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IMPLEMENTING STRATEGIC AI POLICIES FOR ETHICAL AND SUSTAINABLE SMART CITIES

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SUMMARY*: Integrating artificial intelligence (AI) into smart city initiatives holds immense potential to enhance urban sustainability, efficiency, and liveability. However, the ethical and effective implementation of AI technologies in smart cities requires developing and implementing robust policies and governance frameworks. This study explores the critical role of ethical AI policies in the development of smart cities. This study examines the role of ethical AI policies in enabling sustainable and inclusive smart city development. A mixed-methods approach is adopted, combining a narrative review to establish the conceptual foundations and core principles of ethical AI, a PRISMA-guided systematic review to identify implementation challenges and mitigation strategies, and a SWOT analysis to comparatively evaluate national AI policy frameworks across five Northern European countries: the United Kingdom, Germany, Finland, Denmark, and Norway. The findings demonstrate that ethical AI policies are strategically influential across key smart city domains, particularly mobility, energy, governance, infrastructure, and environmental management. While countries with clear financial commitments and long-term strategic planning exhibit stronger policy readiness, persistent barriers remain, including interoperability challenges, data privacy and cybersecurity risks, limited regulatory standardisation, and AI skills shortages. This research offers original cross-national insights into ethical AI governance for smart cities and provides policy-relevant recommendations to support ethical, resilient, and sustainable urban development.*

KEYWORDS*: artificial intelligence (AI), smart cities, AI policy, urban governance, urban sustainability, ethical AI, AI governance, responsible AI.*

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1. INTRODUCTION

Smart City combines physical, digital technologies and human systems within the built environment to offer its residents a sustainable, thriving, and inclusive Future (Pan et al., 2021; Okonta & Vukovic, 2024). Artificial Intelligence (AI) has emerged as a transformative digital technology with profound implications for numerous sectors, including urban development (Yigitcanlar et al., 2020). Integrating AI into smart city initiatives can enhance urban sustainability, efficiency, and livability by enabling more intelligent and data-driven decision-making processes (Sarker, 2022; Okonta, Rahimian, & Agu, 2025). However, the ethical and effective implementation of AI technologies in smart cities presents significant challenges that must be addressed through robust policies and governance frameworks (Ahmad et al., 2022). Ethical AI policies refer to a set of principles, guidelines, and regulations designed to govern the development, deployment, and use of AI technology in a fair, transparent, and accountable manner. These policies aim to promote innovation that benefits society while respecting human rights and preventing harm, bias, discrimination, and unethical applications of AI (Wang et al., 2024; Shukla, 2024; de Almeida et al., 2021). As cities worldwide increasingly embrace smart technologies to tackle complex urban challenges, such as traffic congestion, pollution, and resource management, AI has become a central component of these initiatives (Benbya, Davenport, & Pachidi, 2020). From optimising transportation networks to improving public services and enhancing citizen engagement, AI holds promise for revolutionising urban environments (Deep & Verma, 2023). Yet, realising these benefits requires careful consideration of ethical concerns, privacy implications, and the potential social impacts of AI deployment (Konda, 2022). Developing and implementing effective AI policies and governance mechanisms are essential to ensure that smart city initiatives prioritise the well-being and rights of all citizens (Kolesnichenko et al., 2021). There is a need for Policies to address issues such as data privacy and protection, algorithmic bias and transparency, citizen participation and accountability, and the responsible use of AI technologies (Deep & Verma, 2023; Konda, 2022).

Additionally, policymakers must navigate the complex interplay between technological innovation and regulatory oversight to foster innovation while safeguarding against potential risks and unintended consequences (Yigitcanlar et al., 2020). This study aims to analyse and evaluate ethical AI policies within the context of smart cities, with a focus on identifying key challenges, best practices, and future directions for policy development and implementation. The objectives of this research encompass the following;

- Exploring the core understanding of Ethical AI Policies for smart cities: core principles, significance, and quantifiable metrics.
- Identifying strategic smart city domains with high-impact potential for Ethical AI Policy implementation.
- Comparing AI policy frameworks in five European nations: influence on smart city ethics, governance, and sustainability.
- Analysing key challenges and barriers to Ethical AI Policy implementation in smart cities and evaluating mitigation strategies.

Several studies have delved into various aspects of national AI policies, offering valuable insights into their development, implementation, and impact (Dwivedi et al., 2021). For instance, Ref. (Neumann et al., 2022) conducted a comparative analysis of AI strategies across different countries, shedding light on common trends and disparities in policy priorities and approaches. Similarly, Ref. (Radu, 2021) delved into AI governance's ethical and regulatory dimensions, stressing the necessity of transparent and accountable policymaking processes. In the European context, researchers have focused on specific countries or regions to understand the dynamics of AI policy formulation and implementation. For example, Köstler, & Ossewaarde (2021) scrutinised the German AI Strategy, emphasising the significance of public-private partnerships and investments in research and development. Meanwhile, Jiang et al. (2021) explored the challenges and opportunities of AI adoption in healthcare, emphasising the importance of interoperability and data sharing to maximise its potential benefits. However, despite these notable contributions, there remains a significant research gap in the comprehensive analysis of national AI policies across multiple Northern European countries. While existing studies often concentrate on individual countries or specific aspects of AI policy, they offer limited insights into the broader landscape and potential synergies between national approaches. Moreover, while some studies have identified best practices and lessons learned from individual countries, there is a notable absence of comparative analyses systematically evaluating the strengths and weaknesses of national AI policies in Northern Europe, establishing the global barriers and challenges of

implementing ethical and effective AI policies. Such a gap underscores the need for research that provides a holistic understanding of AI policy landscapes across the region, offering insights into areas for improvement and opportunities for collaboration. This research is significant as it contributes to understanding AI policy evolution in Northern Europe, a region characterised by innovative economies and a strong commitment to digitalisation. Moreover, the analysis of these national AI policies can inform broader European and international discussions on AI governance and regulation, especially concerning smart city initiatives. Understanding these regional dynamics and challenges can facilitate the identification of common ground and promote collaboration among nations with shared interests and concerns, ultimately essential for developing inclusive, responsible, and future-ready urban environments.

2. BACKGROUND

Ethical AI policies are governed by specified principles allowing for structured applicability within smart cities. These principles include fairness, transparency, accountability, data privacy and safety, human oversight, inclusivity, and compliance (Wang et al., 2024; Dolla et al., 2023; Stix, 2021) as seen in Figure 1. Fairness, as a principle of AI policy, requires that all forms of bias and stereotypes related to race, gender, religion, and other factors be actively identified and mitigated by AI developers (Calvetti et al., 2024). This means that AI technology used in smart cities should be non-discriminatory and inclusive for all. An example of this is OpenAI's ChatGPT, which has evolved to accommodate diverse users by incorporating voice prompts. Similarly, transparency is a key principle in AI decision-making. Organisations should not only develop fair AI models but also provide clear documentation on how these models function, their scope, and their limitations (Van, Wong & Abbasnejad, 2025; Bang et al., 2022). This documentation should be both understandable and interpretable, even for non-expert users. Accountability is another crucial principle, ensuring that AI developers are held responsible for the outcomes of the systems they create (Munianday et al., 2024). To uphold this principle, safety measures should be implemented to address any harm caused by AI, particularly in cases of regulatory oversight.

Figure 1: Principles of Ethical AI Policies.

Furthermore, regarding safety and security, AI systems should be designed to achieve their goals without causing harm to users or society. Robust security measures must be implemented to prevent AI misuse (Wang et al., 2024; Munianday et al., 2024). To support this, data protection—another key principle—is essential. AI systems must comply with data protection laws that safeguard user privacy (Jäkel et al., 2024). This means that the collection

and use of data from AI model users in smart cities should be restricted to necessary and ethical purposes. Data should not be used for anything beyond enhancing AI functionality to better serve users. Additionally, concerns about AI displacing the human workforce are addressed by the principle of human oversight. This principle ensures that human intervention remains possible in high-stakes AI applications, such as healthcare and the justice system (Balakrishnan, 2024; Akhart, 2024). AI should assist rather than replace humans in critical decision-making processes.

Inclusivity and acceptability are also central to ethical AI policies, ensuring that AI benefits all individuals within smart cities, including marginalised and hard-to-reach communities (Van, Wong & Abbasnejad, 2025; Munianday et al., 2024; Nnaji et al., 2023; Rampini & Cecconi, 2022). By reducing the digital divide, these policies contribute to a more equitable technological landscape. Furthermore, this principle reinforces sustainability by promoting intelligent and connected communities while considering the environmental impact of AI development (Munianday et al., 2024; van Wynsberghe, 2021; Zhao & Fariñas, 2022). Encouraging sustainable practices in AI infrastructure is essential to balancing technological advancement with environmental responsibility.

Table 1: Methodology: Key Areas of Smart City Development Using Ethical AI Policies.

Strategic Areas of Smart City Development	**Areas of Ethical AI Policy Implementation**
SMART PEOPLE	- facilitating data privacy compliance in health monitoring and education systems for users (Mutuku, 2024; Gabriel, 2023). - creating a fair and inclusive environment in medical diagnostics and educational learning models for all users irrespective of existing hindrances (Goktas & Grzybowski, 2025). - attaining equitable AI-driven healthcare access for all demographics and monitoring AI bias in digital education content (Chakraborty, 2024).
SMART ECONOMY	- facilitating AI-driven workforce reskilling and upskilling programs to enhance the chances of employability of people (Pradhan & Saxena, 2023). - creating ethical automation policies that balance efficiency and employment within various industries (Chirita & Sarpe, 2024). - establishing AI-facilitated economic inclusion for marginalised communities irrespective of demography or economic performance (von Braun & Baumüller, 2021). - Facilitating sustainability-focused AI applications in creating a circular economy (von Braun & Baumüller, 2021).
SMART GOVERNMENT	- designing a bias-free AI-driven public service automation that collects public feedback for data-driven decision-making (Poudel, 2024). - establishing inclusive AI-driven urban planning to prevent discrimination irrespective of demography (Charles et al., 2022). - ensuring AI accountability in city development and zoning policies through reinforced guidelines are regular monitoring (Brand, 2023).
SMART MOBILITY	- strengthening privacy-preserving surveillance by ensuring no data breach in the AI system and end-to-end encryption (Ikwuanusi et al., 2023). - facilitating AI-driven congestion control that prioritises sustainability and efficiency of AI models, ensuring AI systems can evolve even with changes in connectivity levels and time (Vujadinovic et al., 2024). - ensuring a fair and unbiased AI algorithm for transportation accessibility within a smart city (Ahmad et al., 2022).
SMART INFRASTRUCTURE	- regulation of AI-based facial recognition to prevent misuse and identity theft within smart infrastructures (Ahmad et al., 2022). - ensuring data privacy in AI-monitored smart building systems (Satpathy et al., 2024). - designing bias-free crime prediction models to avoid racial profiling within smart cities (Yen & Hung, 2021). - addressing human oversight in AI-driven law enforcement decision-making within smart cities (Shafik, 2024).
SMART ENVIRONMENT	- ensuring that AI algorithms are transparent for energy and water distribution systems, as well as achieving carbon footprint reduction (Jain & Mitra, 2024). - ensuring fair access to AI-optimised renewable energy solutions and climate adaptation without disadvantaging vulnerable communities (Soundariya et al., 2025). - facilitating AI-driven waste sorting that promotes sustainable recycling (Olawade et al., 2024). - establishing environmental impact monitoring through AI-powered analytics on a scheduled basis within smart cities (Rimon et al., 2025).

AI governance plays a vital role in ensuring compliance with ethical standards. Governments and organisations can establish ethical AI frameworks and conduct impact assessments to uphold these principles. Countries such as Finland, the UK, and Germany have already implemented such frameworks to guide responsible AI development (de Almeida et al., 2021; Doe et al., 2024; Godager et al., 2024). Lastly, AI innovations should aim to maximise societal benefits (Ensafi, Thabet & Gao, 2024). This means that AI policies should be designed to enhance fields such as education, healthcare, and environmental conservation, ensuring that technological progress translates into meaningful and ethical improvements for society.

Ethical AI policies are crucial for ensuring that AI systems are designed, deployed, and used responsibly (Ventura et al., 2022). These policies help protect human rights, prevent harm, build trust in AI, and promote accountability and legal compliance. They also ensure data privacy and security, minimise bias and discrimination, and support sustainable and responsible AI innovations while preventing misuse and ethical violations. Furthermore, ethical AI policies align AI development with global ethical standards, enhance workforce and economic stability, and promote fairness, transparency, and accountability (Godager et al., 2024; Khan et al., 2024).

2.1 Ethical AI policies in smart city strategic areas

Ethical AI policies are crucial for guiding the rapid development and adoption of AI within smart cities across diverse sectors. For instance, Khan, Umer, and Faruqe (2024), in their discussion of global AI adoption, highlighted discrepancies between low- and high-income countries, revealing that the limited inclusivity of LICs, despite their developmental needs, conflicts with principles of distributive justice and global equity in AI utilisation. However, Jalili and Dziatkovskii (2023) found that data security, sanctions, and economic pressures also significantly influence the level of advancement offered by AI solutions, positioning security, justice, and the economy as key areas for the implementation of ethical AI policies. Furthermore, the increasing integration of AI into biotechnology and the resulting biosecurity quandaries, as revealed by Namane and Doshi (2024), necessitate the establishment of ethical standards through legislative engagement. This is essential for achieving optimal security levels for biologically hazardous substances and preventing the development or use of bio-weapons, thereby integrating ethical AI considerations into the realm of smart governance.

Despite the global emphasis on environmental sustainability, the translation of this goal into harmonised local actions remains a challenge. Shen et al.'s (2024) study of 280 Chinese cities illustrates this, revealing that foreign investment, international trade, local consumption, and government policies directly influence urban industrial eco-efficiency. This suggests that AI adoption within cities could be significantly shaped not only by governmental factors but also by the nature and origin of investments, as well as local consumption patterns, thereby underscoring the necessity for ethical AI policies. Furthermore, the international governance of artificial intelligence faces a critical juncture between centralisation and fragmentation. Cihon, Maas, and Kemp (2020) argue that while centralisation offers potential benefits, it also presents significant drawbacks, including the risk of creating slow and inflexible institutions and the difficulty of balancing robust regulations with adequate participation, regardless of efficiency or political influence. This further emphasises the imperative for well-defined ethical. Ethical AI policies are essential to navigate these complex governance challenges. Knight et al. (2024), in their work on emerging technologies and research ethics, highlighted that technological advancements invariably introduce new concerns and necessitate comprehensive communication among all stakeholders to establish robust ethical standards. This underscores the need for ethical AI policies in research, education, and emerging technology sectors. For example, the rapid proliferation of Internet of Things (IoT) applications raises significant information security concerns across domains such as smart logistics, smart health, and smart cities (Ullah & Havinga, 2023). Moreover, the imperative for ethical technology, particularly within healthcare, was further emphasised by Petersen et al. (2022), who argued that the responsible development of machine learning and AI systems is crucial for upholding human autonomy, justice, privacy, transparency, and the prevention of harm. Mökander et al. (2022), studying the conformity assessment and post-market monitoring of the proposed European AI regulation, emphasised the importance of understanding how AI system providers can demonstrate adherence to regulatory requirements and the necessity of establishing auditing standards for these systems. They specifically pointed to the challenge of translating vague concepts into verifiable criteria and the need to strengthen institutional safeguards regarding the conformity of AI systems based on internal checks. Consequently, Table 1 was developed to illustrate key areas of smart city development where the effective implementation of ethical AI policies is particularly relevant. These areas include fostering **SMARTER PEOPLE** through AI in education and healthcare; achieving a **SMART ECONOMY** by integrating AI into industry, employment, and the circular economy;

establishing a **SMART GOVERNMENT** with AI-driven urban planning, governance, citizen engagement, and emergency response; enabling SMART MOBILITY via AI in electric vehicles, logistics, and traffic management; building **SMART INFRASTRUCTURE** with enhanced security and surveillance; and creating a **SMART ENVIRONMENT** by applying AI to energy, waste management, and land use.

To explore and investigate the key objectives of the study, the authors utilised a mixed research method, such as the narrative review to explore the core understanding of Ethical AI Policies for smart cities: core principles, significance, and quantifiable metrics and identify strategic smart city domains with high-impact potential for Ethical AI Policy implementation. The SWOT research methodology was used to compare AI policy frameworks in five European nations: influence on smart city ethics, governance, and sustainability. The systematic review was used to analyze key challenges and barriers to Ethical AI Policy implementation in smart cities and evaluate mitigation strategies. Basically, the narrative review provides contextual depth and interpretive richness to the study, the systematic review ensures that there is methodological transparency, and the conducted SWOT analysis offers a comparative insight for strategic evaluation, as shown in Figure 2.

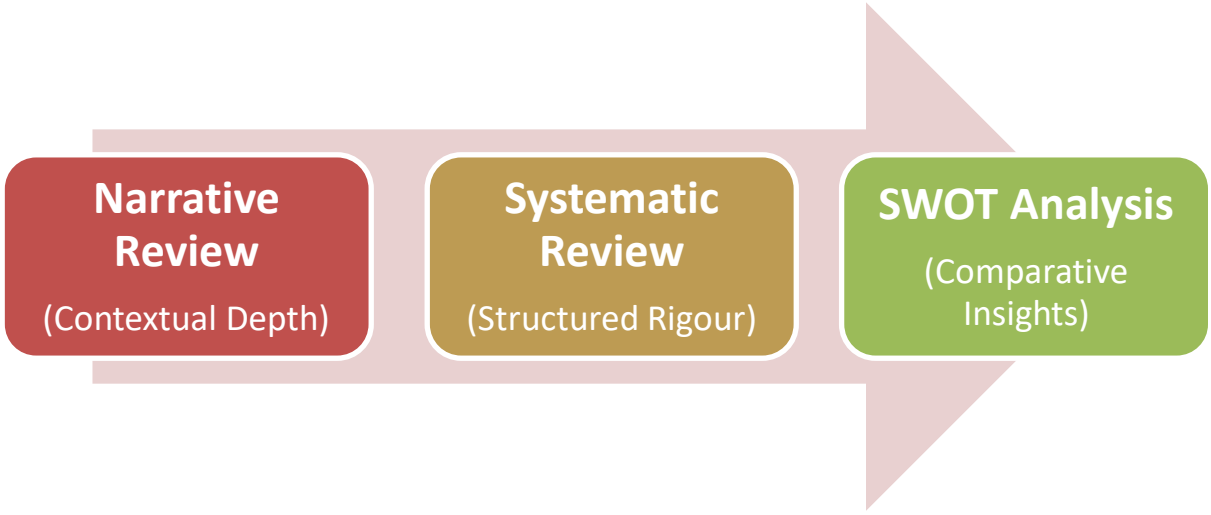

Figure 2: Integrated Ethical AI Policy Insights.

2.2 Narrative review

The authors employed a narrative literature review approach. This involved a non-systematic search and synthesis of existing scholarly literature, policy documents, and relevant reports. The search strategy was iterative and exploratory, utilizing keywords such as "Ethical AI," "Responsible AI," "AI Governance," "Smart Cities," "Digital Cities," "AI Policy," "Urban Development," "AI Implementation," and related terms across various academic databases (e.g., Scopus, Web of Science, Google Scholar) and organizational websites. The selection of literature was guided by its perceived relevance to the research objectives, aiming to capture a broad overview of key concepts, discussions, and emerging trends within the field. The synthesis of the identified literature involved a descriptive and interpretive approach, where key themes, definitions, and arguments were identified, summarised, and critically discussed to address the research aims. The narrative review is vital for several reasons, such as the development of the study`s conceptual understanding (Timotheou et al., 2022) and delineating the strategic domains within smart city development.

2.3 Systematic review

The systematic review aimed to synthesise existing literature on the implementation of ethical AI policies within smart city contexts, adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a transparent and rigorous process, as illustrated in Figure 3. The methodology encompassed structured data collection and analysis to address the research objectives. The systematic review methodology was chosen for its rigour and transparency in identifying, selecting, and synthesising relevant literature (Fan et al., 2022). This approach minimises bias and provides a comprehensive overview of the existing

knowledge base on the complex intersection of ethical AI and smart city development. The structured search strategy ensures that a broad range of relevant publications are captured, while the application of specific inclusion and exclusion criteria ensures the focus remains on high-quality, peer-reviewed research directly addressing the research objectives (Gusenbauer & Haddaway, 2020).

2.3.1 Data collection

The literature search was conducted using the Scopus database, a multidisciplinary database covering peer-reviewed literature, including scientific journals, books, and conference proceedings(Gusenbauer, 2022). Scopus was selected due to its extensive coverage of scientific, technical, medical, and social sciences literature, providing a robust platform for identifying relevant publications (Singh et al., 2021) in the interdisciplinary field of AI ethics and smart city development. The search strategy utilised a combination of keywords and Boolean operators to capture a broad range of relevant articles. The specific search query employed was: *("Ethical AI" OR "Responsible AI" OR "AI Governance" OR "Trustworthy AI" OR "AI Policy Framework") OR ("Smart Cities" OR "Digital Cities" OR "Intelligent Cities" OR "Urban Sustainability") AND ("Implementation" OR "Policy Deployment" OR "Adoption Strategies") AND ("Challenges" OR "Barriers" OR "Ethical Concerns" OR "Risks") AND ("Solutions" OR "Best Practices" OR "Policy Recommendations") AND ("Framework" OR "Model" OR "Policy Design") AND ("Global Adoption" OR "International Standards" OR "Cross-border Governance").* The initial search yielded 542 documents. To refine the dataset and ensure relevance, a series of inclusion and exclusion criteria was applied sequentially. First, the document type was limited to articles (n=240), followed by a language restriction to English (n=237) and a focus solely on journal publications (n=236). Articles in press were excluded to ensure the inclusion of finalised research (n=232). Subsequent filtering based on subject area resulted in a reduced set of 86 documents, as seen in Figure 3.

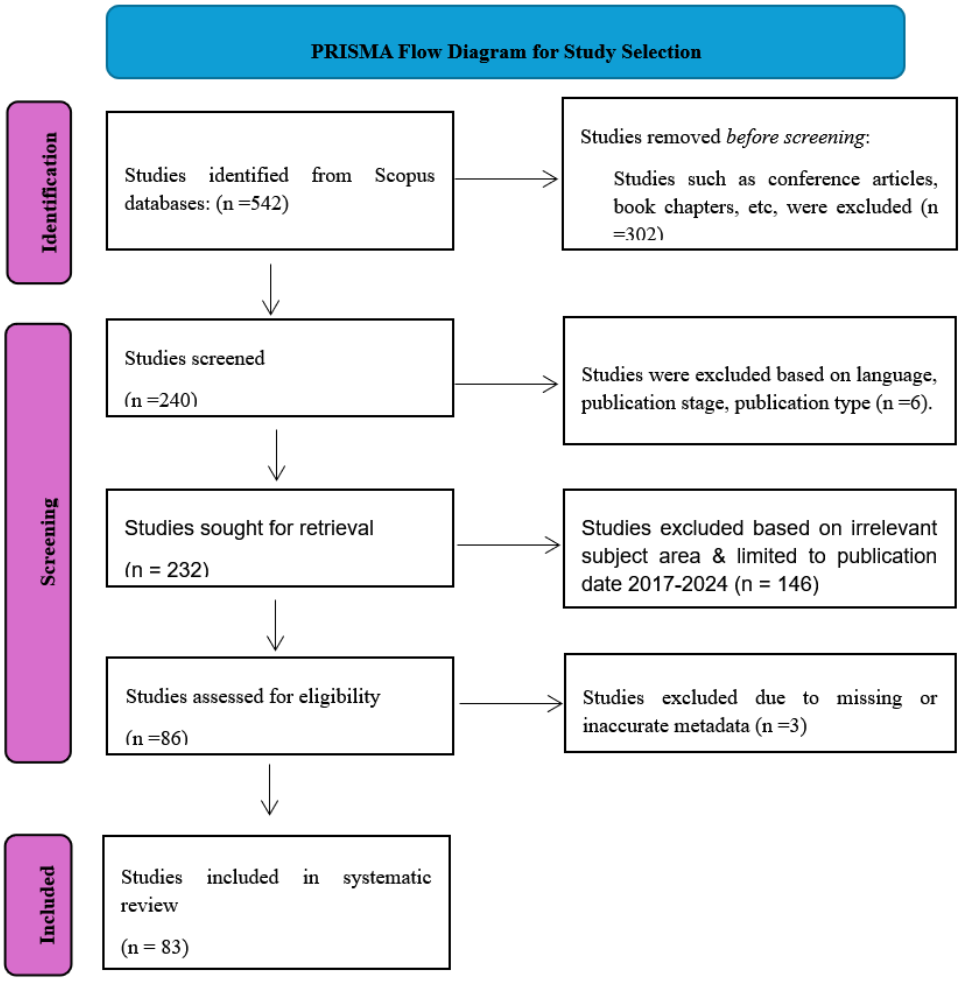

Figure 3: Identification of Studies via Databases on PRISMA for systematic review.

2.3.2 Data analysis

To gain an initial understanding of the subject landscape, a Scopus extract of 86 documents was initially analysed. of these, 3 were excluded due to missing or inaccurate metadata (e.g., unclear publication topic or author information), resulting in 83 documents for further qualitative synthesis. The key subject areas discussed within these 83 publications were identified and categorised to provide an overview of the research focus within the retrieved literature. This initial analysis informed the subsequent thematic synthesis, where the content of the selected articles will be systematically reviewed to identify recurring themes, challenges, solutions, and proposed frameworks related to the implementation of ethical AI policies in smart cities. The analysis will involve a qualitative approach, focusing on extracting key information related to the key challenges and barriers associated with implementing ethical AI policies in smart cities.

2.4 SWOT analysis report

The UN geoscheme has four sub-regions: Eastern, Northern, Southern and Western Europe. Northern Europe includes Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, and the United Kingdom are classified as Northern Europe (UNSD, n.d). The SWOT analysis is significant for many reasons; SWOT analysis can provide evidence-based insights to inform decision-making processes (Palazzo, 2024; Fatima et al., 2020) related to AI policy development and implementation. It helps prioritise actions and allocate resources effectively based on understanding policy strengths, weaknesses, opportunities, and threats (Stix, 2021) as seen in Figure 4. In the rapidly evolving landscape of AI governance, the structured and systematic approach offered by SWOT analysis is invaluable for policymakers and stakeholders seeking to navigate the complexities of national AI policies (Pernaa et al., 2024).

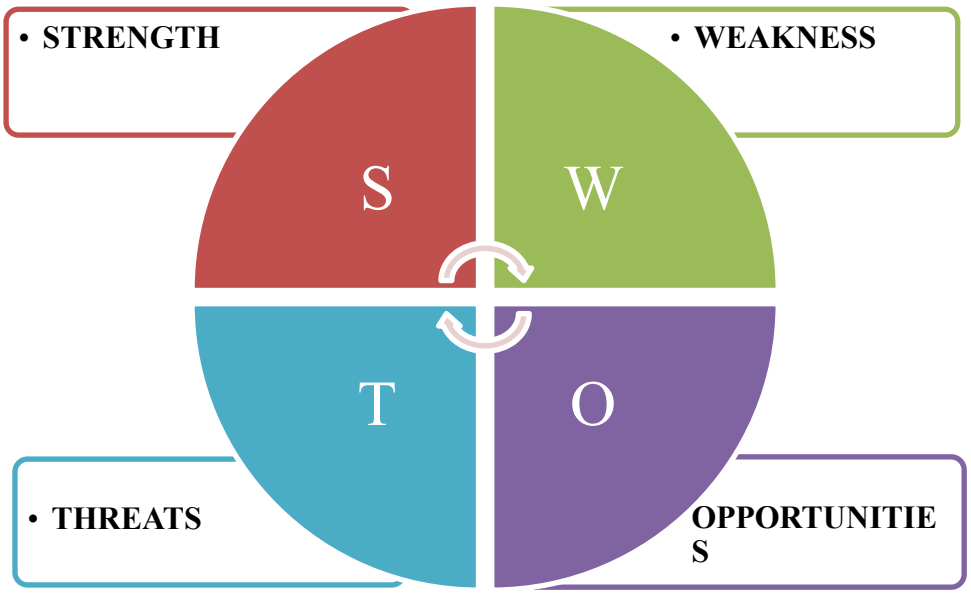

Figure 4: SWOT Analysis Illustration.

The selection of these countries was based on their significant advancements in AI and smart city initiatives and the distinct approaches they offer within the region, making them ideal for a detailed comparative study. The objective was to identify the strengths, weaknesses, opportunities, and threats related to AI policies in the context of smart cities in these nations. To gather relevant data, the study utilised a secondary data collection method involving an extensive review of government publications, including official AI strategy documents, white papers, and policy briefs from each country focusing on smart cities and AI integration. To analyse the data, the study organised the results into a 2 x 2 SWOT matrix format, capturing the strengths, weaknesses, opportunities and threats. Also, the study utilised a comparative analysis to highlight common strengths and weaknesses as well as unique opportunities and threats in their AI policies and their impact on the development of smart cities.

3. RESULTS AND DISCUSSIONS

3.1 Strategic subject areas of AI and Sustainable smart cities

The subject areas were ranked based on the number of documents that discuss their key themes, as displayed in Table 2. Mobility was seen as the most discussed subject area, with 17 publications dedicated to this theme. Furthermore, energy, as another major concern of smart cities, as well as urban sustainability and resilience, were tied with nine documents each. These subject areas covered sub-themes reaching energy management, Electric Vehicle Charging and energy, smart metering, disaster management, and quality of life (QoL), amongst other sub-themes.

Table 2: Key Subject Areas of AI and Sustainable Smart Cities.

S/N	Subject Areas	No of Documents
1	Mobility	17
2	Energy	9
3	Urban Sustainability & Urban Resilience	9
4	Internet of Things (IoT)/Sensor/Connectivity	8
5	Artificial Intelligence (AI)	6
6	Medicine	6
7	Smart City Solution & Circular City Initiatives	5
8	Government	5
9	Data Security	4
10	Higher Education System	3
11	Domain Standard/Ontology/Networks	3
12	Waste	2
13	Industry	2
14	Ethics/Ethical consideration	1
15	Project Management	1
16	4D	1
17	Land Exploration	1

The IoT and AI stood out as the 4th and 5th most studied areas within the data set. These subject areas focused on sub-themes such as agriculture, spatial data infrastructure, AI adoption and Governance. These strategic subject areas have great implications for the development of smart cities. For example, Mobility stands to top the table due to an expanding population spurring the need for people to effectively move daily. In addition, the need to reduce urban congestion has seen the integration of AI through GPS navigation of vehicles as well as traffic control and creating navigation pathways (Nidamanuri et al., 2022). Furthermore, energy is essential to smart cities due to the current drive for clean and sustainable energy. The push against fossil fuel and the pollution it causes has seen more technological efforts being put into the design of cleaner energy systems like solar, wind and renewable energy (Kakkar et al., 2022; Suanpang et al., 2022). Moreover, the drive for urban sustainability and resilience is 3rd due to the need for cities to overcome disasters such as flooding, fire outbreaks and earthquakes through technology systems that simulate and forecast (Bueno et al., 2021; Rezvani et al., 2024). However, the IoT is important to the smart city space as it allows for the connectivity and interoperability of devices and sensors within smart cities (Bovkir & Aydinoglu, 2024; Badawi et al., 2019). It has also allowed for all smart city concepts to come to life and become even more realisable. Hence, AI, as the fifth most studied subject area, has gained traction due to its applicability in various fields from education to government. Furthermore, the ease of use and the integration within everyday systems such as smart devices, amongst others, have also made AI a topical key area for discussion within smart cities (Khan et al., 2024). Furthermore, a publication trend was created from the data set, revealing the year of publication. Findings revealed that there has been a steady growth of publications on AI policy and ethics about smart cities, as within eight years, publications have grown by 1700% from a single publication in 2017 to 17 publications in 2024, as seen in Figure 5.

The growth of publications on AI steadily grew from 2017 to 2020. This steady growth could be due to the introduction of key AI models like ChatGPT and Google Bard. The usability of these models allowed for studies on AI to gain traction. Furthermore, publications between 2020-2021 remained steady, possibly due to the novel

COVID-19 virus. However, a spike was seen in publications from 2021-2022, which could potentially be due to the impact of COVID-19 leading to a higher digital transition. Furthermore, the integration and development of new AI models within smart devices could have further fostered this growth. Technological organisations like Samsung's Bixby and Apple's Alexa stood as innovative AI solutions within this period. The trend between 2022-2024 has been relatively uniform, revealing the innovative growth of AI across various smart city systems such as health, justice, governance and research.

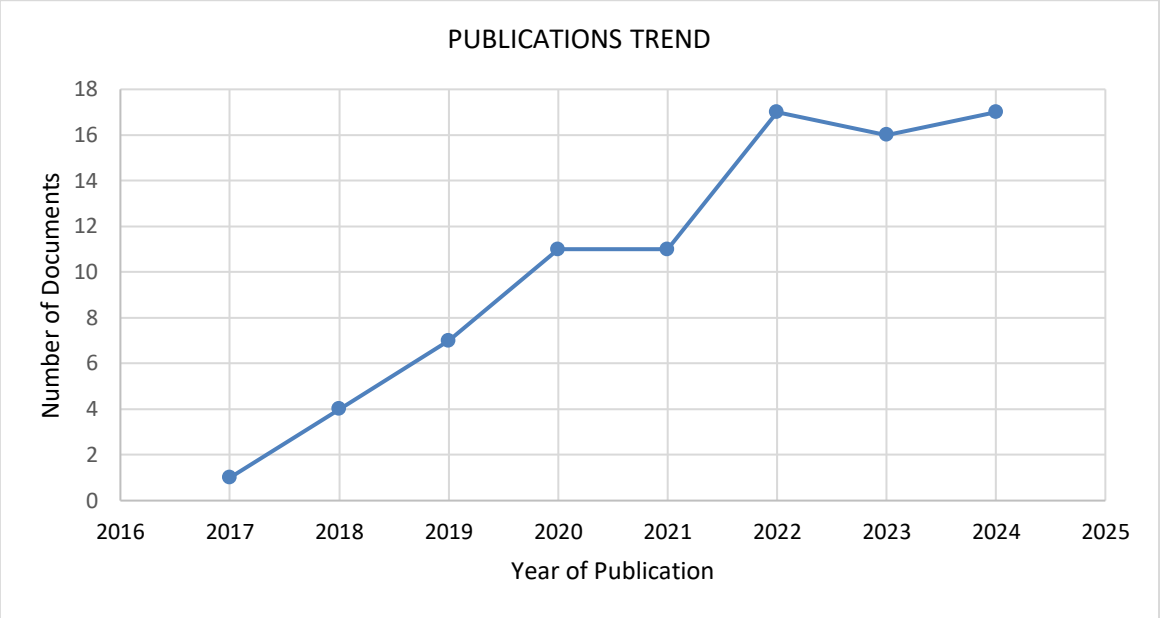

Figure 5: Publication Trend for AI policy and ethics from 2017-2024.

3.2 SWOT analysis of national AI policies

In this section, the study appraises the UK, Norway, Denmark, Finland's and Germany's AI policies, making a comparative analysis, and considers their practical implications for the development of smart cities.

3.2.1 The United Kingdom AI sectoral deal policy

The strengths of the UK AI Sector Deal Policy are embedded in its financial commitments and strategic timeline or commitment, which expires in 2027. The UK AI Sector Deal Policy embodies five key concepts of focus: ideas, the people, infrastructure, business environment and places as seen in Table 3. For each of these components, the UK government rolls out an Industrial Strategy, outlining its goal of making the UK the most inventive economy in the world. It also noted that people are at the centre of the Industrial Strategy, which aims to increase everyone's earning potential and create good jobs in the UK. Furthermore, to achieve the goal of being the AI leader in the world, the government must ensure that the UK has the appropriate digital infrastructure, including data and physical infrastructure, while intending to be the best place to start and grow a business in the world. Finally, the Industrial Strategy set out the goal of helping communities prosper throughout the UK.

Table 3: SWOT Analysis for the UK AI Sector Deal Policy.

IDEAS	
Strength	Weakness
-Increased Research and development (R&D) -Enhanced R&D Tax Credit -£725 million Industrial Strategy Challenge Fund (p. 9)	-Political and financial obstacles may prevent R&D spending from reaching the 2.4% GDP target -Industrial Strategy Challenge Fund and increased R&D tax credits may take some time to pay off.
Opportunities	Threats
-Positioning the UK as a global leader in innovation -Novel innovations in the AI space facilitated by the Industrial Strategy Challenge Fund. (p. 24)	-Economic Uncertainty, especially due to inflation -Global Competition from other nations with keen focus on AI

PEOPLE	
Strength	Weakness
-World-Class Technical Education -£406 million STEM Investment -£64 million National Retraining Scheme (p. 7)	- The time and money to set up a top-notch technical education programme may be more than anticipated. - The population's acceptance and efficient implementation of the National Retraining Scheme are key factors in its effectiveness.
Opportunities	Threats
- A more competent and flexible workforce can be produced through better technical education and reskilling programmes -By investing more in STEM subjects, the nation may establish itself as a leader in science and technology (p, 26)	- Implementation risks associated with this entail opening up to the possibility of poaching of the trained population by other countries. -The uneven pace of AI adoption due to regional disparities leads to an uneven pace of policy progress.
INFRASTRUCTURE	
Strength	Weakness
-£31 billion Productivity Investment Fund -£400 million support for electric vehicles -£1 billion boost for digital infrastructure (p. 7)	-Efficiently managing and distributing the £31 billion Productivity Investment Fund may be difficult. -Adoption and integration on a national level are necessary for the £400 million investment in charging infrastructure to be effective.
Opportunities	Threats
-Working towards interoperable and open data standards was possible. -Development of data-sharing frameworks -Delivering telecommunication and digital infrastructure (p. 19)	- Resource Allocation might slow down due to the time taken for deliberations and the disbursement of funds.
BUSINESS ENVIRONMENT	
Strength	Weakness
-Sector Deals -£2.5 billion Investment Fund -Productivity Review and £20 billion investment in innovative and high-potential businesses (p 7)	-Close industry and government cooperation determines effective sector deal implementation. -Putting into practice efficient strategies to increase productivity in small and medium-sized enterprises would be challenging
Opportunities	Threats
- High potential for sectorial investment -A highly innovative ecosystem drawing talent and investment from around the world. (p. 33)	- Tracking the alignment of business goals to upholding AI policy might be tedious.
PLACE	
Strength	Weakness
- Local Industrial Strategies -£1.7 billion Transforming Cities Fund -£42 million Teacher Development Premium pilot programme (p 7)	-Challenges exist in ensuring local industrial strategies are successfully executed and aligned with national goals. -A mistake in selecting the appropriate projects for the Transforming Cities fund could negatively impact productivity gains
Opportunities	Threats
- Work closely with clusters to provide the support needed for AI businesses to thrive (p, 34) -Regional Growth -Better Education (p. 35)	- Local Strategy might be hampered by inflation and economic uncertainties, leading to delays in funding disbursement.

Source: *Compiled by authors from Department for Science, Innovation and Technology, Department for Business and Trade, Office for Artificial Intelligence, Department for Business, Energy & Industrial Strategy, & Department for Digital, Culture, Media & Sport (2018).*

3.2.2 The Norwegian national strategy for AI

Norway is positioning itself as one of the leading AI countries globally. Norway's government aims to support excellent AI infrastructure with digitalisation-friendly policies, linguistic resources, rapid communication networks, and sufficient computer capacity. This focuses on improving data sharing inside and between industries and sectors, as seen in Table 4. The Norwegian strategy for artificial intelligence, created by the Norwegian Ministry of Local Government and Modernisation, embodies all procedures to achieve the goals.

Table 4: SWOT Analysis for the Norwegian National Strategy for AI.

Strength	Weakness
- Data sharing: The Norwegian strategy possesses separate principles for each AI component (p 17). - Language resourcefulness: Focus on making AI systems accessible in local conditions and languages such as Norwegian and Sami (p 19) - Modernised Regulations: A continuously evolving legal framework to meet new technological developments, starting with the eRegulation project in 2000 (p 21). - Infrastructure: Well-developed fourth-generation (4G) mobile network with excellent coverage (p 29).	Lack of interoperability of sector-specific regulations (p 21). Personal data consent and statutory authority (p. 18)
Opportunities	**Threats**
- Health analysis platform to make health data accessible for research and other secondary uses. - Creating regulatory sandboxes to allow enterprises to test new technologies and/or business models within specific parameters (p 24). - Full-scale implementation of 5G network coverage as an underlying technology for the Internet of Things (IoT) (p 29). - Focus on artificial intelligence in areas of competitive advantages, such as health, seas and oceans, public administration, energy and mobility (p 8).	- Cybersecurity threats. -There is a growing interest in AI by other nations with a clear-cut investment pathway and financial allocations. -Blurred perspective on private sector areas of engagement in the Norwegian AI ecosystem

Source: Compiled by authors from the Norwegian Ministry of Local Government and Modernisation (2020).

3.2.3 The Danish national strategy for AI

The government's vision for Denmark is to be a frontrunner in responsible development and use of artificial intelligence. The National Strategy for Artificial Intelligence, created by the Ministry of Finance and the Ministry of Industry, Business and Financial Affairs in Denmark, houses all strategies to achieve its vision. These goals can be summarised in ethics, research, innovation, and public and private sector collaboration, as seen in Table 5.

Table 5: SWOT Analysis for the Danish National Strategy for AI.

Strength	Weakness
- Denmark is one of the world's most digitised countries and the most digitised in Europe (p. 7). - Already existing coverage of AI technology adoptees in Denmark covering a range of start-up businesses, especially for automated customer service response (pp. 13). - Well-developed digitised infrastructure (p. 14) - High priority on research being among the countries in the OECD with the highest public investment in research and development (p. 14)	- Insufficient resources slow down the progress of AI initiatives and limit the potential impact on various sectors (p. 16) - Limited data access can hinder AI development and reduce the effectiveness of AI solutions (p. 16). - Potential shortage of professionals with advanced digital and AI-related skills (p. 16)
Opportunities	**Threats**
- By leading in ethical AI, Denmark can attract global talent, projects, and investments (p. 17) - Leveraging AI in these areas can lead to new business models, improved services, and economic growth (p. 17) - Strengthening collaborations between the public sector, academia, and private businesses (pp. 19) - Talent attraction and retention, building a strong AI workforce, supporting continuous innovation and maintaining Denmark's competitive edge (p. 44) - Availability of target priority areas (pp. 61)	- Intense global competition for AI talent, investments, and leadership - Increased integration of AI in critical sectors makes them more vulnerable to cyberattacks (p. 26)

Source: Compiled by authors from the Ministry of Finance and Ministry of Industry, Business and Financial Affairs (2019).

3.2.4 The Finish national strategy for AI

The AI strategy for Finland was published by the Finnish Ministry of Economic Affairs and Employment in the 4th Quarter of 2017. This strategy encapsulates the AI Finland programme, which aims to establish AI and Robotics as the Finnish company's cornerstone for success, as seen in Table 6. The primary goal of the Finland AI strategy is to position Finland as a leading AI country, increasing business and industry competitiveness, high-quality public

service and a properly functioning society and well-being of its citizens. It is further interesting to note that from 2017-2020, Finland has continued to improve on the AI strategy with the AI 4.0 programme being realised in November 2020.

Table 6: SWOT Analysis for the Finnish National Strategy for AI.

Strength	**Weakness**
- 100 million euros allocation for the Finnish AI business programme over four years. - Already, the existing Finnish Centre for Artificial Intelligence with an 8.3 million euro flagship funding for 2019-2022. - Highly educated and tech-friendly population. - Creation of the AI Maturity tool, which identifies the most important areas for improvement in AI for business. - The use of innovation vouchers to support companies in innovating and growing - Availability of diverse AI **programs** and tools such as the AIPSE programme, DIMECC, AuroraAI	- Low thresholds in engaging in collaborations for Finnish businesses. - Lack of a high-quality AI-focused educational curriculum. - Minimal-skilled training on AI to adapt to changes in occupational structures.
Opportunities	**Threats**
- Leveraging on a highly educated population through the Competence and Innovations Committee has been established under the Artificial Intelligence Programme to support education reforms. - Reskilling/upskilling AI training to adapt to changes in occupational structures. - Harnessing the Hyteairo Programme (Well-being and Health Sector's Artificial Intelligence and Robotics Programme) to support utilisation of AI and robotics in the well-being sector. - The national intellectual property (IP) strategy is currently in preparation to improve the present IP situation in Finland.	- Intense global competition for AI talent, investments, and leadership - Uncertainty about the application of AI deployment by the current legislation, focusing on data access rights, data ownership, copyrights, security and personal data protection.

Source: Finland AI Strategy Report - European Commission (2021), Ministry of Economic Affairs and Employment (2020; 2017)

3.2.5 The German national strategy for AI

Table 7: SWOT Analysis for the German National Strategy for AI.

Strength	**Weakness**
- 5 billion euro commitment "Package for the Future" - 30% of businesses in Germany as of 2019 had vacancies in the field of AI (p. 5) - Transfer of findings from AI research to the economy as well as the use of AI across the breadth of the SME sector and "Mittelstand" (p. 5). - Active participation of the German Federal Government in AI regulation and framework development (p. 5). With funding for over three decades (p. 12) - Availability of AI monitoring Landscape in two key areas (Economy, Higher Education and Teaching) (p. 6). - Presence of the AI Observatory, which aids in specifically recording and evaluating the use of AI in work and society (p. 6). - Availability of the Plattform Lernende Systeme, which produces the Map on AI showing the current uses and projects, research institutions and transfer activities (p. 6)	- Regulatory frameworks are not still at a sustainable level (p. 5) - Establishing AI research at locations that do not already have an AI focus is a challenge (p. 10). - Minimal transfer of AI knowledge into application (p. 17).
Opportunities	**Threats**
- Citizen engagement in shaping the use of AI in Germany. (p. 5). - Development and use of AI to align with the Sustainable Development Goals (SDGs). - Creating University courses, education and training, as well as an attractive working and research environment for scientists in order to secure more specialists (p. 10). - Strengthening national research structures to a global level through the six centres of excellence for AI research (p. 12). - International research collaborations, especially with France, Canada and Japan) (p. 13). - Development of the Civic Innovation Platform project and Civic Data Lab, an ecosystem for AI for the good of society (p. 24).	- The highly competitive labour market for AI experts (p. 10), - Developing market access for AI would entail setting up a contact point in Silicon Valley, USA, that in the short tem can be a significant threat in terms of capital and data security as a result of cyber threats. (p. 19)

Source: Artificial Intelligence Strategy of the German Federal Government (2020).

The German Federal Government AI strategy stands unique as it prioritises the mind, research, transfer and application, regulatory framework and society. Since its adoption in 2018, the aim of the AI strategy is to place Germany as an internationally competitive centre for AI research, development and application. So far, the government for the AI Future package released 3 billion euros in June 2020 for the promotion of AI and 2 billion in addition to a total 5 billion in 2025 as seen in Table 7. Interestingly, Germany is invested in AI, having been funding its development for over 30 years and updating its 2018 AI strategy in 2020 just to keep up with current changes.

3.3 Comparative analysis of the AI policies and practical implications on smart cities

In making a comparative analysis of the AI policies of the UK, Norway, Denmark, Finland and Germany, five things are identified: clear financial and strategic planning, interoperability and privacy standards, talent development and retention, sustainable development goals, and global collaboration and competition. A close look at all AI policy and strategy documents unveils that each of these countries aims to become a leader in the AI space. However, comparatively assessing these policies in terms of their strengths, weaknesses, opportunities and threats, a few distinctions can be made.

The UK, Finnish and German government stands in a position with clear financial commitments attached to each strategy component and a set date for achievement, making their AI strategy the smartest and most reliable one. This degree of clarity could fast-track investments and investor appetite towards digitalising urban environments, thus bridging the gap in the effective implementation of AI. Countries should adopt similar approaches to maintain momentum in AI development and ensure sustained funding. However, a unifying obstacle to each country is the economic and political obstacles currently facilitated by distinct global unrest, increasing inflation and a need for governments to curtail spending. This would predominantly affect the UK as its financial commitments might need to be adjusted over time. Concerning the funds, which have already been disbursed by the Finnish and German governments, Inflation stands as a primary challenge to the applicability of the funding in areas specified.

In alternation, Norway's emphasis on clear principles for each focus component highlights the importance of interoperability and privacy, a major concern in the digitalisation of cities, especially with the proliferation of IoT devices. Norway's principles show the government's attention to detail for AI and that it wants AI to be integrated into all sectors, as proven by its eRegulation project spanning over two decades. Different definitions and standards across industries pose challenges to AI integration. Although AI should be usable across all devices and data shared, privacy, clarity, and a unifying digital language for information and communication protocol across various economic sectors might not be achievable until a consensus is reached. Countries must work towards unified definitions and standards, addressing these concerns to ensure AI can be effectively used across various devices and sectors.

Denmark's position as number one in terms of digitisation in Europe earns it a spot for faster, high-priority AI investment and research, proving that the government is already big on AI and has a major target of making Denmark a global AI powerhouse. However, the professional shortage and the poaching of experts by other countries present significant challenges. Addressing these issues by investing in education and creating attractive environments for AI professionals is crucial. Proactive measures to retain and attract talent will be essential for sustaining AI advancements. To this end, the German AI policy stands tall within the confines of education, having transferred findings from AI research to the economy as well as the use of AI across the breadth of the SME sector. The 30-year investment of Germany in AI has yielded six centres of excellence for AI research. Learning from this, extensive AI research not just through educational curriculum but AI research centres to FastTrack growth and development of AI within smart cities.

Aligning AI strategies with global environmental goals offers significant opportunities. For instance, the UK's focus on reducing carbon emissions through AI aligns with broader sustainability objectives, which are the core of smart city initiatives. Similar initiatives can drive sustainable development and enhance the appeal of AI projects. Each country can leverage AI to address specific environmental challenges, such as energy efficiency in Norway and talent attraction in Denmark. Furthermore, Finland's AI policy focuses mainly on the applicability of AI to business growth. The policy goes into depth discussing AI business strategies and programmes to facilitate this growth. This makes the Finland AI policy a very essential tool that could be adopted in the place of AI in business within Denmark, Norway and the UK as well as globally.

The intense global competition for AI talent, investments, and leadership is a unifying threat. However, international collaboration can also drive innovation and address common challenges. For example, drawing on the UNESCO Global AI ethics and governance observatory study (2021), the established framework underlined the importance of: (1) inclusive governance, (2) ethical impact assessment, and (3) institutional capacity building. The UNESCO observatory study clearly supports its readiness assessment methodology (RAM), which establishes a unique AI evaluation benchmark that is explicitly used in the UK, Finnish, and German AI policies. It also stressed the importance of establishing privacy and interoperability standards for AI systems, as vigorously advocated by Norway. So far, the AI project, boldly adopted by 193 countries, emphasises the importance of establishing ethical standards across boards via collaborative governance systems.

Furthermore, Roberts et al.'s (2024) study on global AI governance challenges and paths forward concluded that strengthening current organisations and frameworks looks to be a wiser and more practical option than establishing new centralised authorities. This, in turn, demonstrates that, while the Danish and German governments' AI advancement patterns favour national strategies and localised targets, their level of global coordination remains low, emphasising the need for standardisation and collaboration to boost innovation and mitigate risks. Furthermore, Olugbade's (2025) study on global AI governance mechanisms examined the various approaches used by governments in North America (US), Asia (China), and the EU to harmonise global AI governance as a collective action problem. The findings of this study are consistent with the emphasis of Northern European countries on strategic planning and talent retention, particularly in Denmark and Germany. According to Olugbade (2025), worldwide cooperation is essential for overcoming the pressures of competition and fragmented standards. The study also supports the idea that smart sustainability and smart city development activities should be integrated on a global basis.

In terms of smart people, Denmark's professional shortage and expert poaching underline the critical need for talent retention and educational improvement to sustain AI progress. Furthermore, the German government's massive investments in education and AI research centres demonstrate a reversal of the Danish approach to human capital development and long-term labour preparation. As a result, proactive actions to retain and recruit talent are inextricably linked to the development of skilled and inclusive communities in smart cities.

In terms of achieving a smart economy, concrete financial pledges from countries such as the United Kingdom, Finland, and Germany boost investor confidence in AI innovation, promoting economic growth. Furthermore, Finnish AI business strategies and initiatives have the potential to boost entrepreneurial ecosystems and SMEs' competitiveness. It also revealed that Denmark's digitisation leadership and strategic AI investments position the country as a global AI powerhouse with a dynamic economy. However, economic volatility poses a significant threat to long-term innovation and policy execution.

In terms of smart mobility and energy, Norway's emphasis on interoperability and IOT integration, as well as energy efficiency through AI, aligns with smart energy management and sustainable consumption, while requiring unified communication protocols across transport networks to improve mobility. This is due to the fact that real-time data transmission is important for urban mobility solutions, resulting in issues with AI integration across devices and sectors. Furthermore, the UK has shown support for clean energy transition and climate resilience in urban systems, particularly for carbon emissions through AI. Smart environment projects, such as the UK's alignment of AI with sustainability goals, which incorporates environmental stewardship into digital transformation, were seen. Furthermore, Norway's AI-driven solutions to environmental concerns may increase eco-consciousness in urban planning and resource efficiency. The formulation of the global sustainable goals presents an opportunity by positioning AI as a new and innovative tool for international climate action and sustainable development.

In terms of smart governance, Norway's e-regulation project, which implements sector-wide AI integration, demonstrates a long-term regulatory commitment to digital governance as well as maturity in this area. However, there is a need for consistent policy frameworks and cross-sectoral governance. The fragile character of governance structures, which are frequently subjected to external pressure, emphasises this point. Germany's transfer of AI research into SME applications will undoubtedly boost industrial infrastructure and innovation pipelines. Furthermore, one common denominator of improved urban infrastructure is targeted AI financing for smart and data-driven services. However, device and sector interoperability has an impact on the basic infrastructure required for smart city operations.

Countries should balance competition with collaborative efforts to advance AI technology globally. This can include sharing best practices, joint research initiatives, and setting international standards for AI development. Opportunities across boards entail vast investment potential in research and development, education, infrastructure, and overall smart city development. The AI strategy across these three nations all attempts to make their countries smarter, more resilient and sustainable, and no country is permitted to slack off as the AI space is a fast-paced space that is fuelling the next industrial revolution in which every country wants a key stake due to its immense potential for economic returns and benefits.

3.3.1 Recurring patterns and contradictions

Among the five countries, a recurring pattern is visualised. Most predominant are the substantial financial commitments put in place for AI infrastructure, research, and development spearheaded by Germany's *Package for the Future*, the UK's *Industrial Strategy Challenge Fund*, and Finland's AI business program. Investments of this calibre reveal a shared goal of achieving AI innovation. However, the time disparity in funding, implementation, and visible outcomes stands as a shared weakness, implying a need for patience and adaptive policy mechanisms to achieve targets and maintain momentum.

Furthermore, each country emphasises the need for reskilling in education and the workforce, as seen in the UK's STEM investment, Danish ethical AI leadership, Finland's Competency and Innovations Committee, and German university courses. However, despite these efforts, talent poaching and skill shortages remain significant threats. This shows that there is still a major imbalance between AI talent distribution and training, with the risk that smaller nations become training grounds for larger economies unless retention strategies are strengthened.

Also, Norway and Denmark already boast advanced digital infrastructure, whereas countries like the UK and Finland have made heavy investments in AI expansion. However, regardless of the infrastructure, the data-sharing framework and interoperability of AI systems remain heavily underdeveloped and fragmented. This raises the caveat that technical preparedness does not automatically translate into systemic integration of AI systems. Hence, there is a pressing need for digital language standardisation across the board and unified protocols.

Another visible pattern is the prevalence of data privacy concerns and regulatory adaptations across all strategies. This includes statutory consents by Norway, uncertainties within the Finnish legislature, and some unsustainable frameworks by Germany regarding data privacy. This implies that although privacy is a well-documented issue, the existing challenge lies in balancing AI innovation with evolving legal clarity. Furthermore, all countries identified that competition for talent and investment is a major threat, with international collaboration being an opportunity, as seen through Germany's partnerships with France, Canada, and Japan. However, as ambition runs high for AI, a strategic paradox emerges—fuelled by the need for global cooperation and standards. This can be resolved through unified AI governance models that enhance and allow the unification of local innovation with global interoperability frameworks.

Contradictions can also be seen in the analysis. Although countries like Denmark and Norway set the pace in AI digitisation, countries like the UK and Finland face regional disparities in AI adoption. This translates into digital inequalities, not only associated with AI infrastructure but also with misaligned policies between local and national strategies. Furthermore, adequate engagement from private sector players is limited in countries like Norway and Finland, whereas Germany and the UK foster significant sector deals and integrate AI adoption for small and medium-sized enterprises (SMEs).

The divergence between the public and private sectors highlights the need to sandbox the AI ecosystem and provide clearer incentives for private sector engagement and experimentation, particularly in countries with stronger public sector dominance. Furthermore, although Denmark stands as a leader in ethical AI, risks such as cyberattacks are imminent due to AI integration. Hence, there is a need for co-designing AI ethics by matching ethical AI leadership with robust cybersecurity frameworks.

3.4 Key challenges and barriers associated with implementing ethical AI policies in smart cities.

A number of challenges exist in identifying and establishing issues related to ethical AI policy implementation. Firstly, the limited literature that discusses or mentions AI policy presents a significant obstacle. Moreover, research and publications related to AI policy are scarce. This difficulty was highlighted because most of the

reviewed studies did not explicitly use AI-designed models, creating a problem in determining where AI ethics could be relevant within their findings. However, the most commonly identified challenges in the reviewed studies included digital inequality, lack of data privacy, cybersecurity threats, non-interoperable AI systems, regulatory oversight, complexities surrounding decision-making, emerging technologies and societal changes, and a lack of public participation. Table 8 illustrates the challenges and barriers associated with implementing ethical AI policies within smart cities.

3.4.1 Digital and economic inequality

In developing countries, the adoption of AI strategies in sectors such as education and research remains a significant challenge. According to Weerapperuma et al. (2024), digital learning in these regions is still largely underexplored. Khan, Umer, and Faruqe (2024) support this observation, noting a prevalent bias in AI literature that tends to focus on high-income countries (HICs) while largely overlooking low-income countries (LICs), primarily due to economic disparities. This digital and economic bias highlights a broader issue: the uneven adoption of AI technologies across different socioeconomic contexts. Ethical AI policies, therefore, have a role to play in addressing this lack of inclusivity by proposing strategies aimed at bridging the AI divide. One such approach involves the gradual integration of AI into key sectors such as education, healthcare, and governance within LICs. Wang et al. (2023) argue that in the era of Industry 4.0, strategies like curriculum development and updates, the integration of digital technologies for universal education, and the use of cloud computing can significantly help overcome these barriers. Literature challenges identify a digital divide between high and low-income nations, with structural exclusion being the most prevalent concern. This is because LICs are under-represented in both AI system design and data availability, resulting in the deployment of ill-suited solutions to address their current difficulties, resulting in a mismatch. Thus, the difficulty could become an opportunity for the co-creation of AI systems, with LICs represented in training and policy consultations.

3.4.2 Data privacy and cybersecurity

Technology systems form a vital and complex communication infrastructure with integrated IoT components. However, a breach within these systems can result in a complete takeover, highlighting the significant risk of cybersecurity threats (Horalek & Sobeslav, 2023). The integration of AI into smart systems has further underscored data security, privacy, and cybersecurity as major challenges requiring urgent attention. According to Altarawneh et al. (2024), the adoption of smart technology in electronic voting (E-voting) emphasises the importance of principles such as consistency, integrity, and identity verification. Guler and Yomralioglu (2022) note that while digitisation can mitigate inefficiencies in the building sector—improving transparency, reducing permit processing time, and enhancing land administration—it also introduces challenges in safeguarding personal data against cyber threats. Shi, Danquah, and Dong (2022) propose blockchain technology as a potential solution, offering decentralised, secure, transparent, and automated systems to address data security concerns. Consequently, ethical AI policies should consider integrating decentralised frameworks to protect user data—both governmental and private—and to ensure end-to-end encryption and user verification within smart cities. Implications show that when AI systems are able to handle private information, a breach turns this from a technical problem to a sovereignty issue that could erode confidence in civic autonomy and the democratic process. Therefore, data sovereignty must be transferred to data protection in ethical AI policy. Thus, alongside constitutional protections from moral AI policy, cybersecurity should be prioritised as a critical civic infrastructure.

3.4.3 Interoperability

The place of interoperability has been minimally studied and covered in the place of AI ethics, even within the dataset and the identified AI policies of the five reviewed countries (Denmark, Finland, Germany, the UK and Norway). According to Liang et al. (2021), a scalable interoperable sensing solution is required in order to offer real-time situational awareness and early warnings for decision-makers. However, Liang et al., study pinpoints that most IoT solutions are developed without an interoperable way to interconnect heterogeneous systems and exchange data on people and place interactions. Indumathi et al. (2020) further supported this by implying that interoperability could have a significant impact on the future of patient-centric medical care. Furthermore, smart city projects involving complex distributed systems and having multiple stakeholders and diverse applications (Chaturvedi and Kolbe 2019; Kalogianni et al., 2017), Chaturvedi and Kolbe (2019) suggest that having a proper data integration strategy, which must allow working with heterogeneous data sources and platforms in interoperable ways, is essential. Hence, AI ethical policies could be utilised to ensure that AI models are designed

to be interoperable with systems while maintaining user data privacy, especially in critical sectors like health and justice.

Table 8: Barriers and Challenges to Implementing AI Ethical Policies within Smart Cities.

	Barriers/Challenges	Author(s)
1	**Digital Inequality:** Digital and Economic inequality, especially between low and high-income countries.	Weerapperuma et al., (2024), Khan, Umer and Faruqe (2024), Shi, Danquah, & Dong (2023)
2	**Data Privacy:** Lack of adequate data security and privacy, leading to low user confidence and poor adoption of the AI model/tool.	Naseer et al., (2024), Fraga-Lamas & Fernández-Caramés (2019), Indumathi et al., (2020), Lim & Taeihagh (2018), Petersen et al., (2022), Jalili & Dziatkovskii (2023), Siddiqui et al., (2018)
	Cybersecurity: Existing cybersecurity threats to steal user data for fraudulent activities.	Altarawneh et al., (2024), Jalili & Dziatkovskii (2023), Horalek & Sobeslav, (2023), Levshun & Kotenko (2023), Malinka et al., (2022), Indumathi et al., (2020), Fraga-Lamas & Fernández-Caramés (2019), Lim & Taeihagh (2018). Siddiqui et al., (2018)
3	**Interoperability:** Lack of interoperability of AI systems is mainly due to a lack of planning and consideration in the AI model design.	Liang et al., (2021), Indumathi et al., (2020), Chaturvedi and Kolbe (2019) Kalogianni et al., (2017).
4	**Regulatory Oversight/Standardisation/ Indicators:** Limited oversight, existing by international standards organisations, is considered another challenge/barrier to AI ethical policy implementation. A lack of reliable indicators has created barriers in precisely defining and creating AI policies, possibly due to a disconnect between regulatory bodies and decision-making.	Olayiwola, Elsden, & Dhimish (2024), Bovkir & Aydinoglu (2024), Zhou and Asipova (2024), Shen et al., (2024), Naseer et al., (2024), Mökander et al., (2022), Badawi, Laamarti & El Saddik (2019), Blanco et al., (2021), Raspotnik, Grønning & Herrmann (2020), Selinis et al., (2018), Kalogianni et al., (2017), Yusif et al., (2020).
5	**Decision-Making and Government:** The complexities surrounding policy creation and adoption stand as a major challenge. Also, a lack of will by law-makers challenges the implementation of ethical AI policies in smart cities	Ibrahim, Gaber & Zakzouk (2024), Mata-Carballeira et al., (2020), Kirejev, Gerstlberger & Niine (2024), Gnanavendan et al., (2024), Khan, Umer & Faruqe (2024), Zhou & Asipova (2024), Shi, Danquah, & Dong (2023), Ligorio, Venturelli, & Caputo F. (2022), Guler & Yomralioglu (2021), Blanco et al., (2021), Andejany et al., (2023), Villa et al., (2021), Raspotnik, Grønning & Herrmann (2020), Li & Xi, (2019), Robin & Acuto (2018), Wang et al., (2023), Bueno, Bañuls & Gallego (2021), Chaturvedi & Kolbe (2019), Cihon, Maas & Kemp (2020).
6	**Emerging Technologies and Societal Changes:** growing trends and ever-changing technology and societal preferences have led to a need for continuous policy change/upgrades, as well as ethical considerations to match change.	Knight et al., (2024), Nidamanuri et al., (2022), Biadacz & Biadacz (2021), Selinis et al., (2018), Mata-Carballeira et al., (2020), Jiménez-Espada et al., (2023), Andejany et al., (2023), D'Amico (2022), Ibrahim, Gaber & Zakzouk (2024), Bueno, Bañuls & Gallego (2021), Beil et al., (2020), Tan, Zhao & Yang (2022)
7	**Public participation:** Citizen engagement in generating AI ethical policies has become a major challenge due to a number of factors, especially age and the digital divide.	Szczepańska, Kaźmierczak & Myszkowska (2023),

3.4.4 Regulatory oversight/standardisation/indicators

The limited oversight provided by international standards organisations concerning the use of AI across various sectors—particularly within the energy domain—raises significant concerns regarding both potential hazards and untapped opportunities. According to Olayiwola, Elsden, and Dhimish (2024), current safety regulations governing the use of Robotics, Artificial Intelligence, and Drones (RAID) are often based on device-specific adaptations, determined at the discretion of individual companies. This fragmented approach highlights the urgent need for standardised, industry-wide policies and guidelines. Ethical AI policies can help fill this gap by proposing clear monitoring, safety, and maintenance frameworks applicable across sectors. Several scholars, including Bovkir and Aydinoglu (2024), Zhou and Asipova (2024), Shen et al. (2024), Naseer et al. (2024), and Badawi, Laamarti, and El Saddik (2019), emphasise that any technological transition within smart cities should adhere to international standards for the sustainable management of urban systems—not only within the energy sector, but across all domains of development. Mökander et al. (2022) note that the European Artificial Intelligence Act (AIA) represents the first major attempt by a global economic entity to establish a comprehensive legal framework for AI. However, the level of adoption across European countries remains limited. As such, ethical AI policies could play a pivotal role in bridging this gap—enabling AI tools to align urban configurations with broader sustainable development goals.

3.4.5 Decision-making/government

Ligorio, Venturelli, and Caputo (2022) argue that sustainable cities are supported not only by the political efforts of local governments but also by the cultural and technical contributions of institutional actors. Similarly, Kirejev, Gerstlberger, and Niine (2024) note that the beliefs and values of incumbent officials can significantly influence decision-making paradigms within smart cities. However, despite the influential role of government policies (Gnanavendan et al., 2024), the decision-making process is often sluggish. This delay can lead to avoidable consequences, particularly when proactive policies are not implemented in time. For instance, while Khan, Umer, and Faruqe (2024) provide timely recommendations for integrating AI into key sectors, Shi, Danquah, and Dong (2023) highlight that slow and ineffective decision-making continues to hinder adoption despite the clear benefits.

Urban environments, in particular, require a vast array of complex decisions—ranging from land-use planning and disaster response to infrastructure monitoring (Guler & Yomralioglu, 2021). However, as Villa et al. (2021) note, the development of predictive tools and policies to accelerate decision-making remains a major challenge. Moreover, Raspotnik, Grønning, and Herrmann (2020) emphasise that because each city operates within its own unique context, implementing smart systems often results in varied outcomes, further contributing to delays in policy development. A comparison of electric and non-electric vehicles offers further insight into the complexities of urban decision-making. Ibrahim, Gaber, and Zakzouk (2024) explore the multidimensional impacts of electric vehicle (EV) adoption on distribution networks. They find that uncontrolled EV charging can negatively affect energy systems, causing grid instability, degraded power quality, and overloading. Although Vehicle-to-Grid (V2G) charging is proposed as a solution, technical limitations—particularly in planning public charging infrastructure—remain a major barrier to V2G implementation. Conversely, Mata-Carballeira et al. (2020) examine the use of a field-programmable gate array (FPGA) device for real-time assessment of fuel consumption in non-electric vehicles. Their study shows that element-by-element mechanical simulations can improve fuel efficiency and reduce emissions by 9.5% to 31.5%, demonstrating the potential for making fossil-fuel vehicles more sustainable. These cases highlight a broader implication: while the global push for renewable energy remains strong, optimising the performance of existing fossil-fuel technologies may offer a more pragmatic short-term solution. In this context, ethical AI policies can play a dual role. For EVs, such policies could help facilitate V2G systems by establishing secure communication protocols, enhancing cybersecurity, and coordinating between transmission and distribution systems to improve mobility. For non-EVs, AI-driven ethical policies could help standardise eco-driving behaviours by integrating intelligent driving systems into a broader range of scenarios—including autonomous vehicle settings—following comprehensive real-world testing.

3.4.6 Emerging Technology and Societal Changes

Implementing ethical AI policies within the framework of smart cities is far from straightforward, as it involves navigating a range of complex challenges. One such issue, according to Knight et al. (2024), relates to the expression and conveyance of ethics within the outputs of research. They suggest that this challenge can be addressed through the development of new policies that promote ethical understanding and learning via research content. Another significant hurdle is the time required to transition and harmonise existing systems within smart cities. As highlighted by Zhou and Asipova (2024), the academic sector in the Kyrgyz Republic took 15 years to complete just two phases of aligning its education system with European standards. Despite the lengthy process, the integration of European practices was identified as a key factor in advancing the system. In this context, ethical AI policies could serve to ensure that while harmonisation takes place, individual institutions retain their distinctiveness in both education and research approaches. In addition, the rapid and often unregulated expansion of urban areas has raised concerns regarding the quality of life. Bovkir and Aydinogul (2024) argue that this uncontrolled growth negatively impacts urban living conditions. Kirejev, Gerstlberger, and Niine (2024) support this view, noting that mobility within cities has become increasingly problematic due to exponential urban growth. The 21st century's fast pace of innovation often outpaces the development of corresponding ethical frameworks. As a result, there is an urgent need for policies that support controlled, monitored growth—especially through the integration of Information and Communication Technologies (ICT) and Spatial Data Infrastructures (SDI). However, the successful implementation of these technologies depends not only on local socio-economic and environmental contexts but also heavily on the competence, knowledge, skills, and values of the officials responsible for their execution (Kirejev, Gerstlberger, & Niine, 2024).

3.4.7 Public Participation

Engaging citizens in the formulation of AI policies remains a significant challenge and a largely underexplored area. Among the sources reviewed, only the study by Szczepańska, Kaźmierczak, and Myszkowska (2023) addressed the importance of citizen involvement. Their work, *"Smart City Solutions from a Societal Perspective,"* highlights that the satisfaction of residents with implemented smart solutions is critical, as they are the primary beneficiaries of such measures. The failure to effectively inform and involve the public risks creating urban systems in which AI tools are underutilised or misaligned with societal needs. Therefore, ethical AI policies should prioritise public engagement by incorporating user opinions and feedback throughout the development and deployment process. This participatory approach is essential to ensuring that AI tools within smart cities are not only functional but also socially accepted and effectively integrated.

3.5 Global Implications of the Results

The findings suggest that implementing ethical AI policies within the context of smart cities holds immense potential benefits for both high- and low-income countries. However, due to the existing digital and economic divide, the initial step must involve establishing a robust governance and regulatory framework. This framework should function as an oversight mechanism to guide the ethical deployment of AI in smart cities.To develop such a framework, the creation of a standardised AI regulatory body is essential. This body would be responsible for drafting guidelines aligned with globally accepted technology principles, particularly those related to human rights, fairness, and sustainability. Moreover, it should be empowered to monitor, evaluate, and refine ethical policies in an accountable and transparent manner—engaging the public through consultations and feedback mechanisms. The next phase involves the design and development of AI systems in strict accordance with these ethical guidelines and regulatory standards. This process must actively prevent bias, promote human-centric design, and safeguard user data privacy. To ensure inclusivity, data sources used for AI development should encompass rural areas and marginalised communities. Furthermore, AI tools should be developed as open-source and modular systems to allow for future enhancements in areas identified as critical.

Once developed, AI models should undergo rigorous testing and be made interoperable across various platforms and systems. This ensures the models serve their intended purposes effectively and equitably. Citizen engagement also plays a vital role in the successful implementation of ethical AI. It is important to educate the public on how AI tools function, their associated benefits and risks, and the ethical policies that govern their use. Additionally, establishing feedback loops will enable citizens to voice their experiences and concerns regarding deployed AI tools. Mechanisms for inclusion, training, and reporting should be instituted to raise awareness and allow individuals to report breaches in data privacy. Finally, consistent ethical AI auditing and compliance monitoring are essential to ensure that AI tools adhere to established standards and do not deviate from their intended goals. An AI oversight committee should be established to conduct regular reviews, adjust policies when needed, and provide both legal and administrative remedies for individuals adversely affected by AI-related harm.

One could then ask: how would policymakers or city managers utilise the findings? Or better still, what governance mechanisms, institutional reforms, or funding strategies could be recommended?

For governance mechanisms, the findings imply the need to create localised bodies to oversee the deployment of AI across cities, ensuring alignment with community values and ethical standards. These mechanisms could be composed of multidisciplinary teams tasked with reviewing AI projects and ensuring adherence to ethical principles, among other responsibilities. Furthermore, creating controlled AI testing environments—such as Norway's sandbox model—could be adapted for smart city experimentation, encouraging innovation alongside effective monitoring and real-time evaluation. In addition, periodic audits, as embedded in UNESCO guidelines and the EU AI Act, could serve as benchmarks for AI compliance evaluation. Another implication is the need for harmonised roadmaps to integrate old and new AI-driven systems. Thus, publicly funded AI research should embed ethical components from the outset to ensure that ethical considerations play an integral role, rather than being retrofitted into the research process.

Institutional reforms, such as participatory platforms that allow members of the public to contribute to AI decision-making, could be effective in gathering user perspectives on AI projects. This would facilitate trust and responsiveness in AI governance and implementation. Moreover, the issue of interoperable standards highlights the need to define common protocols and definitions to enhance system integration and data exchange. The

findings also imply the importance of training public sector actors on AI ethics through dedicated curricula, equipping decision-makers with knowledge of the associated risks and benefits of AI.

From a funding perspective, the study highlights the need to support AI adoption in low-income and underserved communities at a pace comparable to thriving communities, particularly through public–private partnerships. Additionally, tax credits could be offered to organisations developing interoperable AI tools that preserve user privacy. Governments could also invest in decentralised data governance models to enable transparent data management within smart cities.

The comparative analysis of national AI policies offers valuable insights for policymakers seeking to create effective governance frameworks. The study's findings suggest that successful AI strategies incorporate clear financial commitments, address interoperability and standardisation concerns, and prioritise talent development. The emphasis on aligning AI development with sustainable development goals further guides policymakers in fostering environmentally responsible innovation. By identifying both strengths and weaknesses in existing policies, the research facilitates informed decision-making and encourages continuous improvement in AI governance. Furthermore, the study supports the need for a synchronised national ambition with global responsibilities, as well as systematic tensions that exist between innovation and regulation that must be addressed through inclusive and adaptive governance. This study also offers valuable insight for researchers in the built environment. The study also opens avenues for future research. The identified limitations, such as the focus on Northern European countries and the reliance on secondary data, suggest the need for broader geographical scopes and diverse research methodologies. Future studies could delve deeper into the long-term societal impacts of AI in smart cities, explore innovative solutions to address ethical challenges, and investigate the role of public participation in AI policy formulation. The interdisciplinary nature of the research encourages collaboration across fields such as urban planning, computer science, ethics, and social sciences to foster a holistic understanding of AI in urban contexts.

While the study focuses on Northern Europe, its implications extend to other regions globally. The challenges and opportunities identified—such as data privacy, digital divide, and the need for ethical guidelines—are relevant to any city undergoing digital transformation. The comparative analysis of AI policies can serve as a valuable resource for countries in developing their own strategies, adapting best practices to their specific contexts. The emphasis on international collaboration and standardisation promotes a global dialogue on AI governance, facilitating the development of shared norms and standards. Ultimately, the research contributes to a more informed and responsible approach to AI implementation in smart cities worldwide, fostering sustainable, inclusive, and ethical urban futures.

4. CONCLUSION

In conclusion, this study has underscored the growing importance of ethical AI policies in shaping the development of smart cities. As urban environments increasingly integrate AI to enhance sustainability, efficiency, and livability, the necessity of robust policy frameworks becomes paramount. This research explored the core principles of ethical AI policies, examined their application across strategic smart city domains, and comparatively analysed national AI strategies in five Northern European countries. The findings of the study highlight several key areas of focus. Ethical AI policies are essential for ensuring fairness, transparency, accountability, and data privacy within smart city initiatives. Strategic domains such as smart mobility, smart economy, and smart government stand to benefit significantly from the implementation of these policies. However, challenges such as digital inequality, data privacy and cybersecurity threats, interoperability issues, and regulatory gaps pose significant barriers to effective implementation. The comparative analysis of national AI policies reveals varying strengths and weaknesses, with a need for greater emphasis on clear financial planning, unified standards, talent development, and global collaboration. Countries should collaborate to establish unified AI standards for privacy, interoperability, and data sharing, facilitating smoother cross-border cooperation. Sustained financial commitments are crucial, necessitating flexible frameworks to adapt to economic changes without compromising AI goals. Investment in education and training programs is essential for developing a skilled AI workforce, alongside creating attractive environments to retain and attract talent. Aligning AI strategies with global environmental and ethical standards can drive sustainable development. The continuous evolution of regulatory frameworks and the establishment of regulatory sandboxes will ensure new AI technologies meet ethical and safety standards. Balancing competition with

international cooperation through joint research and shared best practices will accelerate innovation and effectively address common challenges.

This study is not without limitations. The focus on five Northern European countries may limit the generalizability of the findings to other regions with different socio-economic and political contexts. The study's reliance on secondary data, including policy documents and reports, may also introduce limitations in terms of the depth of analysis and the potential for biases in the source material. Furthermore, the rapid evolution of AI technology implies that policy frameworks must be continuously updated, which presents an ongoing challenge for research and governance. The narrative review approach, while useful for providing a broad overview, is inherently subjective and may not be as rigorous as a systematic review in capturing all relevant literature. Additionally, the SWOT analysis, while providing a structured framework for comparison, is limited by its qualitative nature and the potential for subjective interpretation of strengths, weaknesses, opportunities, and threats. Finally, the study acknowledges the limited exploration of public participation in AI policy formulation, indicating a gap in the research regarding the crucial role of citizen engagement. To put these limitations into even more context, it is crucial to recognise that the study's sole reliance on secondary data such as government reports, academic literature, and policy documents may limit the depth of insights, especially when it comes to capturing lived experiences and real-time policy dynamics. The study's capacity to represent complex opinions on AI ethics and application is constrained by the lack of direct stakeholder perspectives, such as those of legislators, technologists, and citizens. Furthermore, the findings' relevance to worldwide contexts is limited by the regional scope restriction to five Northern European countries, particularly in areas with varying government structures, technological development, and sociocultural dynamics. Together, these elements imply that in order to improve validity and relevance, future research would profit from combining primary data collection, wider geographic representation, and participatory approaches.

Future research should explore several avenues. There is a need for continued investigation into effective strategies for addressing the identified challenges, particularly concerning digital inequality and data privacy. Further studies could also examine the long-term impact of ethical AI policies on citizen well-being and urban sustainability. Additionally, expanding the geographical scope of the research to include a more diverse set of countries and incorporating primary data collection methods, such as surveys and interviews, would provide a more comprehensive and nuanced understanding of global AI policy trends and best practices. To increase empirical validity, future research should employ mixed-method approaches such as interactive workshops, stakeholder surveys, and pilot smart city initiatives. Surveys would collect a range of expert and public opinions on the ethical use of AI, while workshops would assist in co-creating policy frameworks with local communities and decision-makers. Through pilot projects, academics would be able to test interoperability, analyse real-world outcomes, and assess the social impact of AI policies in practice—particularly in varied metropolitan contexts—helping to close the gap between theoretical ideas and actual governance.

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