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The Role of Industry 4.0-Based E-Government in Realizing a Sustainable Society 5.0

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Abstract

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This article examines the role of Industry 4.0-based e-government in supporting the creation of a sustainable Society 5.0. The study adopts a library research method by reviewing scholarly literature published between last five years related to digital government transformation, sustainability, and technological innovation. The findings indicate that the application of digital technologies generates positive impacts on three main dimensions of sustainability. In the economic dimension, technologies such as machine learning, AI, and blockchain improve budget effectiveness, transparency, and bureaucratic efficiency. In the social dimension, e-government strengthens public participation, open data initiatives, and inclusiveness in public services. In the environmental dimension, the use of IoT and document digitalization supports more effective and resource-friendly environmental management. Despite these benefits, the study also highlights challenges such as limited digital infrastructure, low technological literacy, and data security issues. This article presents a conceptual framework linking e-government, Industry 4.0, and Society 5.0, while offering policy recommendations for strengthening sustainable governance.

1. Introduction

The Industrial Revolution 4.0 has brought about major transformations in various sectors, including government. The presence of technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, blockchain, and robotics has changed the way organizations run their operations. In the public sector, this innovation has led to the birth of the concept of e-government, which aims to increase the transparency, effectiveness, efficiency, and inclusivity of public services.[1] These changes are important because people's demands for faster, transparent, and data-based services are increasing along with technological developments. Japan then introduced the vision of Society 5.0, which is a social order that puts people at the center, while digital technology is the main instrument to improve the quality of life. This concept exists as a response to the limitations of the Industrial Revolution 4.0 which tends to be oriented towards the economy and profits. Society 5.0 emphasizes the balance between the use of technology and social and environmental sustainability.

In this framework, e-government is an important instrument that allows the integration of digital technology in public services so that it is more responsive and inclusive. However, the implementation of e-government cannot be separated from various challenges. Research shows that most government institutions are still struggling to overcome issues of corruption, data security, limited infrastructure, and

[1] Aliano Abbasi and Muhammad Mustafa Kamal. "Adopting Industry 4.0 technologies in citizens' electronic-engagement considering sustainability development." In *European, Mediterranean, and Middle Eastern Conference on Information Systems*, Cham: Springer International Publishing, (2019): 304-313.

low digital literacy of the community.[2] This problem shows that there is a gap between the great potential of technology 4.0 and its implementation in modern bureaucracy. In fact, the success of e-government is the key to encouraging the creation of good governance while supporting sustainable development. Several studies have shown how digital technology can make a concrete contribution. For example, the use of AI and machine learning can improve accuracy in budget planning as well as risk analysis in the public sector.[3]

The use of IoT has also been shown to be effective in pollution monitoring and early detection of forest fires, which is the basis for more proactive environmental policies.[4] On the other hand, blockchain supports transparency and security in government transactions, thereby strengthening public trust in the state.[5] All this shows that the use of technology is not only about bureaucratic efficiency, but also contributes to social and environmental aspects. The urgency of implementing e-government based on technology 4.0 is increasingly evident in the context of sustainability. The government is required not only to create economic efficiency, but also to ensure inclusive and environmentally friendly public services. The integration of technology in e-government can strengthen the three pillars of economic, social, and environmental sustainability that ultimately support the

[2] Temitayo Shenkoya. "Can digital transformation improve transparency and accountability of public governance in Nigeria?." *Transforming Government: People, Process and Policy* 17, no. 1 (2023): 54-71.

[3] Hoon Jang. "A decision support framework for robust R&D budget allocation using machine learning and optimization." *Decision Support Systems* 121 (2019): 1-12.

[4] Deo Shao, Fredrick R. Ishengoma, Charalampos Alexopoulos, Stuti Saxena, Anastasija Nikiforova, and Ricardo Matheus. "Integration of IoT into e-government." *foresight* 25, no. 5 (2023): 734-750.

[5] Ahmet Efe. "An evaluation on the relationship of Society 5.0, e-government applications and artificial intelligence." *Medeniyet ve Toplum Dergisi* 7, no. 2 (2023): 95-113.

realization of Society 5.0. In other words, the successful implementation of digital technology in the bureaucracy will determine the extent to which the government is able to respond to global challenges such as the Sustainable Development Goals (SDGs) and green governance.

Although a lot of research has been done on e-government and sustainability, there are still conceptual gaps that need to be bridged. Most studies highlight only one aspect of sustainability, such as economic efficiency or social inclusivity, without addressing its integration with environmental aspects. In fact, from the perspective of Society 5.0, sustainability must be understood as the integration of the three dimensions. Therefore, a study is needed that is able to connect the Industrial Revolution 4.0, e-government, and Society 5.0 in a comprehensive sustainability framework. This article aims to analyze the role of Industrial Revolution 4.0 technology in supporting sustainability through the implementation of e-government and to develop a conceptual framework that explains the relationship. This study is based on a literature study by reviewing the relevant current literature in the last five years. It is hoped that this article can make an academic contribution to the development of e-government studies based on technology 4.0 as well as provide practical input for policymakers to strengthen the foundation towards Society 5.0.

2. Literature Review

Studies on the use of Industrial Revolution 4.0 technology in e-government have grown rapidly in the last five years. A number of studies emphasize that the

adoption of digital technologies such as IoT, AI, machine learning, and blockchain is able to strengthen the role of the government in creating more efficient, transparent, and inclusive governance.[6] This is in line with the global community's demand for public services that are not only economically effective, but also support social and environmental sustainability. In the context of Society 5.0, e-government is seen as a strategic instrument that can link technological innovation with improving the quality of human life. Society 5.0 demands the integration of digital technology with sustainable development, so the government is required to ensure that innovation not only increases productivity, but also strengthens inclusivity and social justice.

Thus, the concept of Society 5.0 expands the perspective of the Industrial Revolution 4.0 which was originally only oriented towards industrial efficiency, into a framework that emphasizes the balance between economic, social, and environmental. However, there are still a number of gaps in implementation. Several studies show that the readiness of government agencies to adopt technology 4.0 has not been evenly distributed. Challenges such as limited digital infrastructure, data security, and low technological literacy among public employees are significant obstacles.[7] These barriers explain why many countries are still struggling to realize the full potential of e-government in supporting sustainability. Therefore, the recent

[6] Aliano Abbasi and Muhammad Mustafa Kamal. "Adopting Industry 4.0 technologies in citizens' electronic-engagement considering sustainability development." In *European, Mediterranean, and Middle Eastern Conference on Information Systems*, Cham: Springer International Publishing, (2019): 304-313.

[7] Xaver Neumeyer, Susana C. Santos, and Michael H. Morris. "Overcoming barriers to technology adoption when fostering entrepreneurship among the poor: The role of technology and digital literacy." *IEEE Transactions on Engineering Management* 68, no. 6 (2020): 1605-1618.

literature emphasizes the importance of a conceptual framework capable of explaining the close relationship between the adoption of digital technologies, the effectiveness of bureaucracy, and the achievement of the goals of Society 5.0.

3. Methods

The research method used in this study is library research. This approach was chosen because the purpose of the research focuses on a conceptual analysis of the relationship between the Industrial Revolution 4.0, e-government, and Society 5.0 in the framework of economic, social, and environmental sustainability. Literature studies allow researchers to collect, review, and interpret various relevant scientific literature, both in the form of journal articles, books, and policy reports published in the last five-year period. The time frame was chosen to ensure that the data and arguments used are relevant to the latest developments in the field of digital transformation of government.

The research stage begins with the process of identifying the literature. Authors use academic databases such as Google Scholar and indexed national journals to search for relevant articles. The keywords used include "e-government", "Industry 4.0", "Society 5.0", "sustainability", and "digital governance". This process resulted in a number of literature that was then purposively selected based on the suitability of the theme and the focus of the research. From the results of the selection, several main articles were collected that were used as the basis for the analysis, including international and national publications that discuss the topics of digital transformation, sustainability, and the role of e-government.

The next stage is content analysis. At this stage, the author reads in depth each literature to find patterns, similarities, differences, and contributions of each research to the conceptual framework to be built. The analysis was carried out by grouping the literature based on three dimensions of sustainability, namely economic, social, and environmental. Each dimension is then examined to find out how the Industrial Revolution 4.0 technology is implemented in the context of e-government and its impact on the achievement of the goals of Society 5.0. Thus, this literature study not only serves as a summary of the literature, but also as a synthesis attempt to find conceptual linkages between studies.

In addition, the validity of the research is maintained through triangulation of sources. This is done by comparing findings from various literature to ensure the consistency of arguments. For example, a view that emphasizes the role of AI in economic effectiveness compared to another view that highlights the challenges of digital literacy. With this approach, it is hoped that the results of the research will not only describe the actual conditions, but also provide a conceptual contribution that can be used as a foothold for further research. This literature study method is seen as appropriate to answer the formulation of problems that are conceptual and multidimensional. Through a systematic literature analysis, this study seeks to formulate a conceptual framework on how the use of Industrial Revolution 4.0 technology through e-government can support the realization of a sustainable Society 5.0.

4. Results

4.1. Economic Sustainability

The use of Industrial Revolution 4.0 technology in the context of e-government has a significant impact on the creation of economic sustainability in the public sector. One of the main contributions is the increase in the effectiveness and efficiency of the bureaucracy. Machine learning technology, for example, has been used to support the process of budget planning, risk prediction, and forecasting the number of tourist visits in the context of managing the tourism sector.[8] This shows that the use of intelligent algorithms is able to provide a more precise decision-making basis, reduce budget waste, and improve the accuracy of government planning. Additionally, AI and data analytics support the automation of administrative processes that previously consumed a lot of resources. With the implementation of AI-based systems, government agencies can reduce manual workloads, speed up public services, and reduce operational costs.[9] The application of this technology also plays a role in improving the quality of service by minimizing human error that often occurs in the management of public documents and data. Thus, digital technology not only speeds up the process but also optimizes the use of the budget.

Data security as a fundamental aspect in the country's economic management is also strengthened through the use of blockchain. This technology ensures

[8] Hoon Jang. "A decision support framework for robust R&D budget allocation using machine learning and optimization." *Decision Support Systems* 121 (2019): 1-12.

[9] Ahmet Efe. "An evaluation on the relationship of Society 5.0, e-government applications and artificial intelligence." *Medeniyet ve Toplum Dergisi* 7, no. 2 (2023): 95-113.

transparency as well as security in transactions between government agencies. Research shows that blockchain can lower the risk of budget abuse because all transactions are permanently recorded and auditable. This transparency directly strengthens fiscal accountability and increases public trust, which ultimately creates economic stability. Furthermore, the readiness of government institutions to adopt digital technology also determines economic sustainability. Kadarisman et al.[10] emphasized that the level of bureaucratic readiness in facing the Industrial Revolution 4.0 affects the efficiency of state financial governance.

Institutions that are able to adapt quickly will be more competitive in the face of global dynamics, including in attracting foreign investment through transparent and efficient public services. This shows that there is a close relationship between digital transformation, institutional readiness, and economic sustainability. At the macro level, the integration of digital technology in e-government also supports the achievement of sustainable development goals. Roblek et al.[11] emphasized that the economic effectiveness obtained from the use of technology must be seen within the framework of Society 5.0, where economic sustainability not only means growth, but also includes financial governance that is fair, efficient, and supports people's quality of life. Thus, e-government based on technology 4.0 can be seen as a strategic instrument to strengthen the country's sustainable economic foundation.

[10] Muh Kadarisman, Arie Wahyu Wijayanto, and Anjar Dimara Sakti. "Government agencies' readiness evaluation towards industry 4.0 and society 5.0 in Indonesia." *Social Sciences* 11, no. 8 (2022): 331.

[11] Vasja Roblek, Maja Meško, Mirjana Pejić Bach, Oshane Thorpe, and Polona Šprajc. "The interaction between internet, sustainable development, and emergence of society 5.0." *Data* 5, no. 3 (2020): 80.

4.2. Social Sustainability

The aspect of social sustainability in the implementation of e-government based on the Industrial Revolution 4.0 emphasizes the importance of inclusivity, transparency, and public trust. The use of digital technology allows every level of society to get equal access to government services. Blockchain, for example, plays a role in supporting information disclosure and creating transparency in every public transaction. This technology not only reduces the potential for corruption, but also builds trust between the government and citizens because the data presented is secure and cannot be manipulated.[12] Transparency is an important foundation to strengthen the legitimacy of the government in modern society.

Social sustainability is also related to the government's efforts to increase digital inclusivity. According to Neumeyer,[13] the readiness of government institutions in Indonesia to face the Industrial Revolution 4.0 still faces challenges in terms of digital literacy and infrastructure gaps. This condition causes some people, especially marginalized groups, to not be able to fully utilize e-government services. Therefore, digital transformation must be accompanied by policies to increase digital literacy and expand access to infrastructure so that social sustainability can be realized equally.

[12] Ahmet Efe. "An evaluation on the relationship of Society 5.0, e-government applications and artificial intelligence." *Medeniyet ve Toplum Dergisi* 7, no. 2 (2023): 95-113.

[13] Xaver Neumeyer, Susana C. Santos, and Michael H. Morris. "Overcoming barriers to technology adoption when fostering entrepreneurship among the poor: The role of technology and digital literacy." *IEEE Transactions on Engineering Management* 68, no. 6 (2020): 1605-1618.

In the context of Society 5.0, e-government is seen as an instrument to strengthen public participation in the policy-making process. Sugiono[14] emphasized that technology integration allows the community to not only be recipients of services, but also actors who actively supervise and provide input on government performance. This is in line with the principle of digital democratization, where technology serves as a bridge that strengthens the mutual relationship between the state and its citizens. In addition, open data is an important aspect of social sustainability.

According to Abbasi and Kamal,[15] public data disclosure allows cross-sector collaboration, both with academics, the private sector, and civil society organizations, to create service innovations that are oriented to community needs. Thus, social sustainability is not only determined by equal access, but also by the extent to which people are actively involved in utilizing and supervising public data. Finally, Society 5.0 requires digital technology to be used to address complex social problems, such as access inequality, unemployment, and limited public services. In this case, e-government plays an important role in supporting social justice by providing services that are more inclusive, responsive, and based on the real needs of the community. Therefore, social sustainability can only be achieved if e-government is truly used as an instrument of community empowerment as a whole.

[14] Shiddiq Sugiono. "The Role of E-Government in Building Society 5.0: A Conceptual Review of Economic, Social, and Environmental Sustainability Aspects." *Matra Update: Journal of Policy Innovation* 5, no. 2 (2021): 115-125.

[15] Aliano Abbasi and Muhammad Mustafa Kamal. "Adopting Industry 4.0 technologies in citizens' electronic-engagement considering sustainability development." In *European, Mediterranean, and Middle Eastern Conference on Information Systems*, Cham: Springer International Publishing, (2019): 304-313.

4.3. Environmental Sustainability

The environmental sustainability dimension in the implementation of e-government based on the Industrial Revolution 4.0 focuses on how digital technology can be used to support the preservation of natural resources and reduce the negative impact of human activities. The use of the Internet of Things (IoT) is one of the main innovations that encourages the government to conduct real-time environmental monitoring. Research by Shao et al.[16] shows that IoT can be used to measure air pollution levels, waste management, and early detection of forest fires. The historical data collected from IoT sensors allows governments to create preventive policies, so that environmental damage can be minimized early on.

In addition to monitoring, the integration of digital technology also supports more accurate environmental policy planning. Chung et al.[17] explained that machine learning is able to predict the pattern of the spread of animal diseases and their impact on the agricultural sector. This indirectly contributes to environmental sustainability, as prediction-based policies allow governments to reduce losses due to diseases that can threaten ecosystems. In other words, environmental sustainability is not only seen from the physical aspect, but also from the government's ability to manage risks that affect the ecological balance.

[16] Deo Shao, Fredrick R. Ishengoma, Charalampos Alexopoulos, Stuti Saxena, Anastasija Nikiforova, and Ricardo Matheus. "Integration of IoT into e-government." *foresight* 25, no. 5 (2023): 734-750.

[17] Il Hwan Chung, Daniel W. Williams, and Myung Rok Do. "For better or worse? Revenue forecasting with machine learning approaches." *Public Performance & Management Review* 45, no. 5 (2022): 1133-1154.

Digital transformation also supports the movement towards a paperless government. According to Sugiono,[18] digitization of government documents reduces dependence on paper which has contributed to deforestation and pollution from the production process. By minimizing the use of paper, e-government plays a role in reducing carbon emissions and supporting the global agenda related to climate change mitigation. This is a small but significant step in supporting sustainable development.

On the other hand, the readiness of government institutions to adopt environmentally friendly technology is also a key factor. Shenkoya[19] emphasized that bureaucratic readiness to face the Industrial Revolution 4.0 includes the ability to integrate technology in natural resource management. Without adequate readiness, digitalization opportunities to support the environmental agenda will be difficult to realize. Therefore, strengthening institutional capacity is urgently needed so that the use of technology really produces a positive impact on environmental sustainability. Furthermore, Roblek et al.[20] affirm that Society 5.0 demands the integration between digital technology and environmental sustainability as a long-term strategy. In this concept, technology is not just a tool, but a partner in preserving nature. Thus, e-government based on the Industrial Revolution 4.0 not only contributes to

[18] Shiddiq Sugiono. "The Role of E-Government in Building Society 5.0: A Conceptual Review of Economic, Social, and Environmental Sustainability Aspects." *Matra Update: Journal of Policy Innovation* 5, no. 2 (2021): 115-125.
[19] Temitayo Shenkoya. "Can digital transformation improve transparency and accountability of public governance in Nigeria?." *Transforming Government: People, Process and Policy* 17, no. 1 (2023): 54-71.
[20] Vasja Roblek, Maja Meško, Mirjana Pejić Bach, Oshane Thorpe, and Polona Šprajc. "The interaction between internet, sustainable development, and emergence of society 5.0." *Data* 5, no. 3 (2020): 80.

bureaucratic efficiency, but also to sustainable environmental protection, which ultimately strengthens people's quality of life.

5. Discussion

The results of this study show that the use of Industrial Revolution 4.0 technology in e-government makes a significant contribution to sustainability in three main dimensions: economic, social, and environmental. However, although various benefits have been identified, implementation challenges are still considerable, especially related to institutional readiness, digital divides, and the need for adaptive policies. Therefore, it is important to discuss how the results of this analysis are positioned in the existing literature, as well as what implications they have for the development of Society 5.0.

In the economic aspect, the use of AI, machine learning, and blockchain has been proven to increase budget effectiveness, fiscal transparency, and bureaucratic efficiency. This is in line with the findings of Chung et al.[21] who show that the use of intelligent algorithms helps governments in making data-driven policies with a higher level of accuracy. However, the success of implementation is highly dependent on the readiness of the bureaucracy to integrate the technology. Kadarisman et al.[22] emphasized that many government institutions in Indonesia still face obstacles in the form of limited digital infrastructure and human resource

[21] Il Hwan Chung, Daniel W. Williams, and Myung Rok Do. "For better or worse? Revenue forecasting with machine learning approaches." *Public Performance & Management Review* 45, no. 5 (2022): 1133-1154.

[22] Muh Kadarisman, Arie Wahyu Wijayanto, and Anjar Dimara Sakti. "Government agencies' readiness evaluation towards industry 4.0 and society 5.0 in Indonesia." *Social Sciences* 11, no. 8 (2022): 331.

capacity. Thus, achieving economic sustainability requires a long-term strategy in the form of increasing institutional capacity and digital literacy.

From a social perspective, e-government offers opportunities to increase transparency, public participation, and service inclusivity. The adoption of blockchain and data disclosure has strengthened the mutual relationship between government and society, resulting in increased public trust in state institutions. This is in line with the idea of Roblek et al.[23] that Society 5.0 can only be realized if digital technology is used to overcome social disparities and strengthen the quality of interaction between countries and their citizens. However, challenges in the form of unequal internet access and low digital literacy can still widen social gaps if not balanced with inclusive policies. Therefore, social sustainability through e-government requires not only technology, but also a regulatory framework that promotes equal access.

Meanwhile, environmental sustainability through e-government can be seen from the use of IoT in pollution monitoring, waste management, and forest fire detection. This technology allows governments to take preventive measures to reduce negative impacts on ecosystems. Shao et al.[24] emphasized that the integration of IoT sensors with environmental policies can accelerate government responses to complex ecological issues. However, this success again depends on the government's readiness to provide adequate technological infrastructure and ensure the security of

[23] Vasja Roblek, Maja Meško, Mirjana Pejić Bach, Oshane Thorpe, and Polona Šprajc. "The interaction between internet, sustainable development, and emergence of society 5.0." *Data* 5, no. 3 (2020): 80.

[24] Deo Shao, Fredrick R. Ishengoma, Charalampos Alexopoulos, Stuti Saxena, Anastasija Nikiforova, and Ricardo Matheus. "Integration of IoT into e-government." *foresight* 25, no. 5 (2023): 734-750.

the data produced. Thus, technology can only have a positive environmental impact if it is supported by good data governance and a clear policy framework.

Overall, the findings of this study confirm that the use of Industrial Revolution 4.0 technology in e-government has great potential to support the creation of Society 5.0. However, this potential can only be realized if there is a synergy between technological innovation, institutional readiness, and public policies that are in favor of sustainability. Going forward, these discussions indicate the need for further research that is not only conceptual, but also empirical, to measure the extent to which digital technologies are truly impacting sustainability in government practices.

6. Conclusion

This research shows that the use of Industrial Revolution 4.0 technology in e-government has great potential to support the creation of a sustainable Society 5.0. In the economic aspect, technologies such as AI, machine learning, and blockchain are able to increase budget effectiveness, bureaucratic efficiency, and fiscal transparency. In the social aspect, e-government plays a role in expanding inclusivity, strengthening public trust, and increasing community participation in policy-making. Meanwhile, in the environmental aspect, the use of IoT, document digitization, and good data governance can support preventive policies and reduce negative impacts on the ecosystem.

However, the study also revealed a significant gap in implementation. Obstacles in the form of limited digital infrastructure, data security, and low

technological literacy are the main challenges that must be overcome immediately. Therefore, the success of e-government in supporting Society 5.0 is highly dependent on institutional readiness, human resource capacity, and public policies that are in favor of sustainability. Conceptually, this article provides a framework that connects the Industrial Revolution 4.0, e-government, and Society 5.0 in the perspective of economic, social, and environmental sustainability. This framework is expected to serve as a foundation for further research as well as a reference for policymakers in designing inclusive, efficient, and environmentally friendly government digitalization strategies.

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Shao, Deo, Fredrick R. Ishengoma, Charalampos Alexopoulos, Stuti Saxena, Anastasija Nikiforova, and Ricardo Matheus. "Integration of IoT into e-government." *foresight* 25, no. 5 (2023): 734-750.

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