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| RESEARCH ARTICLE

Investigating Effective Factors in Application of the Artificial Intelligence in Iran's Food Industry and its Effects on Employment

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| ABSTRACT
The fourth industrial revolution has brought tremendous changes with the introduction of artificial intelligence to various industries. In this study, the effective factors in the use of artificial intelligence in Iran's food industry and its effects on employment have been identified. Due to the growing need to improve the quality of food products, increase productivity, and reduce costs, the use of new technologies, including artificial intelligence, in this industry seems inevitable. This research examines the opportunities and challenges in the use of artificial intelligence and analyzes its effects on employment in Iran's food industry. Investigating these factors in Iran's food industry is of great importance and necessity, and increases productivity, changes in employment, competitiveness, research and development, environmental sustainability, improves food security, and develops appropriate policies. The general goal of investigating these effective factors in the use of artificial intelligence in Iran's food industry is to create a stable and innovative ecosystem that will lead to the improvement of product quality, increase employment, and the realization of sustainable development goals. The type of this research in terms of practical purpose, in terms of descriptive-analytical execution method, and in terms of data collection using studies published until 2023 using PubMed, Cochrane, SCOPUS databases, and Google Scholar search engine with key related words have been searched. This research was selected after a complete review of 30 relevant articles that were consistent with the purpose of the present study. The results show that while artificial intelligence can reduce some traditional jobs, it also creates new job opportunities and increases the need for new skills. In this research, we found that workforce skills and technological infrastructure are of higher importance, government support and organizational culture are of high importance, and costs and benefits are of medium importance, and each of them creates its own effects on employment. Finally, this research provides recommendations to policymakers and the food industry to facilitate the transition process towards artificial intelligence.

| KEYWORDS

Employment, Iran, Artificial Intelligence, Food Industry, Productivity, New Technologies.

| ARTICLE INFORMATION

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1. Introduction

Manufacturing industries, particularly in the food sector. This revolution leverages modern technologies such as the Internet of Things (IoT), machine learning, big data analytics, and robotics to revolutionize production and distribution methods, thereby enhancing productivity and product quality (Kamble et al., 2020). In this context, the food industry, as one of the most crucial economic sectors in countries, requires transformations to harness these technologies.

In Iran, with its large population and increasing demand for high-quality food products, the use of artificial intelligence can improve production processes, reduce waste, enhance customer satisfaction, and optimize the supply chain (Zarifian et al., 2021). For example, advancements in artificial intelligence can help farmers determine optimal planting and harvesting times

by analyzing weather and soil data, thereby increasing crop yields. Additionally, in food production processes, the use of robots and automated systems can lead to cost reductions and increased precision in manufacturing.

The food industry, as a key pillar of any country's economy, is essential for meeting society's basic needs. With population growth and changes in consumption patterns, the demand for high-quality and high-volume food production is felt more than ever. In this regard, the adoption of modern technologies can improve product quality, increase productivity, and reduce waste. Moreover, given challenges such as climate change and resource scarcity, the food industry needs fundamental transformations to meet the growing demand. Implementing artificial intelligence in the food sector can assist in various areas, including supply chain optimization, quality control, waste reduction, and demand forecasting. Using machine learning algorithms and big data analytics allows for accurate market needs predictions and supply chain optimization. Additionally, artificial intelligence can play a significant role in identifying defects and ensuring food product quality, as well as reducing waste and managing resources more efficiently.

However, there are challenges that must be addressed. One of the main challenges is examining the factors influencing the adoption of these technologies in Iran's food industry. These factors may include technological infrastructure, organizational culture, workforce skills, and government policies (Mohammad et al., 2022). For instance, the lack of suitable information and communication technology infrastructure can hinder the rapid adoption of new technologies in the food industry. Furthermore, an organizational culture that does not trust innovation and rapid changes can obstruct the implementation of artificial intelligence.

Additionally, the impact of artificial intelligence on employment in the food industry is a noteworthy issue. On one hand, this technology may lead to a reduced need for labor in some processes, while on the other hand, it will also create new jobs in technology and data mining-related fields (Bai et al., 2021). For example, as automation increases in production processes, the demand for skilled workers in programming and data analysis will rise. Thus, policymakers need to take necessary measures to train and prepare the workforce.

Globally, various countries have achieved successes using artificial intelligence in their food sectors. For instance, in developed countries, companies have increased their productivity by employing robots on production lines and advanced data analysis systems. These experiences can serve as suitable models for Iran to smooth the path for the development of its food industry.

In Iran, given the high agricultural potential and ability to produce food, the implementation of artificial intelligence can create significant transformations. However, achieving this goal requires investment in infrastructure, workforce training, and the development of an innovation culture. Furthermore, collaboration between the public and private sectors can play a critical role in accelerating this process.

Thus, the aim of this research is to examine the factors influencing the adoption of artificial intelligence in Iran's food industry and its impacts on employment. This study can assist policymakers and industry stakeholders in identifying challenges and proposing effective strategies for leveraging artificial intelligence in this sector. Additionally, the findings could enhance public awareness regarding the importance of modern technologies in the food industry, paving the way for positive transformations in this economic sector.

2. Literature Review

1.2. Definition of the Fourth Industrial Revolution and Artificial Intelligence

The Fourth Industrial Revolution has emerged due to significant advancements in digital technologies, artificial intelligence, the Internet of Things, and big data, profoundly impacting various industries. The food industry, as a key sector of every economy, is not exempt from these transformations (Schwab, 2016).

Types of Industrial Revolutions

First Industrial Revolution: Began in the mid-18th century in England, known for the use of steam power and machinery in textile and mining industries.

Second Industrial Revolution: Occurred in the late 19th century, marked by the development of electricity, mass production, and new transportation methods like trains and steamships.

Third Industrial Revolution: From the 1970s onwards, associated with digitalization and innovations in information technology, highlighting the emergence of computers and the internet.

Fourth Industrial Revolution: Currently unfolding in the 21st century, it involves automation, artificial intelligence, and the Internet of Things, bringing profound changes to human life and work. Key features include:

- Integration of digital, physical, and biological technologies.
- Extensive use of artificial intelligence, IoT, big data, and robotics.
- Changes in production, distribution, and consumption processes through modern technologies.
- Emphasis on customization, flexibility, and sustainability in production (Schwab, 2016).

Key Sections of the Fourth Industrial Revolution

- **Artificial Intelligence:** The ability of machines to learn and make intelligent decisions.
- **Internet of Things:** Connecting devices to each other and exchanging data in real-time.
- Big Data: Analyzing large datasets to extract patterns and insights.
- **Advanced Robotics:** Utilizing robots in production and service processes.
- **Biological Technologies:** Advances in genetic engineering, biotechnology, and nanotechnology.
- **Blockchain Technology:** Creating secure and transparent systems for information exchange and transactions.

Virtual and Augmented Reality: Using these technologies in education, design, and customer experience (Wang et al., 2020).

Importance of Artificial Intelligence in the Food Industry

Artificial intelligence is crucial to Iran's food industry and can drive fundamental transformations. Its significance derives from several key points:

Improving Product Quality: AI can enhance product quality in production processes. Machine learning algorithms can help identify defects and optimize production processes.

Reducing Food Waste: AI can forecast demand and optimize inventory, thus minimizing food waste and saving resources and costs.

Data Analysis: AI can analyze large datasets and identify consumption trends and patterns, aiding entrepreneurs in making better decisions.

Automation of Processes: AI can assist in automating production and packaging processes, leading to increased efficiency and reduced costs.

Supply Chain Optimization: AI can optimize the supply chain, reducing transportation time and costs.

Employment

Employment refers to the economic activities that individuals undertake to earn income and meet their needs. This concept includes any work or activity in which a person invests time and energy and receives wages or salary in return (ILO, 2023). Employment can take various forms, such as working in an organization, freelancing, entrepreneurship, or temporary and permanent jobs. Essentially, employment not only helps individuals earn a living but also positively impacts economic growth, skill development, and the overall quality of life (OECD, 2022). Employment also encompasses social and psychological aspects, as work provides individuals with a sense of identity and value while strengthening social connections (World Bank, 2023).

Types of Employment

To better understand the different types of employment, we examine the following categories:

1. **Formal Employment**: This type of employment is governed by legal contracts and registered with the relevant organizations. Employees in this sector enjoy legal rights and benefits such as insurance and retirement (ILO, 2023).
2. **Informal Employment:** Refers to activities conducted without legal registration, where workers receive fewer benefits. This type usually includes day laborers and self-employed individuals (World Bank, 2022).
3. **Entrepreneurship:** Individuals contribute to job creation by starting their own businesses. This type of employment can encompass production, services, or technology (OECD, 2023).
4. **Part-Time:** Employment**: In this form of employment, individuals do not work full-time and have fewer working hours. This type can be beneficial for those seeking more flexibility (Eurostat, 2023).
5. **Freelancing:** This involves independent and project-based work where individuals work autonomously for specific clients, typically in fields such as design, programming, and consulting (Upwork, 2023).

2.2. Research Background

Samira Ahmadi and colleagues conducted a study in 2022 titled "Analyzing the Impact of Artificial Intelligence on Optimizing the Supply Chain of Iran's Food Industry," identifying factors influencing the adoption of new technologies. The results indicate that the use of artificial intelligence can increase efficiency and reduce costs.

Ali Akbar Zarei and colleagues, in 2023, conducted research titled "The Role of Artificial Intelligence in Sustainable Development of Iran's Food Industry," analyzing its impacts on employment and food security. The findings show that improvements in production efficiency, waste reduction, job creation, food security, and sustainable development are among the roles that artificial intelligence plays in the sustainable development of Iran's food industry, contributing to greater employment and security.

Mehdi Qasemi and colleagues, in 2021, studied the challenges and opportunities of using artificial intelligence in Iran's food industry, analyzing its effects on employment. Their research indicates that the use of artificial intelligence creates job opportunities in data analysis, programming, system management, and optimizing production processes while reducing

resource waste. Challenges include a lack of necessary skills among the workforce, high initial investment, and changes in job nature.

Zahra Shirazi and colleagues, in 2022, conducted research titled "Examining the Status of New Technologies in Iran's Food Industry" and explored their impacts on employment and productivity. The results show that high productivity, job creation, cost reduction, improved product quality, and market competitiveness are benefits arising from the adoption of new technologies, positively affecting employment and increasing company productivity.

Reza Hosseini and colleagues, in 2023, researched "The Impact of Automation and Artificial Intelligence on Employment in Iran's Food Industry," revealing that in the long term, these technologies can lead to the creation of new jobs, a reduced need for ineffective labor, a demand for new skills, and improved productivity and competitiveness.

Robert Green and colleagues, in 2022, examined "The Future of Employment in the Food Industry in Light of Artificial Intelligence Advancements," discussing existing opportunities and challenges. The results suggest that transformations in roles and jobs, increased productivity, the need for advanced skills, research and development, and labor market transformations are anticipated in the future of the food industry due to advancements in artificial intelligence, creating both opportunities and challenges Methodology.

3. Methodology

This research is applied in terms of its purpose and descriptive-analytical in nature. The current study aims to describe the existing situation and analyze the relationships between variables. Data collection involves using published studies up to 2023 through databases such as PubMed, Cochrane, SCOPUS, and the Google Scholar search engine with relevant keywords.

In this study, our independent variable is the factors influencing the implementation of artificial intelligence (AI), such as :

- Technological infrastructure
- Organizational culture
- Workforce skills
- Government support
- Costs and benefits

The dependent variable is the impact of AI on employment, including:

- Creation of new jobs
- Changes in required skills
- Effects on job quality.

Tools Used in the Research

To collect data, ranking and prioritizing variables were based on studies and articles.

Conceptual Model of the Research

The conceptual model of the research can be designed as follows:

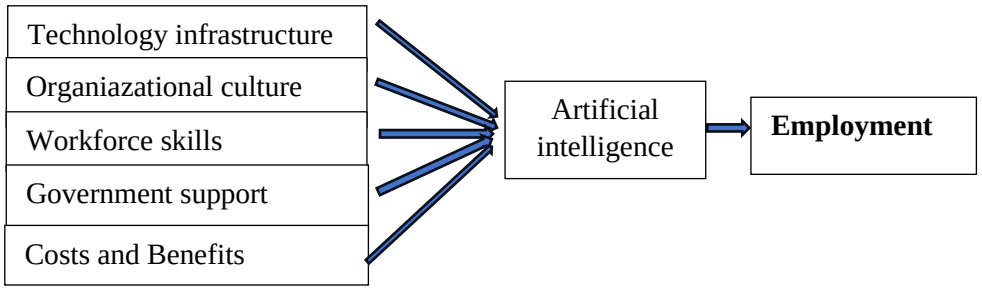

Figure 1: (Conceptual Model of the Research)

Explanation of Model Components

1. **Technological Infrastructure:** This includes internet networks, information systems, and hardware necessary for implementing AI. A study by Khan et al. (2022) emphasizes that a lack of appropriate infrastructure can hinder the adoption of new technologies and subsequently reduce job opportunities. The research indicates that investment in technological infrastructure can enhance efficiency and increase employment.
2. **Organizational Culture:** Organizational culture plays a significant role in the acceptance of innovations. Schein (2019) notes that organizations with a culture of change and innovation are more capable of utilizing new technologies. This culture can motivate employees to learn new skills, positively impacting employment.

3. **Workforce Skills:** Having a skilled workforce capable of leveraging AI is crucial. Bessen (2020) found that a lack of necessary skills can impede effective use of new technologies, thus limiting job opportunities. Training and developing new skills for the workforce are key to successfully implementing AI.
4. **Government Support:** Government support for industries can significantly influence the adoption of new technologies. The OECD (2021) reported that supportive policies, such as financial incentives, consulting, and training, can help industries accelerate the implementation of AI, thereby increasing employment.
5. **Costs and Benefits:** Analyzing the costs and benefits of implementing AI is also a key factor. Brynjolfsson and McAfee (2014) pointed out that if the implementation costs exceed the benefits, companies may refrain from investing in this technology. Therefore, a thorough examination of costs and benefits is essential for making informed decisions regarding workforce hiring and investment in technology.

4. Results and Discussion

The study identified and examined various factors influencing the implementation of AI in Iran's food industries and its effects on employment. Some key factors include:

Appropriate Technological Infrastructure: Such as high-speed internet and advanced information systems, allows companies to effectively utilize AI technologies. The lack of proper infrastructure can hinder the use of these technologies and subsequently reduce job opportunities. Information and communication technology infrastructures play a vital role in developing Iran's food industries, helping to improve efficiency, reduce costs, and increase the quality of food products (world Bank,2022).

Key Aspects Addressed

Supply Chain Management: Information technology infrastructures enable food industries to better manage their supply chains. Using supply chain management software, companies can optimize inventories, transportation, and product distribution, leading to reduced waste and increased productivity (world Bank,2022).

Automation and Process Improvement: Utilizing automation in food production lines can enhance production speed and reduce errors. Smart machines and quality control systems help producers create higher-quality products, thus increasing demand.

Analysis: Modern technologies like data mining and machine learning assist food industries in identifying consumption patterns and making more accurate demand forecasts. This can lead to better production planning and cost reduction (world Bank,2022).

Digital Marketing: Information technology infrastructures allow food industries to use modern digital marketing methods. By creating websites, online stores, and leveraging social media, producers can reach more customers and increase sales (world Bank,2022).

Job Creation: The development of information technology infrastructures in the food industries can lead to the creation of new jobs. The demand for IT specialists, data analysts, automation engineers, and other professionals in this field will increase. Additionally, with increased productivity and business growth, new job opportunities will arise (world Bank,2022).

Sustainability and Product Quality: Information technology helps food industries implement more sustainable processes. The use of modern technologies in agriculture, such as precision farming, can reduce water and fertilizer consumption, thereby enhancing product quality (world Bank,2022).

Export Development: By improving product quality and increasing productivity, Iran's food industries can access international markets. Information technology infrastructures can play a crucial role in the export process, including document management and communication with foreign customers(world Bank,2022).

Organizational Culture

Organizational culture refers to a set of shared values, beliefs, behaviors, and habits within an organization that influences how its members operate and interact. In Iran's food industries, organizational culture can significantly impact employment and productivity. A culture that embraces innovation and change can facilitate the acceptance of AI technologies. Organizations with resistant cultures may face challenges in adopting new technologies, negatively affecting employment. Here are some key aspects:

Motivation and Job Satisfaction: A positive organizational culture can enhance employee motivation and job satisfaction. When employees feel that the organization's values and goals align with their personal values, they are more likely to work hard and strive for the organization's success. This can lead to reduced turnover rates and increased workforce stability (OECDO, 2016).

Skill Development and Training: Organizations that promote a culture of learning and development typically invest more in employee training and skill development. In Iran's food industries, this can improve the quality of products and services, consequently increasing employment and economic growth (OECDO, 2016).

Collaboration and Team Building: A culture emphasizing collaboration and teamwork can boost productivity and innovation. In the food industry, where processes are often complex, effective collaboration between different departments (such as production, marketing, and distribution) can enhance overall organizational performance (OECDO, 2016).
Market Responsiveness: An adaptable organizational culture that responds to market changes can help food industries meet customer needs more quickly. This can lead to increased sales and the eventual creation of new job opportunities (OECDO, 2016).
Change Management: A strong organizational culture can help organizations perform better during times of change (such as crises or market shifts). In Iran's food industries, which may be affected by sanctions or economic changes, having a flexible organizational culture can support job retention and growth (OECDO, 2016).

Workforce Skills
Having a skilled workforce (such as programming, data analysis, and management of AI systems) is essential for leveraging these technologies. A lack of necessary skills can result in an inability to utilize new technologies, thereby reducing employment opportunities. AI, as a modern technology, has profound effects on various industries, including food. Workforce skills are a key factor in effectively utilizing AI and increasing employment in these sectors. Here are some of these factors:
Changing Skill Requirements: The introduction of AI in food industries significantly alters the skill requirements for the workforce. Some of these necessary skills include data analysis, programming, software development, and AI system management (UNDIO, 2021).
Increased Productivity and Reduced Costs: Utilizing AI can lead to improved processes, increased productivity, and reduced costs. This can enhance the competitiveness of Iran's food industries, resulting in the creation of new job opportunities. With lower costs, companies can allocate more resources to hiring and training the workforce (UNDIO, 2021).
Creation of New Jobs: While AI may automate certain jobs, it also creates new ones, such as data analysts, machine learning specialists, and food quality and safety experts
Training and Skill Development: To effectively leverage AI in food industries, there is a need for educational programs and skill development that include both technical and managerial training (UNDIO, 2021).
Diversity of Skills: In the age of AI, the diversity of skills has become increasingly important. The workforce must be able to collaborate with various technologies, including both soft skills (such as communication and teamwork) and hard skills (such as programming and data analysis).
Market Challenge Response: AI can help food industries respond more quickly to market changes. By analyzing data and forecasting market trends, companies can make better decisions, ultimately creating more job opportunities (UNDIO, 2021).
Impact on Employment: The impacts of AI on employment can be dual-faceted: while some jobs that are prone to automation may decline, new jobs related to technology, data analysis, and AI management will increase (UNDIO, 2021).

Government Support
Government support (such as financial incentives, training, and consulting) can assist food industries in implementing AI. The absence of government support can hinder investment in this area and limit job opportunities. Government support for AI in Iran's food industries can play a crucial role in developing this technology and increasing employment, including:
Supportive and Legal Policies: The government can create a conducive environment for the growth of AI in the food industry by formulating supportive and legal policies, including establishing legal frameworks and encouraging investment (SCI, 2023).
Investment in Research and Development: The government can contribute to technological advancement by investing in AI research and development. This investment includes funding research projects and establishing innovation centers (SCI,2023).
Skill Development and Training: The government can prepare the workforce for adopting new technologies by launching educational and skill development programs, such as specialized training courses and workshops (SCI,2023).
Development of Technology Infrastructures: To effectively leverage AI applications, appropriate technology infrastructures are necessary. The government can aid in developing digital infrastructures and communication networks to support AI technologies (SCI,2023).
Encouraging International Collaborations: The government can facilitate knowledge and technology exchange in AI by promoting international collaborations, such as partnerships with foreign universities and research centers and participation in international conferences and exhibitions (SCI,2023).
Impact on Employment: Government support for AI can have positive effects on employment, including the creation of new jobs, improvement in the quality of existing jobs, and increased competitiveness (SCI,2023).

Focus on Sustainability and Food Security: By supporting projects that contribute to sustainability and food security, the government can aid not only the growth of AI but also the creation of sustainable jobs. These projects may include smart agriculture and supply chain monitoring (SCI,2023).

Costs and Benefits

Evaluating the costs and benefits of implementing AI in the food industry can influence decision-making. If the costs outweigh the benefits, companies may forgo investing in this technology, potentially leading to reduced employment. Below is a brief overview of the costs and benefits of AI in the food industry and its impact on employment:

Initial Investment: Implementing AI in food industries requires purchasing software and hardware, as well as developing and customizing systems for the specific needs of each business (FAO,2021).

Training and Skill Development: To have a skilled workforce, investment in employee training and hiring specialists is necessary (FAO,2021).

Maintenance and Support: Costs related to maintaining systems and updating software and hardware to ensure the efficiency of AI systems must be considered (FAO,2021).

Development of Technology Infrastructures: Investing in digital technology infrastructures to support AI systems incurs costs (FAO,2021).

In addition to these costs, utilizing AI offers several benefits, such as increased productivity (process optimization, reduced production time), decreased costs (lower waste, reduced labor costs), improved product quality (quality monitoring, early problem detection), and innovation and development of new products (market analysis and new product development). Considering these aspects can lead to the creation of new jobs, improvement in the quality of existing jobs, development of new skills, and increased competitiveness among companies.

Table 1: Importance of Criteria

Importance	Name of Factors	Number
Very High	Workforce Skills	1
Very High	Technological Infrastructure	2
High	Organizational Culture	3
High	Government Support	4
Medium	Costs and Benefits	5

Thus, by implementing AI, food industries can create new jobs in areas such as data analysis, AI system management, and software development. Additionally, with the introduction of new technologies, the demand for new skills increases, and the workforce must adapt to these changes. It is also important to note that using AI may enhance job quality, as repetitive and tedious tasks are delegated to machines, allowing employees to focus on more creative activities. Ultimately, for the successful implementation of AI in Iran's food industries and the increase in employment, attention to workforce skills and technological infrastructures is crucial. Moreover, organizational culture and government support also play significant roles. Therefore, planning for workforce training and investing in technological infrastructures should be prioritized to take advantage of AI benefits (FAO,2021).

5. Conclusion

The implementation of artificial intelligence (AI) in Iran's food industries can lead to fundamental transformations in production and distribution processes, ultimately impacting employment. Identifying and strengthening the factors influencing this implementation, including technological infrastructure, workforce skills, organizational culture, government support, and costs and benefits, is essential for achieving positive outcomes. Additionally, addressing the challenges and opportunities arising from these changes can help policymakers develop appropriate strategies to manage their effects on employment. Given global trends and domestic needs, investing in AI is not only a necessity but also an opportunity that can pave the way for a brighter future for Iran's food industries. This study examined the effects of using AI in Iran's food industry on employment. The aim of this research was to investigate the factors influencing the adoption of AI to facilitate alignment with this technology. The results indicated that the use of AI in Iran's food industry has had positive effects on the employment sector. AI can enhance efficiency and lead to better decision-making across all industrial fields, especially in the food industry. The findings showed that specializing machines in production and packaging, along with improving employee behavior under AI control, increases productivity and reduces the costs of food production. Furthermore, delivering higher quality products while adhering to hygienic practices is another advantage of using AI in the food industry. Ultimately, utilizing AI can serve as a guide to maximize technology use in the food sector, which can contribute to long-term employment growth in the country.

6. Suggestion

To achieve the aforementioned goals, the following recommendations are suggested:

1. **Infrastructure Development:** The government should strengthen ICT infrastructure and facilitate investment in this area.
2. **Training Programs:** Creating specialized training courses for the workforce in AI and related technologies is essential.
3. **Encouraging Innovation:** Organizations should promote a culture of innovation and provide a conducive work environment for creativity.
4. **Government Support:** Government support policies should be designed to reduce barriers and provide the necessary incentives for investment in this field.

By implementing these recommendations, it is expected that the adoption of AI in Iran's food industries will be more successful, and its positive impacts on employment will be sustained

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