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Artificial Intelligence and Industrial Policy

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Abstract

The study concludes by emphasizing the future of industrial policies in the context of digitalization, sustainability, and innovation. It presents policy recommendations to support AI-based production, workforce adaptation, ethical governance, and global regulatory alignment, ensuring sustainable and competitive industrial transformation. The integration of artificial intelligence (AI) into industrial policy is transforming economic growth, governance structures, and workforce dynamics. AI-driven automation and digital transformation are redefining industrial production, requiring policymakers to develop adaptive regulations that enhance efficiency, promote sustainability, and ensure inclusive economic development. This study explores AI's role in industrial policies, focusing on regulatory frameworks, economic implications, and labor market transformations. It examines AI applications in industrial strategies across different countries, highlighting key regulatory measures adopted by the European Union, the United States, and China. Additionally, it analyzes Turkey's AI-driven industrial policies, emphasizing national strategies, regulatory challenges, and efforts to align AI with industrial transformation. The findings suggest that AI-compatible industrial policies should prioritize ethical integration, workforce adaptation, and public-private collaboration to foster sustainable development. Furthermore, the study underscores the importance of balancing innovation with regulatory oversight to mitigate socio-economic risks. By implementing well-structured AI-driven policies, countries can enhance global competitiveness, stimulate economic growth, and drive technological advancements while addressing ethical and regulatory concerns. The study concludes with policy recommendations aimed at fostering AI innovation while ensuring an inclusive and sustainable industrial future.

Keywords: Artificial Intelligence (AI), Industrial Policy, Digital Transformation, Economic Growth

1.INTRODUCTION

The integration of artificial intelligence (AI) into industrial policy is a multifaceted subject that encompasses dimensions such as governance, economic development, and operational efficiency. As AI technologies continue to evolve, their impact on industrial policies becomes increasingly significant, necessitating a comprehensive understanding for their effective management and regulation. AI's role in enhancing operational efficiency in manufacturing is of critical importance. Research indicates that AI can significantly boost productivity and technological innovation, thereby strengthening the position of manufacturers and countries in the global value chain (Dhamija & Bag, 2020; Liu, 2024). Despite its potential, the application of AI in production operations remains underutilized, suggesting a substantial opportunity for industries to leverage AI for smarter decision-making and operational improvements (Dhamija & Bag, 2020).

Policymakers should emphasize the development of tailored economic strategies, increased investment in AI research and development (R&D), and the importance of personnel training in this field (Huang, 2023).

Ensuring the responsible implementation of AI technologies requires robust governance. Effective AI governance frameworks can guide the development and deployment of AI systems that support ethical standards and mitigate risks related to data privacy, security, and discrimination (Miyamoto, 2023). Establishing such frameworks is essential for building trust among stakeholders, including consumers, businesses, and public institutions. Inclusive governance models that involve diverse stakeholders can enhance the comprehensiveness of AI policies and ensure that the benefits of AI are equitably distributed across society (Moon, 2023).

As AI becomes integrated into industrial policies, it is also crucial to consider its broader economic implications. The advancement of AI has the potential to disrupt traditional economic structures and influence foreign policy and international relations (Bonsu, 2020). As AI technologies reshape industries, governments must adapt their policies to manage economic fluctuations and safeguard national interests. This entails not only developing strategies to promote the adoption of AI but also addressing its ethical and social ramifications (Chatterjee, 2020). The intersection of AI and industrial policy also raises questions regarding its impact on the workforce. The automation capabilities of AI can lead to significant changes in employment patterns, highlighting the need for policies that support worker retraining and skill enhancement. Addressing these challenges is critical for preparing the workforce for the evolving job market shaped by AI technologies.

In summary, the integration of AI into industrial policy requires a holistic approach that addresses operational efficiency, governance frameworks, economic impacts, and labor market transformations. Policymakers must harness the potential of AI while addressing its associated challenges to support sustainable industrial growth in the age of AI. This study discusses the potential ways in which AI may affect industrial policy, examines the challenges encountered in aligning industrial policy with AI-driven production and daily life, and proposes policy recommendations.

2. CONCEPTUAL FRAMEWORK

2.1 Overview of Industrial Policies

Industrial policies refer to strategic approaches aimed at enhancing the structure, development, and competitiveness of a country's industrial sector. Typically, these policies focus on goals such as economic growth, job creation, technology transfer, increased productivity, and strengthening international competitiveness (Rodrik, 2008). The fundamental aim of industrial policies is to boost industrial production capacity, contribute to economic development, support sectoral transformation, and promote sustainable development in the industry (Aiginger & Rodrik, 2020).

Industrial policies generally fall into two main categories: state intervention and free-market approaches. State-interventionist industrial policies involve direct government actions to steer the industrial sector. Through instruments like incentives, subsidies, and tax breaks, the government can stimulate growth in specific sectors (Mazzucato, 2018). Additionally, long-term policies such as infrastructure investments, R&D support, and education initiatives are tools used by the state to guide the industrial sector (Lazonick & Mazzucato, 2013).

On the other hand, free-market-based industrial policies advocate for allowing market dynamics to operate with minimal government intervention. This approach promotes the enhancement of industrial competitiveness through free trade, innovation, and entrepreneurship (Acemoglu & Robinson, 2012).

The effectiveness of industrial policies is measured by the transformations occurring within the industrial sector. Such transformations include modernization of production structures, increased labor productivity, technological advancements, and sectoral diversification (Evans, 1995). Moreover, aligning industrial policies with sustainable development objectives—reducing environmental impacts and delivering social benefits—is also a key criterion (Schot & Steinmueller, 2018).

2.2. Regulatory Measures for AI Applications in Industrial Policies

The regulation of AI applications in industrial policies is critically important for developing innovative strategies that support economic growth. The integration of AI technologies into production processes not only transforms the labor market but also necessitates updating industrial policies to accommodate these new technologies (Brynjolfsson & McAfee, 2014). To ensure the effective use of AI in industry, various countries have developed regulatory frameworks. In industrial policies concerning AI, the existing regulatory frameworks can be categorized as follows:

- **European Union Regulations**
  The European Union (EU) has introduced comprehensive regulations to ensure the ethical and safe use of AI in industry. The EU Artificial Intelligence Act classifies AI applications based on risk levels, imposing stringent regulations on high-risk industrial applications (European Commission, 2021).
- **United States Regulations**
  The United States has implemented regulatory initiatives that both promote the use of AI in industry and provide a risk management framework. The National Institute of Standards and Technology (NIST) has published an AI Risk Management Framework, which offers guidance for the safe application of AI in industrial processes (NIST, 2023).
- **Chinese Regulations**
  China is developing a regulatory framework for AI applications within its national AI strategy. The "New Generation AI Development Plan" published in 2017 promotes the widespread adoption of AI in industry through incentive programs and focuses on data security and algorithmic transparency (China AI Development Plan, 2017).

2.3. Key Regulatory Areas for AI Applications in Industrial Policies

Regulations for AI applications in industrial policies are critical for managing modern production processes in an effective, secure, and sustainable manner. With the widespread adoption of AI technologies in the industrial sector, there is an increasing need to develop regulatory frameworks in areas such as data security, ethical use, market competition, employment impacts, and sustainable production. Inclusive governance in AI policy design is increasingly emphasized in recent literature. Moon (2023) argues that participatory governance models enhance the legitimacy and effectiveness of AI regulation, especially when diverse stakeholders are involved in shaping industrial strategies. Moreover, assessing the maturity of AI governance frameworks provides insights into how policies are operationalized. Miyamoto (2023) highlights that corporate-level AI adoption and governance readiness are critical indicators for evaluating national AI strategies in industrial sectors.

The increasing use of large-scale data processing introduces significant privacy and security risks associated with AI-based systems in industry. In this context, the EU's General Data Protection Regulation (GDPR) and various data security regulations in the United States aim to ensure that the use of AI in industry does not violate the privacy rights of individuals and organizations

(Voigt & Bussche, 2017). The principles of transparency, accountability, and reliability in the analysis of large data sets have become central to industrial policies.

Alongside the widespread adoption of AI, ethical and responsible use principles have become paramount. In particular, preventing biases and discrimination in AI algorithms is a core element of ethical AI policies (Russell & Norvig, 2021). To ensure ethical governance in industry, industrial policies should establish standards and strengthen accountability mechanisms, which are essential for protecting consumer rights and developing reliable AI systems in industrial processes.

Moreover, the widespread integration of AI technologies in production can directly affect market dynamics. The dominance of major technology companies in the AI domain highlights the need for competition policies and antitrust regulations (Shapiro & Varian, 1999). As AI becomes an integral part of industrial processes, policies must be developed to promote competition, prevent market monopolies, and create regulatory mechanisms that enable new entrants to compete in the AI field. Another significant impact of AI on industrial policies is the transformation of labor dynamics. With the rise of automation, many industrial sectors are restructuring their work processes, which may lead to job displacement in some areas while creating new occupational categories (Frey & Osborne, 2017). Accordingly, industrial policies must include education and skill-enhancement programs to train a workforce capable of adapting to AI-supported industrial processes.

Finally, the use of AI in sustainable production processes is gaining increasing importance in industrial policies. Global initiatives such as the EU Green Deal provide policy frameworks for using AI to enhance environmental sustainability in industry (European Green Deal, 2020). AI-driven solutions for energy efficiency, optimized production processes aimed at reducing carbon emissions, and more efficient resource utilization contribute significantly to shaping industrial policies along the lines of environmental sustainability.

2.4. AI Regulations in Industrial Policies in Turkey

Turkey has developed various regulatory measures and strategic documents to align its industrial policies with AI. In this context, the National Artificial Intelligence Strategy (2021–2025) provides the foundational policy framework for integrating AI into industrial policies (Doğan Çalışkan, 2023). The strategy document focuses on accelerating the digital transformation of industry, enhancing domestic technological development capacity, supporting international competitiveness, and transforming employment. Strategic approaches such as increased R&D investments, incentive mechanisms, and public–private partnerships are being adopted to promote the widespread use of AI in industry.

The Digital Transformation Programs implemented by the Ministry of Industry and Technology play a significant role in advancing the digitalization of the industrial sector in Turkey. Within these programs, financial incentive mechanisms have been established to support the broader adoption of AI in production processes (Sanayi ve Teknoloji Bakanlığı, 2022). Various funds and support programs have been applied to accelerate the digital transformation of small and medium-sized enterprises (SMEs), promoting automation, the Internet of Things (IoT), and AI applications in industry. For Turkey to continue its progress in this field, investments in the necessary infrastructure and human resources to enable industrial entities to adopt AI-supported production systems must be increased.

Another key regulatory framework governing the use of AI in Turkey's industry is the Personal Data Protection Law (KVKK) and associated data security policies. To ensure data security and protect individual privacy in AI-driven industrial applications, regulatory frameworks have been

established (KVKK, 2021). Developed in accordance with the EU's GDPR, the KVKK sets out principles of security and transparency for the use of big data in the industrial sector. As data-driven AI applications become more prevalent, issues such as data governance, ethical principles, and algorithmic transparency are expected to gain further prominence.

For the successful implementation of AI-supported industrial policies, it is critical to develop domestic and national AI technologies, increase R&D investments, and strengthen international collaborations. Innovative solutions that promote the use of AI in industry are being developed through projects supported by TÜBİTAK and private sector initiatives (TÜBİTAK, 2023). Additionally, there is a need to nurture a skilled workforce and to establish legal frameworks addressing the ethical use of AI during the industrial transformation.

In conclusion, Turkey's strategies for integrating AI into its industrial policies encompass key goals such as accelerating digital transformation, increasing domestic production capacity, and enhancing global competitiveness. However, to compete on a global scale in the AI domain, Turkey must develop more comprehensive regulatory frameworks, increase AI investments, and support workforce adaptation to this transformation. The widespread adoption of AI in production processes can enable Turkey to achieve a sustainable and innovative industrial transformation that contributes significantly to economic development.

3.METHODOLOGY and THE FUTURE OF INDUSTRIAL POLICY

This study adopts a comparative policy analysis approach to examine how different countries, including Turkey, the European Union, the United States, and China, integrate artificial intelligence (AI) into their industrial policies. The research primarily relies on qualitative content analysis, using national strategy documents, regulatory texts, and relevant scholarly literature. The study aims to identify key themes and regulatory approaches that shape AI-driven industrial transformation.

The future of industrial policies is being reshaped by global economic transformations, technological advancements, and sustainable development objectives. AI, automation, digitalization, and green industry applications have become fundamental determinants of industrial policies. With the advent of Industry 4.0, production processes are undergoing profound changes, rendering traditional industrial policies insufficient. Therefore, policymakers must consider environmental and social sustainability alongside enhancing industrial competitiveness.

Future industrial policies will be built upon innovative production techniques, digitalization strategies, and green economy practices. The digitalization process in industry is being supported by technologies such as big data analytics, machine learning, and the Internet of Things (IoT), while sustainability-focused policies aim to reduce carbon emissions and promote a circular economy. Global initiatives like the EU Green Deal necessitate that industrial policies adopt environmentally friendly and sustainable practices (European Green Deal, 2020).

Furthermore, the role of the state in industrial policies is evolving. Rather than relying solely on traditional state interventions, policies that encourage innovation, strengthen public–private partnerships, and support technology-driven incentive mechanisms are coming to the forefront. Government support is now being designed not only for specific sectors but to contribute to the overall digital transformation of the production ecosystem (Mazzucato, 2018).

Additionally, significant changes in the labor market are anticipated. The proliferation of AI and automation is forcing many occupational groups to adapt, thereby creating new skill requirements. In this context, it is crucial for industrial policies to be structured in a manner that enhances workforce education and digital competencies (Frey & Osborne, 2017).

Ultimately, the future of industrial policies will be defined by digitalization, sustainability, and innovation. Policymakers must develop strategies that enhance global industrial competitiveness, support economic growth, minimize environmental impacts, and prepare the workforce for the future.

4. DISCUSSION AND CONCLUSION

For industrial policies to succeed in the future, it is essential to develop a range of strategic policy recommendations. First, strengthening incentive mechanisms to support digital and green transformation is crucial. Governments should establish financial support mechanisms to promote AI-based production models and sustainable industrial practices. These incentives can accelerate the digitalization process of the industrial sector while encouraging the adoption of environmentally friendly production techniques.

In addition, education and adaptation programs must be developed to ensure that the workforce can adjust to the evolving dynamics of industry. Considering the impact of AI and automation on the labor market, it is necessary to provide retraining and enhance digital skills among employees. Programs aimed at equipping workers with new competencies—especially in technical skills and data analytics—will support their adaptation to the industrial transformation.

Furthermore, to ensure the responsible use of AI in industry, ethical and legal regulations need to be established. As AI-based applications in industry become more widespread, issues such as data privacy, algorithmic transparency, and ethical governance become increasingly important. Accordingly, regulations should be implemented within an ethical framework to ensure that AI systems operate fairly and are accountable.

Moreover, enhancing collaborations among public institutions, the private sector, and academia will play a critical role in increasing the effectiveness of industrial policies. Public–private partnerships can accelerate the implementation of innovative industrial policies and facilitate the integration of AI technologies into a broader industrial ecosystem. These collaborations can support necessary R&D activities and strengthen the overall innovation capacity of the industry.

Finally, industrial policies should be aligned with global standards. Turkey and other countries need to restructure their industrial policies in accordance with international regulations, such as the EU Artificial Intelligence Act and the Green Deal. To sustain global competitive advantage, it is essential to conform to international legislation concerning AI and digital transformation, thereby adopting an industrial policy based on sustainability and innovation.

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