative impacts of rapid technological innovations and the impact of changes in the food industry on consumer perceptions and attitudes. It is important to note that consumers are only sometimes willing to compromise on the taste, smell, and appearance of food to which they are accustomed. Therefore, analyzing how changes in the food industry would affect consumer perceptions and how willing they are to accept lab-grown meat and other new products becoming readily

available in the market is an essential area of research and study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Bongomin, O., Gilibrays Ocen, G., Oyondi Nganyi, E., Musinguzi, A. and Omara, T. (2020) Exponential Disruptive Technologies and the Required Skills of Industry 4.0. *Journal of Engineering*, **2020**, Article 4280156.
https://doi.org/10.1155/2020/4280156

[2] Ginanneschi, M. (2021) Long-Term Strategic Thinking, the Themis Method and the Future of Food. *Technological Forecasting and Social Change*, **165**, Article 120468.
https://doi.org/10.1016/j.techfore.2020.120468

[3] Purba, H.H., Maarif, M.S., Yuliasih, I. and Hermawan, A. (2018) Innovation Typology in the Food Industry Sector: A Literature Review. *International Journal of Modern Research in Engineering and Technology*, **3**, 8-19.

[4] Savastano, M., Amendola, C. and D'Ascenzo, F. (2018).How Digital Transformation Is Reshaping the Manufacturing Industry Value Chain: The New Digital Manufacturing Ecosystem Applied to a Case Study from the Food Industry. In: Lamboglia, R., Cardoni, A., Dameri, R. and Mancini, D., Eds., *Network, Smart and Open*, Springer, 127-142. https://doi.org/10.1007/978-3-319-62636-9_9

[5] Deloitte (2021) Future of Food: Maximising the Benefits of the Digital Ecosystem. Deloitte Future of Food Report.
https://www2.deloitte.com/content/dam/Deloitte/my/Documents/risk/my-risk-sdg2-the-future-of-food.pdf

[6] Demartini, M., Pinna, C., Tonelli, F., Terzi, S., Sansone, C. and Testa, C. (2018) Food Industry Digitalization: From Challenges and Trends to Opportunities and Solutions. *IFAC-PapersOnLine*, **51**, 1371-1378.
https://doi.org/10.1016/j.ifacol.2018.08.337

[7] Klimczuk-Kochańska, M. (2018) Startups as a Source of Innovation in the Agri-Food Industry. *Marketing i Rynek*, **7**, 21-30.
https://www.researchgate.net/publication/344672868_Startups_as_a_Source_of_Innovation_in_the_Agri-Food_Industry

[8] Hassoun, A., Cropotova, J., Trif, M., Rusu, A.V., Bobiş, O., Nayik, G.A., *et al.* (2022) Consumer Acceptance of New Food Trends Resulting from the Fourth Industrial Revolution Technologies: A Narrative Review of Literature and Future Perspectives. *Frontiers in Nutrition*, **9**, Article 972154. https://doi.org/10.3389/fnut.2022.972154

[9] Santeramo, F.G., Carlucci, D., De Devitiis, B., Seccia, A., Stasi, A., Viscecchia, R., *et al.* (2018) Emerging Trends in European Food, Diets and Food Industry. *Food Research International*, **104**, 39-47. https://doi.org/10.1016/j.foodres.2017.10.039

[10] Vecchiato, R. (2017) Disruptive Innovation, Managerial Cognition, and Technology Competition Outcomes. *Technological Forecasting and Social Change*, **116**, 116-128.
https://doi.org/10.1016/j.techfore.2016.10.068

[11] Tait, J. and Wield, D. (2019) Policy Support for Disruptive Innovation in the Life Sciences. *Technology Analysis & Strategic Management*, **33**, 307-319.
https://doi.org/10.1080/09537325.2019.1631449

[12] Raj, S.J.M. (2021) Branding of Green Tea Leaf: A Disruptive Innovation for Build-

ing Market Competitiveness of Small Tea Growers in North East India. *Journal of Agribusiness in Developing and Emerging Economies*, **11**, 88-104.
https://doi.org/10.1108/JADEE-09-2019-0145

[13] Bradley, R., Harnett, J., Cooley, K., McIntyre, E., Goldenberg, J. and Adams, J. (2019) Naturopathy as a Model of Prevention-Oriented, Patient-Centered Primary Care: A Disruptive Innovation in Health Care. *Medicina*, **55**, Article 603.
https://doi.org/10.3390/medicina55090603

[14] Beltagui, A., Rosli, A. and Candi, M. (2020) Exaptation in a Digital Innovation Ecosystem: The Disruptive Impacts of 3D Printing. *Research Policy*, **49**, Article 103833.
https://doi.org/10.1016/j.respol.2019.103833

[15] Ahn, M.J., Shaygan, A. and Weber, C. (2018) Genomics, Rare Diseases, and Disruptive Innovation in the Biopharmaceutical Industry. 2018 *Portland International Conference on Management of Engineering and Technology* (*PICMET*), Honolulu, 19-23 August 2018, 1-10. https://doi.org/10.23919/picmet.2018.8481812

[16] Goldberg, S.B., Tucker, R.P., Greene, P.A., Simpson, T.L., Kearney, D.J. and Davidson, R.J. (2017) Is Mindfulness Research Methodology Improving over Time? A Systematic Review. *PLOS ONE*, **12**, e0187298.
https://doi.org/10.1371/journal.pone.0187298

[17] Carrigan, M., Lazell, J., Bosangit, C. and Magrizos, S. (2017) Burgers for Tourists Who Give a Damn! Driving Disruptive Social Change Upstream and Downstream in the Tourist Food Supply Chain. *Journal of Sustainable Tourism*, **25**, 1563-1582.
https://doi.org/10.1080/09669582.2017.1291652

[18] Nosratabadi, S., Mosavi, A. and Lakner, Z. (2020) Food Supply Chain and Business Model Innovation. *Foods*, **9**, Article 132. https://doi.org/10.3390/foods9020132

[19] Kuokkanen, A., Uusitalo, V. and Koistinen, K. (2018) A Framework of Disruptive Sustainable Innovation: An Example of the Finnish Food System. *Technology Analysis & Strategic Management*, **31**, 749-764.
https://doi.org/10.1080/09537325.2018.1550254

[20] Kuzminov, I., Bakhtin, P., Khabirova, E., Kotsemir, M. and Lavrynenko, A. (2018) Mapping the Radical Innovations in Food Industry: A Text Mining Study. Higher School of Economics Research Paper No. WP BRP 80/STI/2018.
http://dx.doi.org/10.2139/ssrn.3143721

[21] Joshi, B.P. (2018) Disruptive Innovation in Hospitality Human Resource. *Journal of Tourism and Hospitality Education*, **8**, 48-61.
https://doi.org/10.3126/jthe.v8i0.20010

[22] Food Manufacturing (2019) Millennials' Food Fascination Drives Disruptive Innovation for F&B Manufacturers.
https://www.foodmanufacturing.com/home/article/13250401/millennials-food-fascination-drives-disruptive-innovation-for-fb-manufacturers

[23] Wilson, C. (2018) Disruptive Low-Carbon Innovations. *Energy Research & Social Science*, **37**, 216-223. https://doi.org/10.1016/j.erss.2017.10.053

[24] Hämäläinen, E. and Inkinen, T. (2019) Industrial Applications of Big Data in Disruptive Innovations Supporting Environmental Reporting. *Journal of Industrial Information Integration*, **16**, Article 100105. https://doi.org/10.1016/j.jii.2019.100105

[25] Zimpel-Leal, K. and Lettice, F. (2021) Generative Mechanisms for Scientific Knowledge Transfer in the Food Industry. *Sustainability*, **13**, Article 955.
https://doi.org/10.3390/su13020955

[26] Suk, J., Yang, Y.J., Jeong, Y.J., Xiang, M. and Kim, K.O. (2020) Consumer Experience of a Disruptive Technology: An O2O Food Delivery App Case. *International*

Conference on Intelligent Human Systems Integration 2020, Modena, 19-21 February 2020, 1171-1177. https://doi.org/10.1007/978-3-030-39512-4_178

[27] Watanabe, C., Naveed, N. and Neittaanmäki, P. (2018) Digital Solutions Transform the Forest-Based Bioeconomy into a Digital Platform Industry—A Suggestion for a Disruptive Business Model in the Digital Economy. *Technology in Society*, **54**, 168-188. https://doi.org/10.1016/j.techsoc.2018.05.002

[28] Radnejad, A.B. and Vredenburg, H. (2019) Disruptive Technological Process Innovation in a Process-Oriented Industry: A Case Study. *Journal of Engineering and Technology Management*, **53**, 63-79. https://doi.org/10.1016/j.jengtecman.2019.08.001

[29] Hannibal, M. and Knight, G. (2018) Additive Manufacturing and the Global Factory: Disruptive Technologies and the Location of International Business. *International Business Review*, **27**, 1116-1127. https://doi.org/10.1016/j.ibusrev.2018.04.003

[30] Machin, J.E., Moscato, E. and Dadzie, C. (2021) Visualizing Food: Photography as a Design Thinking Tool to Generate Innovative Food Experiences That Improve Food Well-Being. *European Journal of Marketing*, **55**, 2515-2537. https://doi.org/10.1108/EJM-02-2020-0141

[31] Maresch, D. and Gartner, J. (2020) Make Disruptive Technological Change Happen—The Case of Additive Manufacturing. *Technological Forecasting and Social Change*, **155**, Article 119216. https://doi.org/10.1016/j.techfore.2018.02.009

[32] Siegrist, M. and Hartmann, C. (2020) Consumer Acceptance of Novel Food Technologies. *Nature Food*, **1**, 343-350. https://doi.org/10.1038/s43016-020-0094-x

[33] Attia, M. and Edge, J. (2017) Be(com)ing a Reflexive Researcher: A Developmental Approach to Research Methodology. *Open Review of Educational Research*, **4**, 33-45. https://doi.org/10.1080/23265507.2017.1300068

[34] Ngozwana, N. (2018) Ethical Dilemmas in Qualitative Research Methodology: Researcher's Reflections. *International Journal of Educational Methodology*, **4**, 19-28. https://doi.org/10.12973/ijem.4.1.19

[35] Ragab, M.A. and Arisha, A. (2017) Research Methodology in Business: A Starter's Guide. *Management and Organizational Studies*, **5**, 1. https://doi.org/10.5430/mos.v5n1p1

[36] Basias, N. and Pollalis, Y. (2018) Quantitative and Qualitative Research in Business & Technology: Justifying a Suitable Research Methodology. *Review of Integrative Business and Economics Research*, **7**, 91-105.

[37] Dodds, S. and Hess, A.C. (2020) Adapting Research Methodology during COVID-19: Lessons for Transformative Service Research. *Journal of Service Management*, **32**, 203-217. https://doi.org/10.1108/josm-05-2020-0153

[38] Abutabenjeh, S. and Jaradat, R. (2018) Clarification of Research Design, Research Methods, and Research Methodology. *Teaching Public Administration*, **36**, 237-258. https://doi.org/10.1177/0144739418775787

[39] Division, E. (2023) WFP Global Operational Response Plan; Update #7—February 2023. WFP: World Food Programme. https://policycommons.net/artifacts/3456670/wfp-global-operational-response-plan/4257119/

[40] Statista (2021) Food and Drink: Spending 2012-2019. Statista. https://www.statista.com/statistics/289959/expenditure-on-food-and-non-alcoholic-beverages-in-the-united-kingdom-uk-quarterly

[41] TechCrunch (2021) TechCrunch Is Now a Part of Verizon Media.

https://techcrunch.com/2019/10/22/the-foodtech-investment-opportunity-present-and-future/

[42] ING (2021) Food Manufacturers Turn to Robots to Meet Customer's Needs.
https://www.ingwb.com/en/insights/research-reports/food-manufacturers-turn-to-robots-to-meet-customers-needs

[43] TechRepublic (2021) 10 Ways Technology Is Changing Our Food.
https://www.techrepublic.com/article/10-ways-technology-is-changing-our-food/

[44] Hramtsov, A., Evdokimov, I., Lodigin, A. and Budkevich, R. (2014) Technology Development for the Food Industry: A Conceptual Model. *Foods and Raw Materials*, **2**, 22-26. https://doi.org/10.12737/4121
https://www.researchgate.net/publication/262831549_Technology_Development_for_the_Food_Industry_A_Conceptual_Model