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Research article

Application, impacts, and challenges of the Internet of Things in the Philippine digital governance

Aplicación, impactos y desafíos del Internet de las Cosas en la gobernanza digital de Filipinas

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Abstract
Introduction: The integration of digital technologies into governance positions the Internet of Things (IoT) as a tool with the potential to transform the Philippine public sector by improving service delivery and efficiency. However, its actual implementation, structural barriers, and effects in the Philippines remain underexamined. This scoping review addresses this gap by analyzing documented applications, reported impacts (benefits, challenges, and risks), and future research directions for digital governance. **Methodology:** Following PRISMA-SCR, a search was conducted in Scopus, ResearchGate, Google Scholar, and government sources. Results were limited to the 2015–2025 period, and nine eligible documents were selected.

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Results: The identified applications align with national needs, highlighting pilot projects such as a dengue early-warning system in public health and the promotion of precision agriculture to optimize resource use. Adoption faces barriers including inadequate internet infrastructure (with reported speeds far below what is required), low local investment in R&D, a shortage of IT professionals, and cybersecurity and data privacy risks. **Discussion and Conclusions:** Although IoT's potential is high, achieving impact requires moving from isolated projects to systematic implementation and stronger institutional support. This calls for sustained fiscal commitment, the incorporation of standards (e.g., ISO 37122) into accountability frameworks, and strong human capital development through education–industry partnerships.

Keywords: Internet of Things; Digital Governance; Philippines; Public Administration; Smart Cities.

Resumen
Introducción: La integración de tecnologías digitales en la gobernanza sitúa al Internet of Things (IoT) como una herramienta con potencial para transformar el sector público filipino, mejorando la prestación de servicios y la eficiencia. Sin embargo, su implementación real, los obstáculos estructurales y sus efectos en Filipinas siguen poco estudiados. Esta scoping review aborda ese vacío al analizar aplicaciones documentadas, impactos reportados (beneficios, retos y riesgos) y líneas futuras de investigación para la gobernanza digital. **Metodología:** Siguiendo PRISMA-SCR, se realizó una búsqueda en Scopus, ResearchGate, Google Scholar y fuentes gubernamentales. Se limitaron los resultados al periodo 2015–2025 y se seleccionaron nueve documentos elegibles. **Resultados:** Las aplicaciones identificadas se alinean con necesidades nacionales, destacando proyectos piloto como un sistema de alerta temprana de dengue en salud pública y la promoción de agricultura de precisión para optimizar recursos. La adopción enfrenta barreras: infraestructura de internet insuficiente (con velocidades reportadas como muy por debajo de lo requerido), baja inversión local en I+D, escasez de profesionales TI, y riesgos de ciberseguridad y privacidad. **Discusión y conclusiones:** Aunque el potencial del IoT es alto, su impacto exige pasar de proyectos aislados a una implementación sistemática y con refuerzo institucional. Se requiere compromiso fiscal sostenido, incorporación de estándares (p. ej., ISO 37122) en marcos de rendición de cuentas y un impulso fuerte al capital humano mediante alianzas educación–industria.

Palabras clave: Internet de las Cosas; Gobernanza Digital; Filipinas; Administración Pública; Ciudades Inteligentes.

1. Introduction

The integration of digital technologies into governance has become a global trend, with countries worldwide adopting digital or e-government platforms to enhance administrative efficiency and provide better services to their citizens (Jou et al., 2024). Like many other nations, the Philippines has embraced this digital transformation, recognizing the potential of information and communication technologies to revolutionize public service delivery and improve citizen engagement (Panganiban, 2018).

Digital governance is the use of digital technologies and strategies to transform government operations, increase citizen participation, and improve overall governance outcomes (Al-Ansi et al., 2024). Within this framework, the Internet of Things emerges as a transformative force that connects physical objects, devices, and sensors to the internet. This connectivity enables real-time data collection, automated decision-making, and enhanced situational awareness across various sectors (Yoshida et al., 2021).

The Internet of Things has been recognized as the next generation of the internet due to its significant potential impact on society (Wirtz et al., 2018). Additionally, the COVID-19 pandemic has prompted many enterprises to adjust their business models to leverage digital technologies, further accelerating this development (Aminah & Saksono, 2021).

The Internet of Things encompasses a range of digital innovations, including blockchain, big data, cloud computing, sensors, actuators, and artificial intelligence, all brought together in a cohesive framework (Saadé et al., 2023). The economic potential of Internet of Things is significant, with estimates indicating trillions of dollars in value across various industries. Additionally, it holds promise for substantial societal improvements across energy efficiency, healthcare, and productivity (Fu et al., 2020).

In the Philippines, integrating Internet of Things technologies into digital governance initiatives presents both opportunities and challenges. While the potential benefits—such as enhancing public services, promoting transparency, and improving decision-making—are considerable, the actual implementation and effects of these technologies in the Philippine digital governance landscape remain relatively underexplored. Despite being classified as a lower-middle-income country, the Philippines shows promise for advancing e-government initiatives (Mercurio & Hernandez, 2022).

To effectively deploy digital solutions in public finance, it is essential to fully leverage information system capabilities and carefully design and implement the necessary legal and institutional reforms. Furthermore, ensuring robust data security measures, protecting privacy, and guaranteeing the resilience of digital solutions—along with proactive management of disruptions—are crucial considerations (Alhalafi & Veeraraghavan, 2019; Kaur et al., 2021; Saadé et al., 2023; Shah et al., 2015).

The rise of interconnected devices through the Internet of Things enables extensive data collection and tracking, which can be applied in various areas, such as monitoring traffic patterns and air quality and optimizing energy consumption in public spaces (Vujko et al., 2025). However, the widespread use of Internet of Things devices also raises significant concerns regarding privacy, data security, and the potential misuse of personal information (Ziegeldorf et al., 2013). Currently, government technology use is primarily observed in the most progressive nations (Mercurio & Hernandez, 2022).

More technologically advanced countries have already begun implementing 'Government 3.0' initiatives to create a more service-oriented, efficient, and transparent government, thereby enhancing citizens' quality of life (Panganiban, 2018). Moreover, the existing literature offers limited insights into the specific challenges and barriers faced during the implementation of the Internet of Things in digital governance in the Philippines. These challenges include infrastructure limitations, regulatory frameworks, digital literacy, and cybersecurity threats. Despite the Philippines' aggressive efforts to improve information and communication infrastructure and e-government services, attempts to enhance democracy through e-participation have yet to provide tangible benefits to the average citizen (Huffman, 2017).

The government must address the digital divide to ensure inclusivity and accessibility for all citizens, particularly those in underserved communities. According to the World Economic Forum's Global Competitiveness Report, the most significant obstacles to doing business in the Philippines are corruption, inefficient government bureaucracy, and inadequate infrastructure. Public awareness regarding online privacy and security is just beginning to develop in the Philippines (Capuno et al., 2022).

Citizens need to be informed about their rights and responsibilities in the digital realm to encourage them to take proactive measures to protect their personal information and engage safely online. This review addresses these gaps by comprehensively mapping the existing literature on the applications, impacts, and challenges of the Internet of Things in Philippine digital governance. By synthesizing the available evidence, this study provided a holistic overview of the current state of research and practice in this area.

Given the increasing emphasis on digital transformation and the growing recognition of the Internet of Things as a key enabler of innovative governance and sustainable development, this research is both timely and relevant. By synthesizing existing literature, this study identified key themes, research gaps, and potential future research directions, offering valuable insights for policymakers, practitioners, and researchers seeking to harness the Internet of Things to enhance digital governance in the Philippines.

This paper aims to address these gaps by exploring the following research questions:

1. What are the documented applications of Internet of Things technologies within digital governance initiatives in the Philippines?

2. What are the reported impacts (benefits, challenges, and risks) of implementing the Internet of Things in the context of digital governance in the Philippines?

3. What are the key themes, gaps, and future research directions identified in the existing literature concerning the integration of the Internet of Things in Philippine digital governance?

This review's findings enhanced the researchers' understanding of the opportunities and challenges of adopting the Internet of Things in the Philippine public sector. Additionally, the insights gained inform evidence-based policies and strategies to promote effective and inclusive digital governance.

2. Methodology

2.1. Protocol

This scoping review was conducted following a detailed research protocol established in advance (Tricco et al., 2018). Researchers adhered to the PRISMA-SCR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines to ensure transparent and comprehensive reporting (Lee & Gambiza, 2022). This thorough approach enhances the reliability and integrity of the review findings.

Table 1.

Search Eligibility Criteria

Criterion	Inclusion	Exclusion	Rationale
Population	Studies focusing on government, citizens, officials, or other participants involved in or impacted by IoT initiatives in the Philippines.	Studies focusing solely on technology adoption without explicitly addressing governance or public sector aspects.	To ensure the focus remains on the governance implications of IoT technologies in the Philippine context.
Concept	Studies exploring key concepts of IoT in governance, such as smart cities, sensor-based services, real-time data monitoring, and related security or privacy issues.	Studies focusing solely on technical aspects of ICT without addressing governance dimensions.	To maintain a focus on the public administration and governance aspects of IoT technologies.
Context	Studies examining IoT in governance initiatives in the specific context of the Philippines (national or local level).	Studies focusing on IoT in other countries without specific reference to the Philippines.	To establish applicability to the Philippine situation and avoid generalizations from other settings.
Time span	Studies published between 2015 and 2025 (adjusted to capture a decade of emerging technology literature).	Studies published before 2015.	To obtain the latest relevant research on the adoption of emerging IoT technologies in governance, highlighting its initial academic exploration and subsequent rapid growth in the Philippines.
Types of Sources	Peer-reviewed journal articles, government reports, policy documents, white papers, and conference proceedings.	Editorials, opinion pieces, news articles, and blog posts.	To prioritize credible and reliable sources of information with a focus on research-based evidence and official publications.
Language	Studies published in the English language.	Studies published in other languages.	To ensure accessibility and comprehensibility of research findings.

Source: Own elaboration (2025).

2.2 Search Strategy

A thorough search strategy was developed to identify relevant studies on the Internet of Things and digital governance in the Philippines (Moradpour et al., 2025).

- Databases: The search was performed across various electronic databases, including Scopus, ResearchGate, and Google Scholar, as well as pertinent government websites (e.g., DICT, Official Gazette of the Philippines) to ensure comprehensive coverage of academic and gray literature.

- Keywords: The search employed a combination of keywords including "Internet of Things," "IoT," "digital governance," "e-governance," "Philippines," "public service delivery," "smart city," "sensors," "data privacy," and "cybersecurity."

- Search strings used included examples such as ("Internet of Things" OR "IoT") AND ("Philippines" OR "Filipino") AND ("digital governance" OR "smart cities").

- The search was limited to the specified period of 2015-2025. Reference list checking and citation searching were conducted to identify additional relevant publications and enhance overall comprehensiveness.

2.3. Data Extraction

The data extraction process was guided by the research questions and aimed to capture information related to three key areas:

1. Applications of the Internet of Things: This section covers the various types of Internet of Things initiatives, the specific technologies used (such as sensors and big data), and the government sectors involved.

2. Impacts of the Internet of Things: This section provides data on reported benefits from the Internet of Things, including improvements in efficiency and transparency. It also discusses the challenges faced, including infrastructure, digital literacy, and security issues, as well as the associated risks of privacy and data misuse.

3. Future Directions: Here, researchers identify key themes, research gaps, and emerging trends in the literature related to the integration of the Internet of Things in the Philippines.

All data extracted were carefully checked for accuracy and consistency before being organized into relevant thematic clusters for analysis.

3. Results

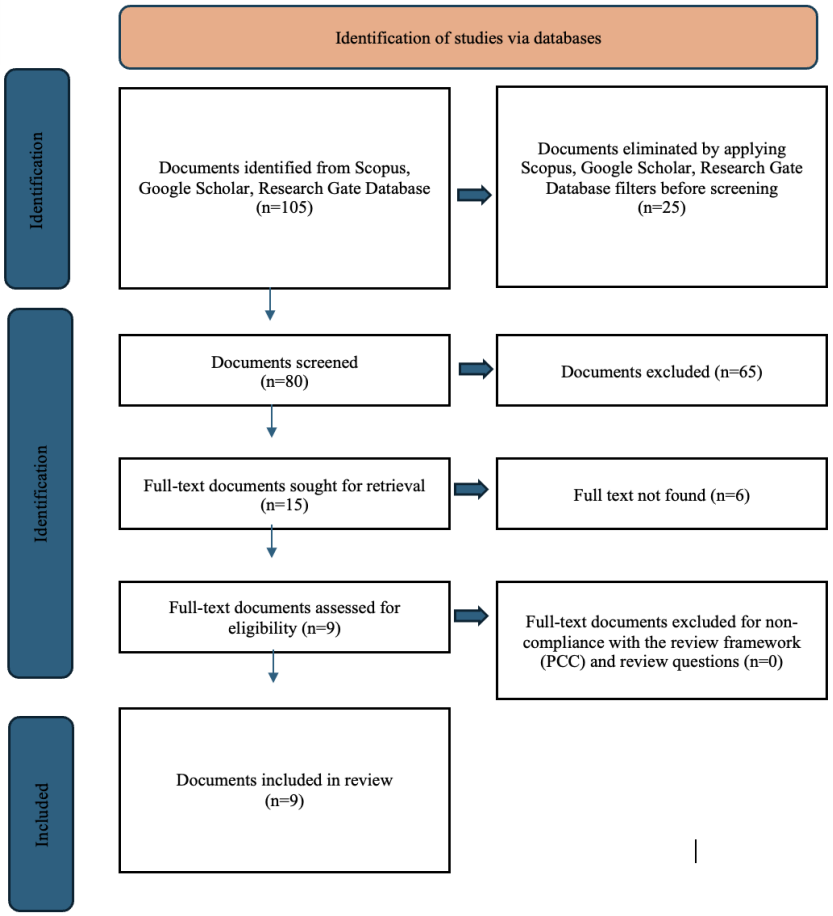
3.1. Search and Selection Results

The final search was conducted on October 5, 2025. Initially, 105 records were obtained from selected databases and government websites, representing the results of the preliminary search stage. After applying filters for language, subject area, and time span (2015-2025), and removing duplicates, the number of records was reduced to 80. Titles and abstracts were then evaluated for relevance, leading to the removal of 65 records that did not address the research questions.

Full texts were retrieved for the remaining 15 records, but 6 were disqualified after a detailed assessment of their eligibility against the PCC framework and specific exclusion criteria. This left a final sample of 9 studies included in the scoping review. The PRISMA flow diagram illustrates the search and selection procedure (Figure 1).

Figure 1.

Selection of Publications for Review



Source: Own elaboration (2025).

3.2. Documents Ultimately Included in the Review

The review identified nine documents that met the objectives and eligibility criteria (Table 2), including academic journals, conference proceedings, and technical reports.

Table 2.

Documents included in the review

Reference	Publication Title
(Aguinaldo & Sicam, 2025)	Design and implementation of an Internet of Things-OL trap for community-based dengue early warning system.
(Agustin et al., 2022)	The Emergence of Disruptive Smart Farming Technologies in the Philippine Agriculture Under the New Normal.
(Bithay et al., 2025)	Developing a smart city framework for Philippine Local Government Units: A policy-driven approach to digital transformation.
(Dadios et al., 2018)	Preparing the Philippines for the Fourth Industrial Revolution: A Scoping Study.
(Kato et al., 2022)	Emerging Technologies in the Philippines: Internet of Things (IoT).
(Motea, 2023)	The Dawn of a Connected Province: A Review of the Internet of Things (IoT) Landscape in Pangasinan.
(Obiso et al., 2019)	Management of Industry 4.0 – reviewing intrinsic and extrinsic adoption drivers and barriers.
(Paradina & Noroña, 2021)	Applications and Challenges of Adopting Internet of Things (IoT) in Reducing Road Traffic Accidents.
(Yasay, 2021)	Internet of Things in the Philippine Agribusiness.

Source: Own elaboration (2025).

3.3. Hypothetical Thematic Clusters

The key findings are organized into three clusters aligned with the study's Research Questions (RQs), as shown in Table 2. These clusters thoroughly address the Internet of Things' applications, impacts, and future directions in Philippine digital governance.

Table 3.

Thematic Clusters

Thematic Clusters	Cluster Descriptions
Cluster One: Applications and Benefits	Examines the specific documented applications and viable proposals of the Internet of Things in Philippine public sectors (e.g., smart agriculture, disaster monitoring) and the resultant benefits (e.g., efficiency, enhanced service delivery, resource optimization).
Cluster Two: Challenges and Risks	Focuses on the primary challenges to Internet of Things implementation, including infrastructure limitations, economic constraints, digital literacy gaps, and critical associated risks like data security and technological unemployment.
Cluster Three: Policy, Gaps, and Future Trends	Identifies existing or proposed policy frameworks, details key research gaps for future investigation, and outlines emerging trends required for scalable and sustainable adoption in the Philippines (e.g., standardization, Public-Private Partnerships).

Source: Own elaboration (2025).

The thematic analysis of the included literature synthesized findings across the three predetermined clusters, addressing the key research questions.

3.4. Cluster One: Documented Applications and Benefits of Internet of Things Technologies

Public Health and Disaster Resilience: A successfully deployed pilot project, the Community Dengue Early Warning System in Cauayan City, Isabela, utilizes autonomous Internet of Things ovicidal-larvicidal traps (Aguinaldo & Sicam, 2025). The system employs a convolutional neural network to accurately detect and count Aedes aegypti eggs in real time, providing reliable data for local health officials (Aguinaldo & Sicam, 2025).

Additionally, IoT technology is proposed for early warning systems for natural disasters, incorporating automated weather stations and water-level sensors in areas prone to flooding (Motea, 2023). Local Government Units have established upgraded Emergency and Disaster Command Centers equipped with digital surveillance capabilities to enable real-time monitoring of incidents (Bithay et al., 2025).

Agricultural and Aquacultural Productivity: Internet of Things applications are primarily promoted for precision agriculture and innovative aquaculture, aiming to optimize resource usage and enhance national output (Agustin et al., 2022; Motea, 2023). Proposed solutions involve real-time monitoring of soil moisture, nutrient levels, and climatic conditions using Internet of Things sensors (Motea, 2023).

The combination of drones and image recognition technology, enabled by the Internet of Things, is deemed adequate for the early detection of pest infestations and crop diseases (Motea, 2023). The use of drones in combination with image recognition technology is effective for early detection of pest infestations and crop diseases (Yasay, 2021).

Smart Governance and Citizen Services: The introduction of digital transaction systems, such as digital payment kiosks in a pilot Local Government Unit (Angeles City), enhances the efficiency of tax and fine revenue collection (Bithay et al., 2025). Additionally, the deployment of free Wi-Fi in public areas is a municipal initiative aimed at improving connectivity and reducing the digital divide (Bithay et al., 2025).

In a broader industry context, the Industrial Internet of Things facilitates real-time machine monitoring, which is essential for developing robust, automated supply chains (Kato et al., 2022; Obiso et al., 2019).

3.5. Cluster Two: Reported Impacts (Benefits, Challenges, and Risks)

The reported impacts offer a positive outlook for transformation, but structural obstacles stemming from both infrastructure and human factors remain.

Challenges of Infrastructure and Connectivity: The main challenge is the widespread need for reliable, affordable internet connectivity to encourage adoption (Motea, 2023). In the Philippines, internet connection speeds are reported to be 55 times slower than required for consistent performance in the Internet of Things (Kato et al., 2022).

This national issue—particularly the lack of information technology infrastructure and networks—is especially pronounced in rural areas, limiting adoption due to geographic obstacles (Agustin et al., 2022). Reliance on these technologies introduces new risks, as cybersecurity vulnerabilities are often not addressed from the outset in new systems (Dadios et al., 2018). The lack of information technology infrastructure and networks is especially pronounced in rural areas, hindering adoption due to geographical limitations (Yasay, 2021).

Economic and Financial Barriers: The high initial costs of investing in Internet of Things infrastructure and hardware constitute a significant economic barrier (Motea, 2023). This situation is concerning, as local government units often lack investment in research and development, which impedes sustainable innovation (Bithay et al., 2025).

Their spending is reported to be below the one percent threshold recommended by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) (Dadios et al., 2018). Additionally, economic risk barriers arise from the perception that costs are excessively high and that returns on investment may take too long to materialize (Obiso et al., 2019).

Human Capital and Societal Risks: There is a significant need for a skilled workforce, including specialized information technology professionals, capable of conducting strategic analysis and system maintenance (Motea, 2023; Kato et al., 2022). Digital literacy remains a barrier, particularly in rural areas where educational attainment is often lower (Agustin et al., 2022).

Security and privacy concerns pose a significant obstacle, especially given the increased sharing of information across interconnected systems (Kato et al., 2022; Obiso et al., 2019). Additionally, there is a social risk associated with technological unemployment, as automation may eliminate more jobs than it creates, prompting the government to take action (Kato et al., 2022; Obiso et al., 2019).

3.6. Cluster Three: Policy, Gaps, and Future Research Directions

The government has established essential policies, but further efforts are needed to address regulatory and research gaps.

Policy and Strategy Direction: The national government has laid the groundwork for the "Smarter Philippines" vision through the National Internet of Things Roadmap (Motea, 2023). The transition associated with the Fourth Industrial Revolution will require the government to systematically review and adapt its policies, institutions, and development efforts (Dadios et al., 2018).

Local strategies should focus on promoting public-private partnerships and prioritizing government-led pilot projects to demonstrate the viability of new technologies (Motea, 2023). Additionally, governments must institutionalize support for infrastructure and address cybersecurity risks to encourage industry participation (Obiso et al., 2019).

Institutionalization and Standards: Local Government Units are encouraged to develop a localized Internet of Things Roadmap that aligns with the national strategy (Motea, 2023). There is a strong initiative to institutionalize standards, such as ISO 37106 and ISO 37122, by integrating them into the criteria for the Seal of Good Local Governance. This aims to standardize smart city readiness across the country (Bithay et al., 2025). Programs like the Digital Farmers Program actively engage with youth to help small-scale farmers adopt digital tools (Agustin et al., 2022).

Research and Future Gaps: There is an urgent need for empirical research to establish baseline data on the current state of digitalization and Internet of Things readiness across various regions (Motea, 2023; Bithay et al., 2025). Future technical research should focus on optimizing system performance to reduce latency and minimize energy consumption for sustainable long-term deployments (Aguinaldo & Sicam, 2025).

The country requires increased investment in data collection, monitoring, testing, and evaluation to fully harness the benefits of this technological revolution (Dadios et al., 2018). Additionally, further studies are necessary to examine the impact of the Internet of Things on government enforcement of road and traffic regulations, as well as the support required from private Information and Communications Technology providers (Paradina & Noroña, 2021).

3.7. Characteristics of the Included Studies

The research methods used in the selected literature are highly varied, reflecting the interdisciplinary nature of the Internet of Things in governance (Table 3). Most studies employed descriptive and qualitative approaches, utilizing techniques such as document analysis, focus group discussions, and interviews to explore the perceptions and experiences of local government unit (LGU) officials regarding the adoption process. Additionally, many studies adopted quantitative research designs, primarily relying on surveys and financial record analysis to assess LGU capacity and evaluate technology-related costs.

Table 3.

Included Studies

Title	Author(s) and Year	Method and Design
Design and implementation of an Internet of Things-OL trap for community-based dengue early warning system	Aguinaldo & Sicam, (2025)	Action research and experimental design involved the physical design, development, and deployment of a functional IoT system called OL Trap, which utilized Convolutional Neural Networks (CNN) for the objective detection and counting of eggs.
The Emergence of Disruptive Smart Farming Technologies in the Philippine Agriculture Under the New Normal	Agustin, et al. (2022)	Examined the shift towards precision agriculture by analyzing facilitating factors, barriers, and necessary policies through a descriptive review of both global and local trends.
Developing a smart city framework for Philippine Local Government Units: A policy-driven approach to digital transformation	Bithay, et al. (2025)	Mixed-Methods Case Study: Combined quantitative assessment utilizing competitiveness rankings and census data for readiness indicators, alongside a qualitative policy review and comparative analysis of existing smart city frameworks.
Preparing the Philippines for the Fourth Industrial Revolution: A Scoping Study	Dadios, et al. (2018)	Scoping Study and Policy Analysis: A comprehensive literature and document review to identify technological trends, assess economic and social impacts, and examine the policy and regulatory landscape in preparation for the Fourth Industrial Revolution.
Emerging Technologies in the Philippines: Internet of Things (IoT)	Kato, et al. (2022)	Provided an overview of IoT advancements, emphasizing local trends, benefits, drawbacks, and their economic and social impacts within the Philippine context.
The Dawn of a Connected Province: A Review of the Internet of Things (IoT) Landscape in Pangasinan	Motea, (2023)	Thematic literature review synthesizes findings from national and regional research on IoT in critical sectors such as agriculture, aquaculture, and smart governance, applying them to the specific socio-economic context of the province.
Management of Industry 4.0 – reviewing intrinsic and extrinsic adoption drivers and barriers	Obiso, et al. (2019)	Systematic literature review and conceptual analysis: Categorized the psychological, technical, economic, and regulatory barriers and drivers to adopting Industry 4.0, including IoT.
Applications and Challenges of Adopting Internet of Things (IoT) in Reducing Road Traffic Accidents	Paradina & Noroña, (2021)	Utilized secondary data from MMARAS reports for statistical analysis, including ANOVA and Regression, to identify traffic risk factors. This was complemented by a survey designed to assess the perceived moderating effect of proposed IoT applications.
Internet of Things in the Philippine Agribusiness	Yasay, (2021)	Literature Review/Descriptive Analysis: This section highlights the benefits, drawbacks, and current state of IoT in agriculture, using existing literature to propose a framework for its application in agribusiness.

Source: Own elaboration (2025).

4. Discusion

The analysis of the evolving technological landscape in the Philippines, particularly through the perspective of the Internet of Things and digital governance, highlights a proactive yet inconsistent approach to adapting to the Fourth Industrial Revolution (FIRe). This assessment indicates that while the country has a clear policy vision (Motea, 2023), its execution is often hindered by shortcomings in foundational infrastructure and human capital (Kato et al., 2022; Agustin et al., 2022; Dadios et al., 2018).

4.1. Strategic Alignment and Proven Applications

The documented applications of the Internet of Things are strategically aligned with some of the nation's most pressing governance and economic challenges. In the agricultural sector, where the Internet of Things is actively promoted, key benefits include automated monitoring for precision agriculture. This reduces waste, lowers costs, and increases productivity (Agustin et al., 2022; Yasay, 2021). Moreover, the adoption of digital transaction systems by Local Government Units reflects a strong, policy-driven commitment to enhancing governance efficiency and transparency (Bithay et al., 2025).

Successful local initiatives, such as the Community Dengue Early Warning System, demonstrate how advanced technologies can produce reliable public health outcomes, significantly surpassing traditional manual surveillance methods (Aguinaldo & Sicam, 2025). The overall trajectory is guided by the national strategic commitment to develop a “Smarter Philippines” through the National Internet of Things Roadmap (Kato et al., 2022; Motea, 2023).

4.2. Critical Structural Barriers

Despite the positive momentum, realizing a "Connected Province" faces structural challenges due to ongoing barriers identified in Cluster Two (Agustin et al., 2022; Kato et al., 2022; Obiso et al., 2019).

Infrastructure and Digital Divide: The country's primary challenge is its weak Information and Communications Technology (ICT) infrastructure (Dadios et al., 2018). Unreliable network access and slow Internet connection speeds—up to 55 times slower than necessary—severely limit the scalability and reliability required for real-time Internet of Things systems (Kato et al., 2022; Agustin et al., 2022). This lack of robust, affordable connectivity contributes to a significant digital divide, especially evident in rural areas, where poor internet access hinders the effective adoption of innovative technologies in agriculture and remote communities (Yasay, 2021; Motea, 2023).

Human Capital and Institutional Deficits: The long-term success of the Internet of Things is jeopardized by a severe shortage of skilled Information Technology (IT) personnel with strategic analysis capabilities (Kato et al., 2022; Motea, 2023). This issue is exacerbated by a general lack of research and development investment—falling below the UNESCO benchmark—at the Local Government Unit level, which stifles autonomous innovation and fosters dependence on external solutions (Bithay et al., 2025; Dadios et al., 2018).

Security and Regulatory Risk: The inherent complexity of integrated cyber-physical systems introduces significant security and data privacy threats (Kato et al., 2022; Obiso et al., 2019). The existing literature indicates that adequate regulatory frameworks and standards are either nonexistent or lagging behind technological advancements, leading to compliance uncertainties and allowing risks to persist (Obiso et al., 2019; Paradina & Noroña, 2021).

Additionally, security protocols must be designed from the outset to effectively address evolving cyber threats (Dadios et al., 2018).

4.3. Pathways to Scale and Sustainability

To successfully transition from promising pilot programs to widespread implementation, the focus must shift to addressing the structural constraints identified in Cluster Three. While adopting the National Internet of Things Roadmap provides valuable direction, it is essential to ensure institutional alignment and actively develop human capital (Motea, 2023).

Institutionalizing Standards and Funding: National agencies should prioritize integrating internationally recognized standards, such as ISO 37122 metrics, into existing accountability frameworks, such as the Seal of Good Local Governance criteria. This will ensure consistency and measurability across various Local Government Units (Bithay et al., 2025). Additionally, establishing strong public-private partnerships is essential to share the significant initial investment costs and facilitate necessary technology transfer (Motea, 2023).

Human Capital Development: To move forward, the government must invest in upskilling and reskilling the workforce (Agustin et al., 2022). Academic institutions are crucial partners in this effort, as they are responsible for incorporating Internet of Things concepts into their curricula and supporting extension services that help bridge the knowledge gap. Programs like the Digital Farmers Program can play a vital role in this endeavor (Motea, 2023; Agustin et al., 2022).

Future Research Imperatives: The existing literature suggests that researchers should go beyond feasibility studies and conduct empirical research to establish baselines for Internet of Things readiness and viability in various regional contexts (Motea, 2023; Bithay et al., 2025). In addition, further technical research focused on system optimization is necessary to reduce latency and minimize energy usage for sustainable long-term deployments. This approach will ensure that future solutions are both technologically advanced and economically viable (Aguinaldo & Sicam, 2025).

5. Conclusion

This scoping review offers a comprehensive overview of the Internet of Things and its potential to transform the Philippine public sector. While the initial promise is significant—evidenced by impactful pilot projects in public health and e-governance—the journey towards a fully integrated "Smarter Philippines" faces challenges due to widespread infrastructure issues and critical gaps in human capital.

To effectively harness the development and transformative capabilities of the Internet of Things, policymakers and stakeholders must transition from an ad hoc approach to systematic implementation and institutional reinforcement. This requires three interconnected measures:

Sustained Infrastructure and Fiscal Commitment: The government must tackle the fundamental connectivity issue by increasing investment in complex infrastructure (such as internet and network access) and Information and Communications Technology (ICT) networks. This investment is necessary to close the digital divide.

Institutionalizing Standards and Accountability: Adherence to national and international standards, such as ISO 37122 metrics, should be formalized and integrated into existing performance mechanisms, such as the Seal of Good Local Governance. This will help standardize smart city readiness across local government units.

Aggressive Human Capital Development: The education and training systems must be designed to produce a skilled, adaptable workforce. This involves forming strong academic-industry partnerships and expanding initiatives like the Digital Farmers Program to cultivate the next generation of information technology professionals and data scientists.

By prioritizing these foundational and institutional measures, the Philippines can effectively use the Internet of Things to create a more responsive, efficient, and inclusive government that is competitive in the era of the Fourth Industrial Revolution.

6. References

Aguinaldo, B. E., & Sicam, A. M. (2025). Design and implementation of an IoT-OL trap for community-based dengue early warning system. *Journal of Biodiversity and Environmental Sciences*, *26*(3), 81-87. https://acortar.link/2Zswzh

Agustin, E. B., Alcaraz, H. A., & Bristol, D. (2022). The Emergence of Disruptive Smart Farming Technologies in the Philippine Agriculture Under the New Normal. *International Journal of Progressive Research Science and Engineering*, *3*(3), 23-32. https://journal.ijprse.com/index.php/ijprse/article/view/510

Al-Ansi, A. M., Garad, A., Jaboob, M., & Al-Ansi, A. (2024). *Elevating E-Government: Unleashing the Power of AI and IoT for Enhanced Public Services*. Heliyon. https://doi.org/10.1016/j.heliyon.2024.e40591

Alhalafi, N., & Veeraraghavan, P. (2019). Privacy and Security Challenges and Solutions in IOT: A review. *2019 International Conference on Smart Power & Internet Energy Systems.* IOP Conference Series: Earth and Environmental Science. https://doi.org/10.1088/1755-1315/322/1/012013

Aminah, S., & Saksono, H. (n.d.). Digital Transformation of the Government: A Case Study in Indonesia. *Jurnal Komunikasi: Malaysian Journal of Communication, 37*(2). https://doi.org/10.17576/JKMJC-2021-3702-17

Bithay, L. L., Aranas, A. L., Aranas, T. L., & Armas, K. L. (2025). *Developing a smart city framework for Philippine LGUs: A policy-driven approach to digital transformation*. Edelweiss Applied Science and Technology. https://doi.org/10.55214/2576-8484.v9i7.8998

Capuno, R., Suson, R., Suladay, D., Arnaiz, V., Villarin, I., & Jungoy, E. (2021). Digital citizenship in education and its implications. *World Journal on Educational Technology Current Issues, 13*(1). https://doi.org/10.18844/wjet.v14i2.6952

Dadios, E. P., Culaba, A. B., Albert, J. G., Paqueo, V. B., Orbeta, A. C., Serafica, R. B., Bandala, A. A., & Bairan, J. C. A. C. (2018). Preparing the Philippines for the Forth Industrial Revolution: A Scoping Study. https://www.econstor.eu/handle/10419/211030

Fu, K., Kohno, T., Lopresti, D., Mynatt, E., Nahrstedt, K., Patel, S., Debra, R., & Zorn, B. (2020). *Safety, Security, and Privacy Threats Posed by Accelerating Trends in the Internet of Things*. Computers and Society. https://doi.org/10.48550/arXiv.2008.00017

Huffman, B. D. (2017). E-Participation in the Philippines: A Capabilities Approach to Socially Inclusive Governance. *eJorunal of eDemocracy & Open Government*, *9*(2). https://doi.org/10.29379/jedem.v9i2.461

Jou, Y.-T., Mariñas, K., Saflor, C., Baleña, A., Gutierrez, C., Dela Fuente, G., Mauren Manzano, H., Tanglao, M. S., Verde, N. A., Alvarado, P., & Young, M. N. (2024). Investigating Various Factors Influencing the Accessibility of Digital Government with eGov PH Mobile Application. *Sustainability*, *16*(3). https://doi.org/10.3390/su16030992

Kato, G. A., Yamongan, J. S., Manao, J. N., Arcega, R. A., Espino, R. E., Capili, R. D., & Magsumbol, J.-A. V. (2022). Emerging Technologies in the Philppines: Internet of Things (IoT). *Proceedings of the 5th International Conference on Intelligence Computing and Optimization* (pp. 300-308). Springer Nature Link. https://doi.org/10.1007/978-3-031-19958-5_28

Kaur, J., Santhoshkumar, N., Nomani, M., Sharma, D., Maroor, J., & Dhiman, V. (n.d.). Impact of Internets of Things (IOT) in retail sector. *Materialstoday: Proceedings*, 51. Elsevier. https://doi.org/10.1016/j.matpr.2021.04.246

Lee, M., & Gambiza, J. (2022). The Adoption of Conversion agriculture by smallholder famers in southern Africa: A Scoping Review of Barriers and Enablers. *Journal of Rural Studies*, 92, 214. https://doi.org/10.1016/j.jrurstud.2022.03.031

Mercurio, D. I., & Hernandez, A. A. (2022). *An Open Data and Geo-based Information Systems*. Information Retrieval. https://doi.org/10.48550/arXiv.2201.12544

Moradpour, Z., Barik, A., Jorjani, G., Taherian, M., Tousizadeh, S., Halimi, A., Soleimani, Y., Karimian, M., Khavari, T., Azizi Kalankari, F., Asadipour, F., Azari, M., Yousefzadeh Shakouri, N., Karamian, S., Bahari, N., & Mosavi Jarrani, A. (2025). Prostate Cancer incidence and morality linked to metalworking fluid exposure: a systematic review and meta-analysis. *Front. Oncol*, 14. https://doi.org/10.3389/fonc.2024.1491159

Motea, W. V. (2023). The Dawn of a Connected Province: A Review of the Internet of Things (IoT) Landscape in Pangasinan. *Southest Asian Journal of Science and Technology*, *8*(1). https://www.sajst.org/online/index.php/sajst/article/view/338

Obiso, J.-J. A., Himang, C. M., Ocampo, L. A., Bongo, M. F., Caballes, S. A., Abellana, D. M., Deocaris, C. C., Padua, R., & Ancheta Jr., R. (2019). Managemnet of Industry 4.0 - reviewing intrinsic and extrinsic adoption drivers and barriers. *International Journal of Technology Management*, 210-255. https://doi.org/10.1504/IJTM.2019.105310

Panganiban, G. F. (2018). E-governance in agriculture: digital tools enabling Filipino farmers. *Journal of Asian Public Policy*, *12*(1), 51-70. https://doi.org/10.1080/17516234.2018.1499479

Paradina, R. M., & Noroña, M. I. (2021). Applications and Challenges of Adopting Internet of Things (IoT) in Reducing Road Traffic Accidents. In *Proceedings of the Second Asia Pacific International Conference on Industrial Engineering and Operations Management* (pp. 1210-1230). Surakarta: IEOM Society International. https://ieomsociety.org/proceedings/2021indonesia/204.pdf

Saadé, R., Zhang, J., Wang, X., Liu, H., & Guan, H. (2023). Challenges and Opportunities in the Internet of Intelligence of Things in Higher Education—Towards Bridging Theory and Practice. *Internet of Things, 4*(3). https://doi.org/10.3390/iot4030019

Shah, A., Archarya, H., & Pal, A. (2015). *Cells in the Internet of Things*. arVix. https://doi.org/10.48550/arXiv.1510.07861

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Moher, D., Peters M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang Ch., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, Ch., Lewin, S., Godfrey, Ch. M., Macdonald, M. T., Langlois, E. V., Soares-Weiser, K., Moriarty, J., Clifford, T., Tunçalp, Ö., Straus, S. E. (2018). *PRISMA extension for scoping reviews*. Annals of Internal Medicine. https://doi.org/10.7326/m18-0850

Vujko, A., Knežević, M., & Arsić, M. (2025). *The Future Is in Sustainable Urban Tourism: Technological Innovations, Emerging Mobility Systems and Their Role in Shaping Smart Cities*. Urban Sci. https://doi.org/10.3390/urbansci9050169

Wirtz, B. W., Weyener, J. C., & Schichtel, F. T. (2019). An integrative public IoT framework for smart government. *Government Information Quarterly*, *36*(2), 333-345. https://doi.org/10.1016/j.giq.2018.07.001

Yasay, J. R. (2021). Internet of Things in the Philippine Agribusiness. *International Journal of Advanced Research in Science, Communication and Technology, 6*(1), 518-525. https://doi.org/10.48175/IJARSCT-1409

Yoshida, M., Theeraroungchaisri, A., Thammetar, T., & Khlaisang, J. (2021). Exploring MOOCs That Promote Innovative Public Services. *Sustainability*, *13*(24). https://doi.org/10.3390/su132413939

Ziegeldorf, J., Morchon, O. G., & Wehrle, K. (2013). *Privacy in the Internet of Things: Threats and Challenges*. Security and Communication Networks. https://doi.org/10.1002/sec.795

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