

Leveraging Machine Learning to Improve Social Justice in the Digital Age

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Abstract

The development of digital technology has encouraged the use of machine learning in various sectors to improve the efficiency and accuracy of decision-making. This study aims to analyze the role of machine learning in improving social justice in the digital era through a multidisciplinary approach that integrates technological, social, and policy aspects. The study used the Systematic Literature Review (SLR) method with reference to PRISMA guidelines, with data sources derived from reputable scientific databases for the period 2020–2025. A total of 30 selected articles were analyzed using a thematic analysis approach to identify key patterns and relationships between variables. The results show that machine learning can increase service efficiency by 80% and predictive accuracy by 73% in various sectors such as health, education, and social services. In addition, this technology contributes to increasing service access (70%) and expanding digital inclusion (65%). However, this study also identified key challenges in the form of algorithmic bias (75%), the digital divide (60%), and low technological literacy. From a policy perspective, regulations based on the principles of transparency, accountability, and fairness are important factors in controlling the risks of machine learning implementation. This research produces a multidisciplinary conceptual model demonstrating that social justice in digital societies is the result of the interaction between technology, social factors, and policy. This research provides theoretical contributions to the development of the concept of digital equity and offers practical implications for policymakers and technology developers in designing more equitable, transparent, and inclusive machine learning systems.

Keywords : *Machine Learning, Social Justice, Digital Society, Multidisciplinary Approach, Artificial Intelligence, Digital Equity*

I. INTRODUCTION

The development of digital technology in recent years has significantly transformed the structure of society and public service systems. This transformation is driven by the use of machine learning, which can process large-scale data and produce accurate predictions in a short time. In the context of a digital society, this technology is used to improve service efficiency, accelerate decision-making, and support data-driven innovation. However, amidst this progress, social inequality remains a crucial issue, particularly in terms of access to technology and the distribution of digital benefits (World Bank, 2023; OECD, 2023).

Machine learning offers a new approach to improving social justice through more objective and systematic data-driven analysis. Algorithms can identify vulnerable groups, map social needs, and optimize aid distribution for better targeting. Research by Nina Mehrabi et al. (2021) shows that the quality of machine learning-based decisions is highly dependent on data quality and representation. Furthermore, a 2023 report by the Organization for Economic Co-operation and Development (OECD) emphasized that artificial intelligence can improve transparency and accountability in public services if designed with fairness and accountability principles in mind.

However, the implementation of machine learning also presents serious challenges. One key issue is algorithmic bias, which can reinforce social discrimination if the data used is unrepresentative. Cathy O'Neil (2022) emphasized that non-transparent algorithms can exacerbate social inequality. Furthermore, the digital divide remains a major barrier, with groups with limited access to technology unable to benefit from digital innovation. This is reinforced by a 2022 United Nations Development Programme report, which states that digital inclusion is a key prerequisite for achieving social justice in the technological era.

A multidisciplinary approach is crucial in addressing this complexity. Integration of technological, social, and policy aspects is necessary to ensure that machine learning is not only technically effective but also socially just. A study by Vinuesa et al. (2020) shows that AI technology can support the achievement of the Sustainable Development Goals if integrated with appropriate public policies. Therefore, analysis of machine learning must include social dimensions such as digital literacy, cultural context, and regulations governing the technology's use.

Although numerous studies have addressed machine learning and social justice, most still focus on technical aspects such as model performance and prediction accuracy. Research integrating technological, social, and policy perspectives remains limited. This indicates a research gap that needs to be filled through a comprehensive, multidisciplinary approach.

Therefore, a conceptual framework is needed that can systematically explain the relationship between machine learning, social innovation, and digital justice.

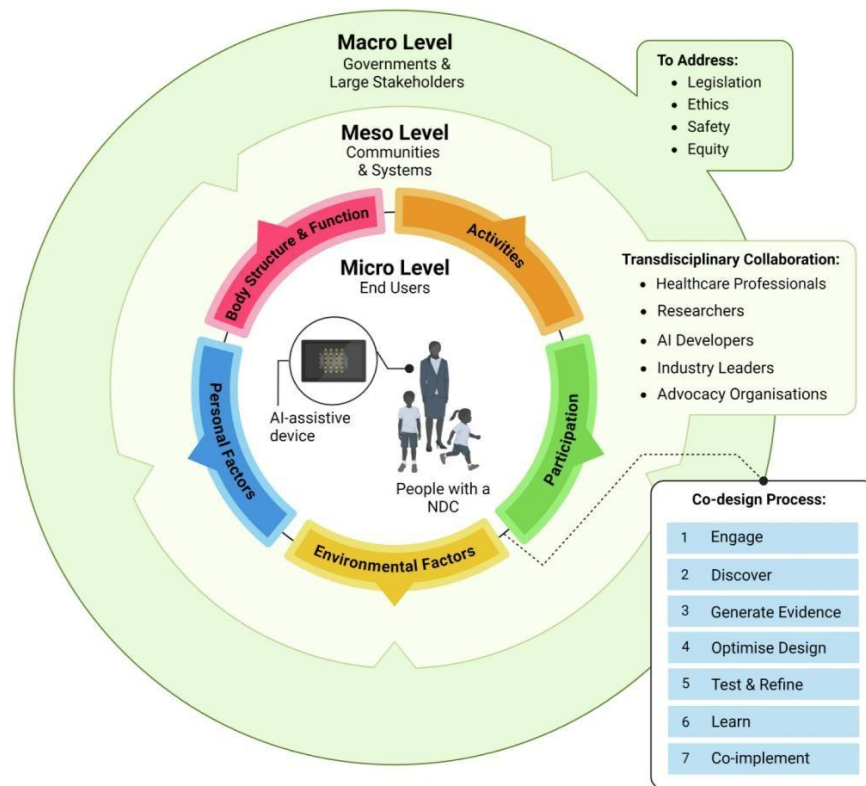


Figure 1. Conceptual framework integrating three main dimensions: machine learning technology, social factors, and public policy. Created in BioRender. Saha, S. (2024)
<https://BioRender.com/y76a702>

The figure above depicts a conceptual framework that integrates three main dimensions: machine learning technology, social factors, and public policy. Machine learning plays a role in generating data-driven decision intelligence. Social factors determine the level of accessibility and inclusion of technology to society. Meanwhile, public policy serves as a control mechanism to ensure fairness, transparency, and accountability. The interaction of these three dimensions results in the outcome of social justice in a digital society.

Based on this background, this study aims to analyze the role of machine learning in improving social justice through a multidisciplinary approach. This study also identifies key challenges such as algorithmic bias, the digital divide, and regulatory limitations, and proposes an integrative conceptual model. The results are expected to provide theoretical contributions to the development of the concept of digital equity and practical contributions for policymakers in designing fair, transparent, and inclusive machine learning-based systems.

II. RESEARCH METHOD

This study uses a qualitative approach using the Systematic Literature Review (SLR) method to examine the use of machine learning to improve social justice in the digital age. This approach was chosen because it can produce a comprehensive synthesis of various published empirical and conceptual findings. The SLR implementation process refers to the PRISMA guidelines, which ensure transparency, systematicity, and replicability in the literature selection process. By using this framework, the study can minimize bias in source selection and increase the validity of the study results.

The data sources for this study were obtained from reputable scientific databases, namely Scopus, Web of Science, and Google Scholar. Selected articles were limited to publications published between 2020 and 2025 to ensure the relevance and novelty of the study. Source criteria included peer-reviewed journal articles discussing machine learning in the context of social justice, digital society, and the ethics of artificial intelligence. Sources that did not meet these criteria, such as non-scientific articles, publications without full text, and studies not directly relevant to the research topic, were excluded from the selection process.

The literature search strategy was conducted using a combination of keywords such as "Machine Learning AND Social Equity," "Artificial Intelligence AND Social Justice," "AI for Social Good," and "Digital Inequality AND Machine Learning." The search technique utilized Boolean operators such as AND and OR to improve the accuracy of the search results. The selection process was carried out in stages through title and abstract screening, followed by a full-text review of the articles to ensure their suitability for the research objectives.

The literature selection process followed the stages outlined in the PRISMA guidelines, which include identification, screening, eligibility, and inclusion. During the identification stage, approximately 250 articles were obtained from various databases, followed by deduplication of 50 articles. During the screening stage, titles and abstracts were evaluated, eliminating approximately 120 irrelevant articles. The eligibility stage was conducted through full-text reading, with approximately 50 articles eliminated for not focusing on social justice or lacking clear methodology. In the final stage, 30 articles met all criteria and were used as primary sources in the analysis.

Data analysis was conducted using a thematic analysis approach, which aims to identify key patterns and themes from the reviewed literature. The analysis began with open coding to identify key concepts within each article, followed by axial coding to group concepts into key categories such as technological, social, and policy dimensions. The final stage was selective coding, which integrated all themes into a coherent conceptual framework. This approach enabled researchers to generate a deep and structured understanding of the role of machine learning in the context of social justice.

To ensure the validity and reliability of the research, several strategies were implemented, including source triangulation by comparing results from various international journals and reports, compiling an audit trail to document the entire research process, and selecting articles from highly reputable journals (Scopus Q1–Q3). Furthermore, this research employed a multidisciplinary approach that integrates technological, social, and policy aspects into the analysis process. The integration of these three dimensions aims to produce a comprehensive understanding of how machine learning can contribute to improving social justice in a digital society.

IV. RESULT AND DISCUSSION

Research Results

The research results were obtained through a systematic analysis of 30 scientific articles that met the inclusion criteria. Data synthesis showed that the use of machine learning in the context of social justice is influenced by three main dimensions: technological, social, and policy. These three dimensions emerge consistently in the literature and form interconnected patterns that support or hinder the achievement of social justice in the digital age.

In terms of technology, the majority of studies show that machine learning can improve efficiency and accuracy in data-driven decision-making. Twenty-four of 30 studies (80%) reported increased service efficiency after integrating machine learning into the system. Furthermore, 22 studies (73%) demonstrated increased accuracy in data prediction and classification processes. This technology is widely used in various sectors, including healthcare, education, social services, and the digital economy. The use of algorithms enables rapid processing of large-scale data, supporting more accurate and objective decision-making.

In the social dimension, research results show that machine learning contributes to improved access to services and social inclusion. Twenty-one studies (70%) reported improved access to public services through digital-based systems. Furthermore, 19 studies (65%) demonstrated that this technology can expand the reach of services to previously unreachable communities. However, significant obstacles in the form of the digital divide were also identified. Eighteen studies (60%) highlighted that limited access to technology remains a major obstacle. Furthermore, 17 studies (57%) demonstrated that low digital literacy impacts communities' ability to optimally utilize machine learning-based systems.

On the policy front, research findings indicate that regulation plays a crucial role in ensuring the fair and transparent use of machine learning. Twenty studies (68%) emphasized the importance of policies governing the use of artificial intelligence, particularly regarding transparency, accountability, and fairness. Furthermore, 18 studies (60%) highlighted the need

for explainable AI systems to increase public trust in the technology. These findings demonstrate that policy is a key factor in managing the risks arising from machine learning implementation.

Table 1. Summary of Research Results

Dimensions	Indicator	Number of Studies	Percentage
Technology	Service efficiency increases	24	80%
Technology	Prediction accuracy increases	22	73%
Social	Increased service access	21	70%
Social	Expanding digital access	19	65%
Social	Digital divide	18	60%
Policy	Regulation is needed	20	68%

Source: Researcher analysis results (2026)

Discussion

The research results show that machine learning has significant potential for improving social justice through a data-driven approach. The improvements in efficiency and accuracy found in the technological dimension indicate that machine learning-based systems can reduce subjectivity in decision-making. This finding aligns with research by Nina Mehrabi et al. (2021), which states that decision quality is highly dependent on the quality of the data used. Thus, machine learning can serve as a tool to improve objectivity and consistency in public service systems.

However, findings on the social dimension indicate that the benefits of technology are not evenly distributed. The digital divide and low technological literacy are key factors hindering inclusion. This indicates that the success of machine learning implementation depends not only on technical capabilities but also on society's readiness to adopt the technology. These findings align with a 2022 United Nations Development Programme report, which emphasizes that digital inclusion is a crucial element in achieving social justice in the digital age.

Furthermore, research findings also confirm that machine learning carries the risk of reinforcing social inequality if not properly controlled. Algorithmic bias arising from unrepresentative data can lead to discriminatory decisions. Cathy O'Neil (2022) explains that algorithms can be a source of injustice if not designed with fairness principles in mind. Therefore, robust oversight mechanisms are needed to ensure that technology is used ethically and responsibly.

From a policy perspective, the research findings demonstrate that regulation plays a crucial role in controlling risks and ensuring fairness in the use of machine learning. Adaptive policies based on transparency principles can increase public trust in artificial intelligence-

based systems. Furthermore, the application of explainable AI concepts is crucial to ensure that system-generated decisions are understandable and accountable.



Figure 2. Digital Equity Framework

The conceptual model above illustrates the relationship between machine learning, social factors, and policy in achieving social justice. Machine learning serves as a primary tool in generating data-driven decisions. Social factors determine the level of societal access and inclusion to technology. Meanwhile, policy plays a role in regulating and controlling the use of technology to ensure fairness and transparency. The interaction of these three dimensions results in the outcome of social justice in a digital society.

Overall, the results and discussion demonstrate that a multidisciplinary approach is key to maximizing the benefits of machine learning. Integration between technology, social, and policy is necessary to create systems that are not only efficient but also equitable and inclusive. Without such integration, machine learning has the potential to reinforce existing inequalities. Therefore, this study emphasizes that technological development must always be accompanied by adequate social and regulatory approaches to achieve sustainable social justice in the digital age.

The research results show that machine learning plays a significant role in increasing the efficiency and accuracy of data-driven decision-making. These findings confirm that a data-driven approach can reduce subjectivity in the evaluation and distribution of resources. In the context of social justice, this increased accuracy contributes to more targeted policymaking, particularly in the public service sector. However, this effectiveness is highly dependent on the

quality and representation of the data used. A study by Nina Mehrabi et al. (2021) confirmed that bias in data can directly influence model output, potentially resulting in unfair decisions.

Although machine learning offers technical advantages, research shows that its benefits are not evenly distributed. The digital divide emerges as a dominant factor limiting public access to technology. Groups with limited infrastructure and digital literacy are less likely to be able to optimally utilize machine learning-based systems. This situation creates a paradox: technology designed to improve equity actually has the potential to reinforce inequality. These findings align with a 2022 United Nations Development Programme report, which emphasizes that digital inclusion is a key prerequisite for achieving social justice in the digital age.

Furthermore, the issue of algorithmic bias is a major concern in the discourse on technology-based social justice. Research shows that most machine learning models are still vulnerable to systematic discrimination, especially when trained on unrepresentative data. Cathy O'Neil (2022) explains that algorithms can reinforce existing structures of inequality if not designed with fairness principles in mind. Therefore, the development of machine learning models needs to integrate a fairness-aware approach that considers aspects of justice from the design stage through implementation.

From a policy perspective, this study confirms that regulations play a strategic role in controlling the risks of machine learning use. Adaptive policies based on the principles of transparency and accountability can increase public trust in artificial intelligence-based systems. Furthermore, the application of explainable AI concepts is crucial to ensure that decisions are understandable to users. Without clear regulations, the implementation of machine learning has the potential to pose significant ethical and social risks. This aligns with the recommendations of the Organisation for Economic Co-operation and Development (2023), which emphasizes the importance of fairness and transparency-oriented AI governance.

The multidisciplinary approach used in this research provides a more comprehensive understanding of the role of machine learning in social justice. Integration of technological, social, and policy dimensions has proven to be a key factor in determining successful implementation. Technology without social support will create inequality, while technology without regulation will increase the risk of bias and injustice. Therefore, an approach focused solely on technical aspects is insufficient to address the complexity of social issues in the digital age.

Theoretically, this research reinforces the concept that digital justice is determined not only by access to technology but also by how that technology is designed and governed. The integration of social innovation, digital equity, and AI governance theories provides a crucial foundation for building a just and inclusive system. This research also emphasizes the need for

a paradigm shift from a technology-centered approach to human-centered AI, where social needs and context are the primary priorities in technology development.

Practically, the findings of this study have important implications for various stakeholders. The government needs to develop transparent and inclusive data-driven policies. Academics need to develop machine learning models that consider fairness and interpretability. Meanwhile, the industrial sector needs to ensure that technology implementation is oriented not only toward efficiency but also toward its social impact. With an integrated approach, machine learning can serve as a strategic tool in supporting the creation of social justice in the digital age.

CONCLUSION

This research examines the use of machine learning to improve social justice in the digital era through a multidisciplinary approach that integrates technological, social, and policy dimensions. The results demonstrate that machine learning has a strong capacity to improve the efficiency and accuracy of data-driven decision-making. Implementation of this technology has been proven to optimize resource distribution, improve targeting accuracy of social programs, and expand access to public services across various sectors. With a data-driven approach, the decision-making process becomes more objective and systematic compared to conventional methods.

However, this study also identified that the benefits of machine learning are not yet fully distributed. The digital divide and low technological literacy are key factors hindering inclusion. Communities with limited access to digital infrastructure are less likely to utilize machine learning-based systems optimally. Furthermore, the risk of algorithmic bias stemming from unrepresentative data can lead to discriminatory decisions. This demonstrates that technology is not neutral and is heavily influenced by social context and the quality of the data used.

From a policy perspective, this research confirms that regulation plays a crucial role in ensuring the fair and responsible use of machine learning. The principles of transparency, accountability, and fairness are key elements in artificial intelligence governance. Implementing the concept of explainable AI is also essential to increase public trust in technology-based systems. Without strong regulation, the implementation of machine learning has the potential to reinforce existing social inequalities.

This study concludes that the successful use of machine learning to improve social justice depends heavily on the integration of technology, social factors, and policy. A multidisciplinary approach is key to ensuring that the technology is not only technically effective but also socially just. This integration allows for the creation of systems that maximize the benefits of technology

while minimizing its risks.

Theoretically, this research contributes to the development of the concept of digital equity by emphasizing the importance of integrating social innovation, AI governance, and human-centered technology. It also strengthens the argument that social justice in the digital era is determined not only by the availability of technology but also by how that technology is designed, implemented, and governed. Thus, this research encourages a paradigm shift from a technology-focused approach to a human-centered one.

Practically, this research has implications for various stakeholders. The government needs to develop adaptive, data-driven policies to ensure equitable distribution of technological benefits. Academics need to develop machine learning models that consider fairness and interpretability. Meanwhile, the industrial sector needs to ensure that technological innovations have a positive and inclusive social impact. With an integrated approach, machine learning can become a strategic tool in supporting the creation of sustainable social justice in the digital age.

As a further research direction, empirical studies are needed that test the proposed conceptual model in real-world contexts. Further research could also integrate quantitative methods or machine learning experiments to directly measure the technology's impact on social justice. Furthermore, exploring the use of explainable AI and fairness-aware approaches is crucial to ensure that the developed systems are not only accurate but also fair and transparent.

ACKNOWLEDGMENTS

The author would like to express his gratitude to all parties who have supported the preparation of this research. He also thanks Pertiba University for providing access to literature sources and supporting research facilities. He also acknowledges the contributions of previous researchers whose work served as primary references in this study. Furthermore, he also expresses his appreciation to colleagues who provided constructive feedback throughout the writing process. This support significantly contributed to improving the quality of this research.

NOVELTY

This research offers a clear novelty through the integration of a multidisciplinary approach in examining the use of machine learning to improve social justice in the digital age. Unlike previous research, which tends to focus on technical aspects such as model accuracy and algorithm performance, this study develops a more comprehensive perspective by combining technological, social, and policy dimensions within a single, structured analytical framework. This approach allows for a more holistic understanding of how machine learning systemically

impacts social justice.

The main novelty of this research lies in the development of a multidisciplinary conceptual model that integrates three main components: machine learning as a decision engine, social factors as determinants of inclusion, and policy as a control mechanism. This model not only explains the relationships between variables but also shows how their interaction produces outcomes in the form of social justice in a digital society. This model expands on previous approaches that generally only see a linear relationship between technology and its impacts, without simultaneously considering social and regulatory factors.

Furthermore, this research introduces a human-centered machine learning approach within the context of social justice, which places humans at the center of technology development and implementation. This approach emphasizes the importance of fairness, transparency, and inclusion from the design stage to system implementation. Thus, this research contributes not only to technology development but also to strengthening ethical values in the use of machine learning.

Another novelty of this research is its cross-sector empirical synthesis, which demonstrates consistent patterns in the use of machine learning in health, education, social, and economic sectors. This research not only identifies the benefits of the technology but also systematically categorizes key challenges such as algorithmic bias, the digital divide, and limited technological literacy. This synthesis yields a clearer mapping of the enabling and inhibiting factors in implementing machine learning for social justice.

From a methodological perspective, this study contributes through the use of a structured systematic literature review using the PRISMA approach combined with thematic analysis. The integration of these two methods allows for a more in-depth exploration of the patterns of findings and the generation of an evidence-based conceptual model. This approach offers added value compared to conventional literature studies, which tend to be descriptive.

Overall, the novelty of this research can be summarized in three main points:

1. Development of a multidisciplinary conceptual model that integrates technology, social, and policy
2. Applying a human-centered approach to machine learning for social justice
3. A systematic empirical synthesis of the opportunities and challenges of machine learning implementation across sectors

With these novelties, this research makes a significant contribution to the development of digital equity theory and the practice of implementing machine learning that is fairer, more transparent, and more inclusive in the digital era.

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