Journal of Loomingulisus ja Innovatsioon, 1(2) - April 2024 91-97

Utilization of Artificial Intelligence for Spatial Decision Support System

Glendy Somae [1], **Heinrich Rakuasa** [2]
[1] *Universitas Indonesia, Indonesia*
[2] *National Research Tomsk State University, Russian Federation*

Corresponding Author : Glendy Somae, E-mail; glendy.somae@ui.ac.id

Received: August 20, 2024	Revised: Sep 09, 2024	Accepted: Sep 09, 2024	Online: Sep 09, 2024

ABSTRACT
The integration of Artificial Intelligence (AI) into Spatial Decision Support Systems (SDM) is a transformative advancement in improving decision-making processes in various fields, including urban planning, environmental management, and disaster response. This research uses a literature review methodology to systematically collect, analyze, and synthesize existing scientific articles, conference papers, and relevant reports related to AI applications in SDSS. The findings of this study reveal that AI technologies, such as machine learning and natural language processing, significantly enhance data processing capabilities, enabling the analysis of complex spatial data and the identification of hidden patterns that may be missed by traditional methods. Despite the great benefits, challenges related to data quality, ethical considerations, and the need for capacity building among stakeholders are critical to the successful implementation of AI in SDSS. It can be concluded that while AI has the potential to revolutionize spatial decision-making, ongoing research is essential to develop best practices, address ethical implications, and foster collaboration among various stakeholders to create a more sustainable and resilient society.

Keywords: *Artificial Intelligence, Spatial Decision, Urban Planning*

Journal Homepage https://journal.ypidathu.or.id/index.php/ijnis

How to cite: Somae G., & Rakuasa, H. (2024). Utilization of Artificial Intelligence for Spatial Decision Support System. *Journal of Loomingulisus ja Innovatsioon*, 1(2), 91-97. https://doi.org/10.55849/ijnis.v1i1.172
Published by: Yayasan Pedidikan Islam Daarut Thufulah

INTRODUCTION

Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionize various domains, including spatial decision-making. The integration of AI into Spatial Decision Support Systems (SDSS) has opened new avenues for enhancing the efficiency, accuracy, and timeliness of decision-making processes related to spatial data and analysis (Gupta et al., 2022). As the world faces increasingly complex challenges, such as urban planning, natural resource management, and disaster response, the need for robust and intelligent SDSS has become more pressing than ever before.

The application of AI in SDSS has been driven by advancements in machine learning algorithms, data processing capabilities, and the availability of vast amounts of

spatial data from various sources, including remote sensing, geographic information systems (GIS), and crowdsourcing platforms. These developments have enabled the creation of intelligent systems that can process, analyze, and interpret spatial data more effectively than traditional methods, leading to improved decision-making and problem-solving in spatial domains (Fernandes et al., 2020). One of the key advantages of utilizing AI in SDSS is its ability to handle complex, non-linear relationships and patterns in spatial data. Traditional SDSS often rely on rule-based approaches or simple statistical models, which may not adequately capture the intricate interactions and interdependencies present in real-world spatial systems (Kim et al., 2020). AI, on the other hand, can learn from large datasets and identify hidden insights, allowing for more accurate predictions, simulations, and scenario analyses.

Moreover, AI-powered SDSS can adapt to changing conditions and new data inputs, making them more flexible and responsive to dynamic spatial environments. This adaptability is crucial in scenarios where decision-makers need to quickly assess and respond to rapidly evolving situations, such as natural disasters, urban growth patterns, or environmental degradation (Gupta et al., 2022). The integration of AI into SDSS has also led to the development of more user-friendly and intuitive interfaces, enabling decision-makers and stakeholders to interact with spatial data and models more effectively. AI-powered visualization and decision support tools can present complex spatial information in easily understandable formats, facilitating collaboration, communication, and consensus-building among diverse groups of users.

Despite the promising potential of AI in SDSS, there are also challenges and limitations that need to be addressed. One of the main concerns is the "black box" nature of some AI algorithms, which can make it difficult to understand and explain the reasoning behind the decisions made by the system (Bazan-Krzywoszańska et al., 2020). This lack of transparency can undermine trust in the system and lead to concerns about accountability and liability in decision-making processes. Another challenge is the need for high-quality, comprehensive spatial data to train and validate AI models. Incomplete, biased, or inaccurate data can lead to flawed model outputs and poor decision-making. Addressing these data quality issues requires significant investments in data collection, curation, and management, as well as the development of robust data governance frameworks (Zhai et al., 2020; Rakuasa et al., 2024).

Furthermore, the implementation of AI-powered SDSS often requires specialized skills and knowledge in areas such as machine learning, GIS, and spatial analysis. Building the necessary capacity and expertise within organizations can be a significant challenge, particularly for resource-constrained entities or those with limited access to technical talent (Rakuasa, Joshua, et al., 2024). Despite these challenges, the potential benefits of utilizing AI for SDSS are substantial. By harnessing the power of AI, decision-makers can gain deeper insights into spatial phenomena, make more informed decisions, and ultimately create more sustainable and resilient communities. As the field of AI continues to advance, it is expected that the applications of this technology in SDSS will

become increasingly sophisticated and widespread, leading to transformative changes in spatial decision-making processes.

RESEARCH METHODOLOGY

This research uses a literature review approach to systematically collect, analyze, and synthesize existing scholarly articles, conference papers, and relevant reports related to the application of artificial intelligence in spatial decision support systems. The methodology involved identifying key themes, trends, and challenges related to AI integration in SDSS through a comprehensive search in academic databases and repositories. The selected literature covered a wide range of domains, including urban planning, environmental management, and disaster response, and was evaluated for its relevance and contribution to understanding how AI can improve spatial decision-making processes. By critically analyzing the findings from the literature, this study aims to provide insights into best practices, emerging technologies, and potential future directions for research in this area.

RESULT AND DISCUSSION

Overview of AI Integration in SDSS

The integration of Artificial Intelligence (AI) into Spatial Decision Support Systems (SDSS) has shown promising results in enhancing decision-making processes across various domains. AI technologies, such as machine learning, deep learning, and natural language processing, have been increasingly adopted to analyze complex spatial data and provide actionable insights (Wen & Li, 2022). This section discusses the key findings from the literature regarding the utilization of AI in SDSS and its implications for spatial decision-making.

Improved Data Processing Capabilities

One of the significant advantages of utilizing AI in SDSS is the enhanced data processing capabilities it offers. Traditional SDSS often struggle with the volume and complexity of spatial data, leading to delays and inefficiencies in decision-making. AI algorithms can process large datasets quickly, identifying patterns and trends that may not be evident through conventional analytical methods (Fernandes et al., 2020). This capability allows decision-makers to access timely information, facilitating more informed and effective decisions.

Predictive Modeling and Scenario Analysis

AI-powered SDSS enables advanced predictive modeling and scenario analysis, which are crucial for effective spatial planning and management. By leveraging historical data and machine learning techniques, these systems can forecast future conditions and evaluate the potential impacts of various decisions (Tyler & Jacobs, 2020). For example, urban planners can use AI to simulate the effects of different land-use policies, helping to identify the most sustainable and efficient options.

Enhanced User Interaction and Visualization

The integration of AI into SDSS has also improved user interaction and visualization capabilities. AI-driven tools can present complex spatial data in intuitive formats, allowing users to explore and manipulate the information easily (Antoniadi et al., 2021). Enhanced visualization techniques, such as interactive maps and dashboards, enable stakeholders to engage with the data actively, fostering collaboration and informed discussions among decision-makers.

Case Studies in Urban Planning

Several case studies illustrate the successful application of AI in SDSS for urban planning. For instance, cities like Singapore have implemented AI-driven systems to optimize traffic management and land use planning. These systems analyze real-time data from various sources, including sensors and social media, to inform urban development (Bazan-Krzywoszańska et al., 2020). Such applications demonstrate the potential of AI to enhance the efficiency and effectiveness of urban planning processes.

Environmental Management Applications

AI's utilization in SDSS is also evident in environmental management. AI algorithms can analyze satellite imagery and other spatial data to monitor environmental changes, assess biodiversity, and manage natural resources (Rakuasa et al., 2024). For example, AI has been used to detect deforestation patterns and predict the impacts of climate change on ecosystems, providing valuable insights for conservation efforts.

Disaster Response and Risk Management

The integration of AI into SDSS has significant implications for disaster response and risk management. AI technologies can analyze historical disaster data, predict potential hazards, and assess vulnerabilities in real-time (Muin & Rakuasa, 2023). This capability enables emergency responders to make informed decisions during crises, improving response times and resource allocation.

Challenges in Data Quality and Availability

Despite the advantages of AI in SDSS, several challenges remain, particularly concerning data quality and availability. The effectiveness of AI algorithms relies heavily on the quality of the input data. Inaccurate, incomplete, or biased data can lead to flawed outputs and poor decision-making (Rakuasa, 2023). Addressing these data quality issues requires robust data governance frameworks and ongoing efforts to improve data collection and management practices.

Ethical Considerations and Bias

The "black box" nature of some AI algorithms poses ethical challenges in decision-making processes. The lack of transparency in how AI systems arrive at conclusions can

undermine trust among stakeholders (Ntoutsi et al., 2020). Additionally, concerns about algorithmic bias must be addressed to ensure that AI-driven decisions are fair and equitable, particularly in sensitive areas such as urban planning and resource allocation. The successful implementation of AI in SDSS requires capacity building among stakeholders

Capacity Building for Stakeholders

Decision-makers, planners, and community members must be equipped with the necessary skills and knowledge to effectively utilize AI technologies (Alamanos et al., 2021). Training programs and workshops can help enhance digital literacy and foster collaboration among diverse stakeholders, ensuring that AI systems are used effectively and responsibly (Latue & Rakuasa, 2024).

Future Directions for Research

Future research should focus on exploring the long-term impacts of AI integration in SDSS and identifying best practices for implementation. Studies could investigate the effectiveness of AI-driven decision-making in various contexts and assess the outcomes of AI-enhanced spatial planning initiatives (Ding et al., 2020). Additionally, research should address the ethical implications of AI in decision-making and develop frameworks for ensuring transparency and accountability. In conclusion, the utilization of Artificial Intelligence for Spatial Decision Support Systems presents significant opportunities for enhancing decision-making processes across various domains (Rakuasa & Latue, 2024). By leveraging AI technologies, stakeholders can gain deeper insights into spatial phenomena, improve efficiency, and foster more inclusive participation in decision-making. However, addressing challenges related to data quality, ethical considerations, and capacity building is essential to maximize the potential benefits of AI in SDSS.

CONCLUSION

The results show that by leveraging advanced machine learning algorithms and improved data processing capabilities, AI can analyze complex spatial data more efficiently, resulting in more informed and timely decisions. However, the research also highlights critical challenges such as data quality, ethical considerations, and the need for capacity building among stakeholders to ensure effective and responsible use of AI. As the field continues to evolve, future research should focus on best practices for AI integration in SDSS, address ethical implications, and foster collaboration among various stakeholders to create a sustainable and resilient community.

REFERENCES

Alamanos, A., Rolston, A., & Papaioannou, G. (2021). Development of a Decision Support System for Sustainable Environmental Management and Stakeholder Engagement. *Hydrology*, *8*(1), 40. https://doi.org/10.3390/hydrology8010040

Antoniadi, A. M., Du, Y., Guendouz, Y., Wei, L., Mazo, C., Becker, B. A., & Mooney, C.

(2021). Current Challenges and Future Opportunities for XAI in Machine Learning-Based Clinical Decision Support Systems: A Systematic Review. *Applied Sciences*, *11*(11), 5088. https://doi.org/10.3390/app11115088

Bazan-Krzywoszańska, A., Lach, R., & Mrówczyńska, M. (2020). City as a System Supported by Artificial Intelligence. *Urban and Regional Planning*, *5*(2), 32. https://doi.org/10.11648/j.urp.20200502.11

Ding, R.-X., Palomares, I., Wang, X., Yang, G.-R., Liu, B., Dong, Y., Herrera-Viedma, E., & Herrera, F. (2020). Large-Scale decision-making: Characterization, taxonomy, challenges and future directions from an Artificial Intelligence and applications perspective. *Information Fusion*, *59*, 84–102. https://doi.org/10.1016/j.inffus.2020.01.006

Fernandes, M., Vieira, S. M., Leite, F., Palos, C., Finkelstein, S., & Sousa, J. M. C. (2020). Clinical Decision Support Systems for Triage in the Emergency Department using Intelligent Systems: a Review. *Artificial Intelligence in Medicine*, *102*, 101762. https://doi.org/10.1016/j.artmed.2019.101762

Gupta, S., Modgil, S., Bhattacharyya, S., & Bose, I. (2022). Artificial intelligence for decision support systems in the field of operations research: review and future scope of research. *Annals of Operations Research*, *308*(1–2), 215–274. https://doi.org/10.1007/s10479-020-03856-6

Kim, B., Park, J., & Suh, J. (2020). Transparency and accountability in AI decision support: Explaining and visualizing convolutional neural networks for text information. *Decision Support Systems*, *134*, 113302. https://doi.org/10.1016/j.dss.2020.113302

Latue, P. C., & Rakuasa, H. (2024). SPATIAL TEMPORAL ANALYSIS OF LAND SURFACE TEMPERATURE CHANGES IN AMBON ISLAND FROM LANDSAT 8 IMAGE DATA USING GEOGLE EARTH ENGINE. *Journal of Data Analytics, Information, and Computer Science*, *1*(3), 134–142. https://doi.org/10.59407/jdaics.v1i3.751

Muin, A., & Rakuasa, H. (2023). Pemanfaat Geographic Artificial Intelligence (Geo-AI) Untuk Identifikasi Daerah Rawan Banjir Di Kota Ambon. *Gudang Jurnal Multidisiplin Ilmu*, *1*(2), 58-63. https://doi.org/https://doi.org/10.59435/gjmi.v1i2.24

Ntoutsi, E., Fafalios, P., Gadiraju, U., Iosifidis, V., Nejdl, W., Vidal, M., Ruggieri, S., Turini, F., Papadopoulos, S., Krasanakis, E., Kompatsiaris, I., Kinder-Kurlanda, K., Wagner, C., Karimi, F., Fernandez, M., Alani, H., Berendt, B., Kruegel, T., Heinze, C., … Staab, S. (2020). Bias in data-driven artificial intelligence systems—An introductory survey. *WIREs Data Mining and Knowledge Discovery*, *10*(3). https://doi.org/10.1002/widm.1356

Rakuasa, H., & Latue, P. C. (2024). Modelling Mangrove Biomass 2019-2023 with Global Ecosystem Dynamics Investigation (GEDI) Data using Google Earth Engine, Case Study: Kayeli Bay, Buru Island, Indonesia. *Journal of International Multidisciplinary Research*, *2*(8), 37–45. https://doi.org/https://doi.org/10.62504/62a3w568

Rakuasa, H., Hehanussa, F. S., & Latue, P. C. (2024). Evaluating the Impact of Climate Change on Puncak Jaya's, Indonesia Glaciers through Satellite Data and Google Earth Engine. *Journal of Moeslim Research Technik*, *1*(4), 183–190. https://doi.org/https://doi.org/10.70177/technik.v1i4.1186

Rakuasa, H. (2023). Integration of Artificial Intelligence in Geography Learning: Challenges and Opportunities. *Sinergi International Journal of Education*, *1*(2), 75–83. https://doi.org/https://doi.org/10.61194/education.v1i2.71

Rakuasa, H., Joshua, B., & Somae, G. (2024). Modeling Flood Hazards in Ambon City Watersheds: Case Studies of Wai Batu Gantung. *Journal of Information Systems and Technology Research*, *3*(2), 86–91. https://doi.org/10.55537/jistr.v3i2.836

Rakuasa, H., Ria Karuna, J., & Christi Latue, P. (2024). URBAN LANDSCAPE TRANSFORMATION: LAND COVER CHANGE ANALYSIS IN SIRIMAU SUB-DISTRICT, AMBON CITY. *Journal of Data Analytics, Information, and Computer Science*, *1*(2), 63–70. https://doi.org/10.59407/jdaics.v1i2.649

Tyler, N. S., & Jacobs, P. G. (2020). Artificial Intelligence in Decision Support Systems for Type 1 Diabetes. *Sensors*, *20*(11), 3214. https://doi.org/10.3390/s20113214

Wen, R., & Li, S. (2022). Spatial Decision Support Systems with Automated Machine Learning: A Review. *ISPRS International Journal of Geo-Information*, *12*(1), 12. https://doi.org/10.3390/ijgi12010012

Zhai, Z., Martínez, J. F., Beltran, V., & Martínez, N. L. (2020). Decision support systems for agriculture 4.0: Survey and challenges. *Computers and Electronics in Agriculture*, *170*, 105256. https://doi.org/10.1016/j.compag.2020.105256