

## **Harnessing Internet of Things for a Community Development Program of Higher Education Institutions towards Society 5.0 Integration: A Review**

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### **ABSTRACT**

This review examines how the Internet of Things (IoT) can strengthen the community development programs of Higher Education Institutions (HEIs) through the lens of Society 5.0—a human-centered, technology-driven vision that leverages innovation to address social challenges. Positioned within the broader shift toward Community 5.0, the study explores how IoT, alongside AI, blockchain, and data-driven systems, can enhance inclusivity, sustainability, and well-being in community engagement initiatives. Guided by the DNA Community 5.0 Framework, the review employs categorization, initial outcome mapping, and quality assessment to synthesize published and unpublished literature on Society 5.0, IoT, community development, and Information and Communication Technology (ICT). Findings highlight the potential of integrating IoT with blockchain to support secure, interoperable community-based applications, though further research is needed on wireless networking and AI-driven optimization. The study also demonstrates how Human-Centered Design and the Web Engineering Process Framework can be embedded into HEI extension programs to ensure that technological solutions remain responsive to community needs. The resulting Community 5.0 Conceptual Framework positions HEIs as key enablers of societal transformation, aligning institutional CSR mandates with long-term, technology-supported and sustainable community empowerment.

### **RESUMO**

Esta revisão bibliográfica apresenta estudos em que a Internet das Coisas (IoT), uma rede de dispositivos inter-relacionados que conectam e trocam dados, é integrada aos programas de desenvolvimento comunitário de Instituições de Ensino Superior (IES) nas Filipinas. À medida que transitamos para a Sociedade 5.0, uma sociedade centrada no ser humano assistida por tecnologias digitais, é imperativo avaliar como a inteligência artificial, o blockchain e o big data usados em sistemas comunitários têm incentivado a autossuficiência e a eficiência nas comunidades. Sessenta e duas publicações recentes sobre este tópico foram selecionadas com base nos critérios de expertise de autoria, qualidade do desenho da pesquisa e citações, incluindo impacto geral de bancos de dados de pesquisa proeminentes. Esta pesquisa complementa as defesas para fortalecer os meios de implementação e revitalizar a parceria global para a tecnologia de desenvolvimento sustentável. Além disso, também contribui para o objetivo mais amplo de integrar os princípios da Sociedade 5.0 nas IES, alinhando-se com as políticas nacionais que enfatizam o papel das universidades no crescimento econômico e no desenvolvimento comunitário.

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## Introduction

Almost a decade ago, the Internet of Things (IoT) became widely recognized across the globe, revolutionizing the way devices communicate and interact. It has since played a transformative role in various sectors by enabling wireless communication between computer hardware and networks. Through Wireless Communication Protocols (WCPs), the seamless integration of Internet Protocols (IPs) has allowed for the creation, processing, and management of real-time information, enhancing efficiency and innovation in everyday systems. According to Kassab et al. (2020), IoT applications have found their way into numerous fields such as healthcare, smart shopping, customer support, home automation, environmental monitoring, and industrial systems demonstrating IoT's vast and increasing potential. Given these applications, the author aims to harness the power of IoT in this major project as a key technology for achieving sustainable and inclusive community development.

In alignment with the Commission on Higher Education Memorandum Order No. 2 Series of 2016 (CHED CMO No. 2 S2016), and pursuant to Republic Act 7722, Philippine higher education institutions (HEIs) are envisioned not only as centers for academic excellence and cultural preservation but also as vital agents of national progress. HEIs are called to take on broader responsibilities as research and development hubs, as catalysts for innovation, and as key participants in building a globally competitive human capital. It is within this framework that HEIs are encouraged to actively design and implement community-based programs that extend their knowledge and technological capacity to address real-world social challenges.

Moreover, HEIs are mandated to collaborate with local communities to promote empowerment and self-sufficiency through inclusive programs. Frias, H.S., et al. (2025) Through community engagement and service-learning initiatives, universities create opportunities for learners to apply theoretical knowledge to real-world situations while fostering empathy, leadership, and civic participation. These programs serve as dynamic platforms where academic learning meets community service, allowing students to gain hands-on experience, develop essential skills, and contribute meaningfully to society. Gavino and Panganiban (2023) The community extension program and outreach activities act as a bridge between the community and the university. It is the channel a higher education institution expands its competence under its program. As volunteers use their discipline knowledge to address issues in the real world, there is a growing understanding of the benefits of higher education extension on the teaching and learning process. Through this lens, partnerships between educational institutions and communities are viewed not as one-way engagements but as reciprocal relationships that foster mutual development.

To elevate these community extension programs to a new level of relevance and innovation, this study seeks to integrate Society 5.0 sometimes referred to in its local or context-driven application as Community 5.0 into the design and implementation of higher

education outreach initiatives. Society 5.0 is a human-centered vision of the future proposed by the Japanese government, where technological innovation is not pursued for its own sake, but rather to solve pressing social issues and improve quality of life for all people. Kale (2025) Unlike Industry 4.0, which centers on automation and the digital transformation of manufacturing, Society 5.0 envisions a “super-smart society” that puts humans at the heart of technological advancement. This includes the use of AI, robotics, big data, blockchain, and especially IoT not to replace human activity, but to enhance inclusivity, sustainability, and well-being across all layers of society.

Community 5.0, as a localized application of Society 5.0 principles, emphasizes the use of emerging technologies to foster intelligent, responsive, and compassionate communities. It encourages stakeholders especially HEIs to integrate digital technologies into the fabric of local development, ensuring that no member of society is left behind in the digital age. For example, through IoT, HEIs can build data-driven systems to monitor health, environmental conditions, education delivery, and resource management in underserved communities. In turn, these smart solutions can empower community members to make informed decisions, access better services, and participate actively in their own development.

As Stahl, B. C. (2023) Digital transformation must be accompanied by ethical considerations and responsible innovation to ensure technologies benefit society and promote sustainable development. Yet, as Dluhopolskyi, O., et al. (2024) Society 5.0 represents a model integrating advanced technologies with human-centred values to create a more sustainable and inclusive society.

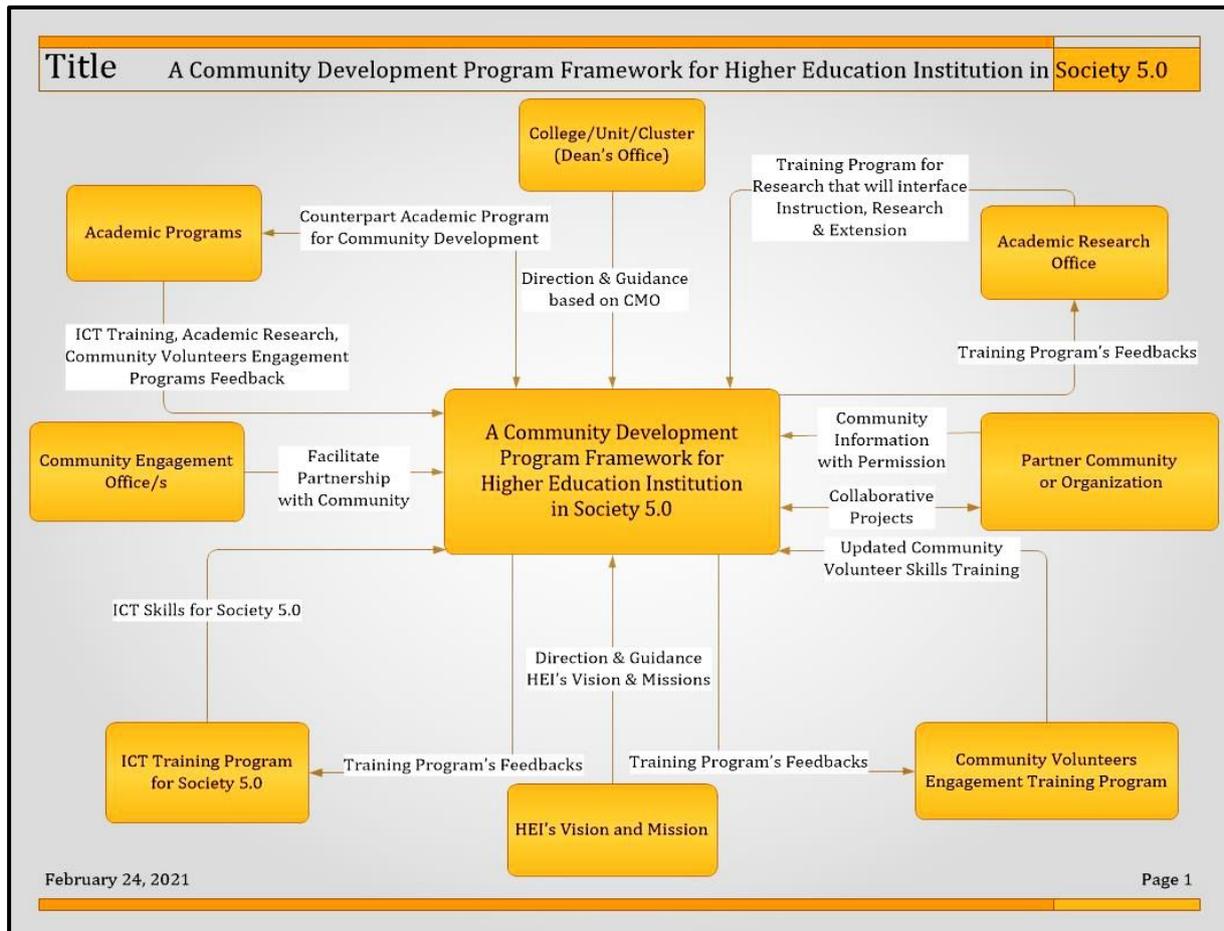
Therefore, the general objective of this paper is to critically review recent literature on IoT and its role in developing community-based systems for higher education institutions, in alignment with the principles of Society 5.0. This study explores both published and unpublished resources that focus on Society 5.0, IoT, community development, higher education, and ICT. It also builds upon the author’s earlier works “A Community Development Program Framework for Higher Education Institutions in Society 5.0” and “Blockchain as a Baseline Technology for Community Development Program of Higher Education Institutions in Society 5.0: A Literature Review” with the goal of shaping a future where HEIs act as the bridge between innovation and inclusive, empowered communities.

## **Methodology**

To further pursue the author’s main objective, the researcher built upon the previous work, the DNA Community 5.0 Framework as shown in figure 1, by utilizing a comprehensive set of reviewed literature. This literature set included sixty-two (62) recently published and unpublished journals, books, and articles. In this methodology, quotation statements related to Society 5.0, the Inter

net of Things (IoT), higher education institutions (HEIs), human-centered design, and community development programs (CDPs) were carefully examined and analyzed. This approach ensured a thorough evaluation of relevant concepts and perspectives from both established and emerging sources.

**Figure 1.**  
DNA Community 5.0 Framework (De Guzman, 2025)



**Categorization**

Data collection for this study involved a systematic filtering process, wherein relevant information was identified using specific keywords. The keywords utilized included “Society 5.0,” “Internet of Things (IoT),” “Community Development,” “Higher Education Institutions,” and “Information and Communication Technology (ICT).” These keywords were carefully selected based on a thorough review of the literature to ensure their relevance and alignment with the research objectives.

Prior to the actual data gathering, the chosen keywords were encoded into a Microsoft Form, which served as a standardized tool for organizing and capturing data entries. This approach facilitated a more structured and efficient screening process, allowing the

researchers to consistently identify and select studies and resources that matched the thematic focus of the research. By employing these pre-determined keywords and utilizing a digital form, the study ensured both the reliability and replicability of the data filtering process.

### ***Initial Outcomes***

The data encoded in the form was meticulously sanitized by cross-checking it against the original papers to ensure accuracy and correctness of the content. To prepare for quality assessment, the data was substantially reduced to include only the most critical key statements. Leveraging ICT tools such as spreadsheet software, the author constructed comprehensible tables that were ready for quality assessment. This allowed the researcher to effectively demonstrate the importance of IoT in developing a community-based system within higher education institutions for Society 5.0.

### ***Quality Assessment and Final Outcome***

According to Taylor et al. (2020), part of the methodology of the research is the quality assessment. The author checks the relevancy of each quotation statement in every paper filtered during the categorization process to align with the research objectives. However, instead of analyzing all sixty-two (62) papers, the researcher selectively identified the most insightful literature and significant quotations during categorization.

Moreover, the researcher independently and carefully analyzed all quotation statements for their relevancy to the research objectives (De Guzman, 2025). Traditionally, potential researchers had to painstakingly read, collect, and study all reference materials before conducting a substantive review of related literature. After gathering a substantial review of related literature, researchers analyze further to develop a framework or determine essential tools that contribute to achieving the main goal of integrating "Society 5.0" into Higher Education Institution's Community Development Program.

## **Results and Discussion**

### ***Categorization Results***

Table 1 presents the twenty-two (22) filtered papers, including their titles, authors, copyrights, and keywords. These filtered papers serve as the foundation for the results and analysis in this literature review. It is important to carefully examine these papers in relation to the general objective of the study. A key consideration is the number of quoted statements in each research paper; the greater the number of quoted statements, the more significant the paper's contribution to the review.

**Table 1.** Titles and other details of IoT filtered papers

No	Complete Title of Research	Author/s	Year of Publication
1	Internet of Things for Sustainable Community Development Wireless Communications, Sensing, and Systems	Giancarlo Fortino, Rende, Antonio Liotta, Edinburgh	2020
2	Society 5.0: For Human Security and Well-Being	Serpanos, Dimitrios	2018
3	A literature review: efficacy of online learning courses for higher education institutions using meta-analysis	Castro, Mayleen Dorcas B.	2019
4	A Systematic Literature Review of Blockchain Cyber Security	Taylor, Paul J., Dargahi, Tooska, Dehghantanha, Ali, Parizi, Reza M.,	2019
5	A systematic literature review on the Internet of things in education: Benefits and challenges	Kassab, Mohamad, DeFranco, Joanna, Laplante, Phillip	2019
6	Blockchain in agriculture	Kalimaris, Andreas, Cole Ian, Prenafeta-Boldú, Francesc X.	2018
7	Blockchain Security as "People Security": Applying Sociotechnical Security to Blockchain Technology	Nabben, Kelsie	2021
8	Blockchain and IoT-based architecture design for intellectual property protection	Lin, Jun, Long, Wen, Zhang, Anting, Chai, Yueting	2020
9	Blockchain for the Internet of Things: a Systematic Literature Review	Conoscenti, Marco, Vetro, Antonio, De Martin, Juan Carlos	2016
10	Blockchain implementation for IoT devices, Blockchain of Things	Pavlovic, Nikola, Sarac, Marko	2021
11	Blockchain technology in the future of business cyber security and accounting	Demirkan, Sebahattin, Demirkan, Irem, McKee, Andrew	2020
12	Impact of lot on social innovation in Japan	Temitayo, Shenkoya, Cho Dae-Woo	2019
13	Information Security in Higher Education: A Neo-Institutional Perspective	Hwee-Joo, Kam, Pairin, Katerattanakul	2014
14	Internet of Things and supply chain management: a literature review	Ben-Daya, Mohamed, Hassini, Elkafi, Bahroun, Zied	2017
15	Internet of Things: Architecture, Applications and Challenges	Hussain, Mubashir, Saqib, Mohammad	2021
16	Sustainability Strategy in Higher Education Institutions: Lessons learned from a nine-year	Ramisio, Paulo J., Costa Pinto, Ligia M., Gouveia, Nuno, Costa,	2019
17	Total Quality Management & Business Excellence	Manatos, Maria J., Sarrico, Cláudia S., Rosa, Maria J.	2015
18	IoT Community Technologies: Leaving Users to Their Own Devices or Orchestration of Engagement?	Balestrini, M., Diez1, T., Marshall, P., Gluhak, A., Rogers, Y.	2015
19	The Model of State Management of Economy on the Basis of the Internet of Things	Popkova, Elena G.	2019
20	IoT information sharing security mechanism based on blockchain technology	Si, Haiping, Sun, Changxia, Li, Yanling, Qiao, Hongbo, Shi, Lei	2019
21	Society 5.0: balancing of Industry 4.0, economic advancement and social problems	Vojko Potocan, Matjaz Mulej and Zlatko Nedelko	2020
22	IT Governance in Higher Education Institutions: A Systematic Literature Review	Khouja, Medhli, Rodriguez, Ismael, Bouassida, Halima, Youssef Ben.	2018

### **Initial Outcomes and Selection of Significant Papers**

The analysis of Table 2 highlights the categorization of filtered papers based on the number of quoted statements. Specifically, this process identified papers with more than three (3) quoted statements, which were considered more significant in contributing to the objectives of the study. As a result, nine (13) out of the twenty-two (22) filtered papers were determined to be highly significant. These papers stand out due to their substantial content and relevance, providing valuable insights that align closely with the study's focus on Internet of Things (IoT), and their integration into community development programs of higher education institutions with Society 5.0.

**Table 2a. Titles and other details of IoT filtered papers**

No	Complete Title of Research	Quotation Statement 1	Quotation Statement 2	Quotation Statement 3
1	Internet of Things for Sustainable Community Development Wireless Communications, Sensing, and Systems	The Internet of Things has strong potential to foster the creation of these cross-disciplinary next-generation sensing and communication systems using IoT.	The research in Internet of Things for sustainability has a vital role to play in shaping the future of our community as they must create a research and education ecosystem promoting impactful solutions-oriented science to help citizenry, government, industry, and other stakeholders work collaboratively to make informed, socially responsible, science-based decisions. CPS can bridge different sectors, countries, regions, and societies that otherwise tend to be divided.	This IoT approach in energy systems is envisioned to enhance the bidirectional interchange of network services in grid by using Internet of Things in grid that will result in enhanced system resilience, reliable data flow, and connectivity optimization.
2	Society 5.0: For Human Security and Well-Being	The Japanese Cabinet's Society 5.0 initiative envisions the creation of a Super Smart Society—a sustainable society where various types of values are connected through CPS and where people can live in safety, security, and comfort.		The key to implementing Society 5.0/SDGs is that stakeholders share and address the challenges together by fully utilizing the potential of CPS.
3	A literature review: efficacy of online learning courses for higher education institutions using meta-analysis	Online learning programs are an important strategy to improve course access and flexibility in a higher education institution, especially in universities, with benefits from both the student perspective and the institutional perspective.	From the student perspective, the convenience of online learning is particularly valuable to adults with multiple responsibilities and highly scheduled lives; thus, online learning can be a help to workforce development, helping adults to return to school and complete additional education that otherwise could not fit into their daily routines.	From an institutional perspective, online modalities allow colleges to offer additional courses or course sections to their students, increasing student access to required courses. Finally, to maintain or increase enrolments, universities must be responsive to the needs and demands of their students and believe that their students need the flexibility of online learning
4	A systematic literature review on the Internet of things in education: Benefits and challenges	The advances in sensors, nanoelectronics, smart objects, cloud computing, Big Data, and communication on a wide scale will make innovation continuous in IoT, and it will clout a great number of domains.	The education domain is not an exception. Although IoT in education is a new conceptual paradigm and it is still in its starting phase, IoT is set to transform the education domain in many ways in the near future.	We also argued that the potential of IoT to improve educational outcomes needs to be moderated with attention to the important challenges uncovered in this literature review, that is, security issues, scalability of solutions, and humanization of the delivery system.

5	Information Security in Higher Education: A Neo-Institutional Perspective	Regrettably, several cases of data leakage have occurred at higher education institutions in the United States.	Regrettably, several cases of data leakage have occurred at higher education institutions in the United States.	These external pressures may serve as a powerful force driving higher education institutions in the United States to attain information security.
6	Internet of things and supply chain management: a literature review	Internet of Things (IoT), one of the latest IT developments, is a new IT revolution providing a paradigm shift in several areas including SCM.	The Internet of Things is a network of physical objects that are digitally connected to sense, monitor and interact within a company and between the company and its supply chain enabling agility, visibility, tracking and information sharing to facilitate timely planning, control and coordination of the supply chain processes.	Ferreira, Martinho, and Domingos (2010) defined the logistics functions of different internet of things in terms of identifying, tracing, location tracking, monitoring, real-time responsiveness and optimization.
7	Internet of Things: Architecture, Applications and Challenges	Internet of Things, a system of interconnected devices, was first coined by Kevin Ashton in 1999.	Rather to run from machine to machine giving them commands to do work, with the intervention of the internet of things these devices can interact, collaborate and learn from the experiences of one another just like humans do. As a result, Sustainability Values need to be incorporated in Higher Education Institutions' mission and practice.	Internet of Things equips a multitude of domains and millions of devices with connectivity every day
8	Sustainability Strategy in Higher Education Institutions: Lessons learned from a nine-year case study	Higher Education Institutions have the vision, the knowledge and the power to lead this transition, and to induce the changes towards this new paradigm.	As a result, Sustainability Values need to be incorporated in Higher Education Institutions' mission and practice.	Based on the findings it is possible to derive some important lessons for the implementation of Sustainability Strategies in Higher Education institutions.
9	Total Quality Management & Business Excellence	Theoretically, we believe this second point to be a general trend in the evolution of the quality management literature, and empirically it represents a trend for quality management principles and practices in governance and management systems of		

***Quality Assessment and Final Outcome: Conceptual Framework of Integrating “Society 5.0” in Higher Education Institution’s Community Development Program (Community 5.0 Framework)***

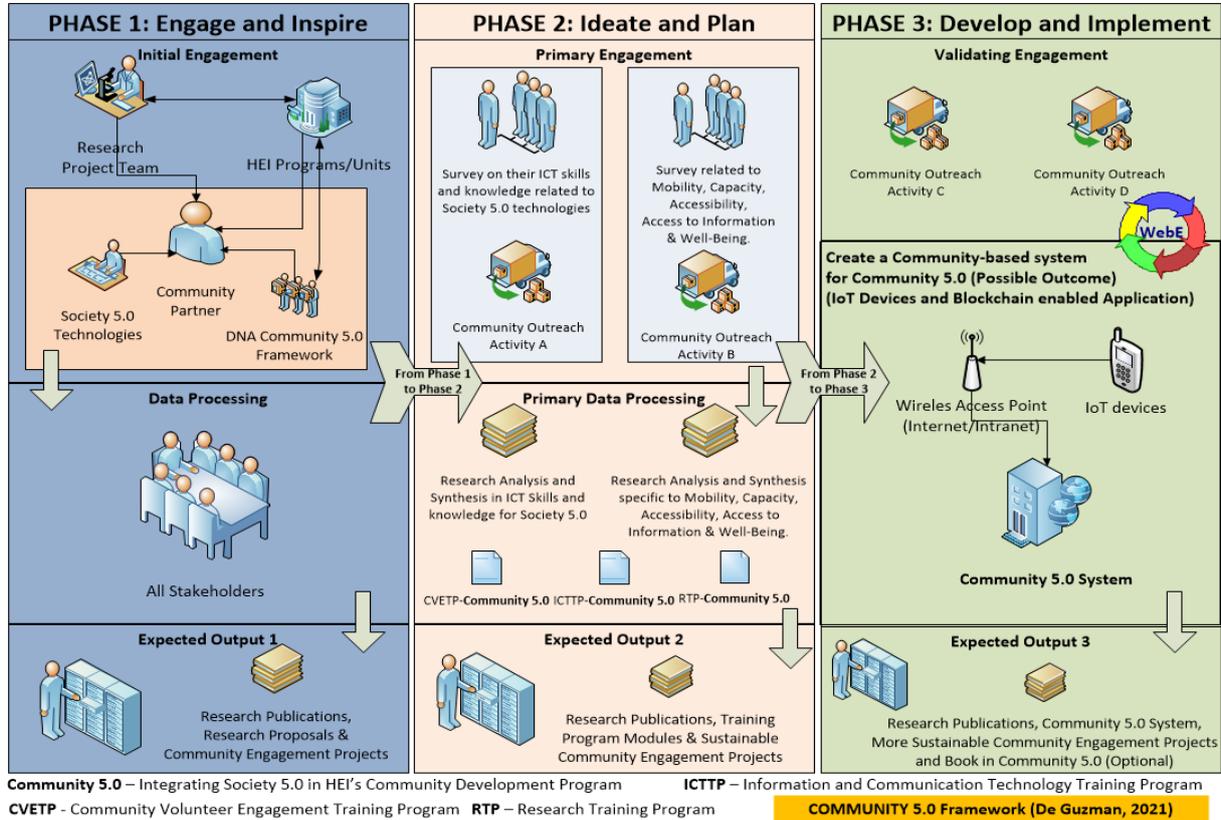
Using the two previous research studies by the author titled A Community Development Program Framework for Higher Education Institutions in Society 5.0 (DNA Community 5.0 Framework) and Blockchain as a Baseline Technology for Community Development Program of Higher Education Institutions in Society 5.0: A Literature Review, and pursuing the main goal of integrating "Society 5.0" into Higher Education Institutions' (HEI) Community Development Programs, this conceptual framework was established with the support of this literature review.

Using Design Thinking’s Human-Centered Design (HCD) Framework as a base, the author developed the framework presented in Figure 2. This structured framework integrates

Society 5.0 principles into HEIs' community development programs, divided into three phases: Engage and Inspire, Ideate and Plan, and Develop and Implement.

**Figure 2.**

**Community 5.0 Framework**



**Phase 1: Engage and Inspire**

The primary objective of this phase is to engage HEI programs and units with partner communities to better understand the needs of both parties in integrating Community 5.0. This phase consists of two sub-phases: initial engagement and data processing.

In this phase, the Research Project Team collaborates with HEI programs/units and community partners to introduce the concept of Community 5.0 using ICT tools from Society 5.0. Stakeholders collectively process gathered data, resulting in research publication, research proposals based on their areas of expertise and community engagement projects. The primary output includes these proposals. Additionally, the Research Project Team conducts a minimum three-day, two-night immersion to gain insights into real community challenges and establish sustainable partnerships with HEIs.

**Phase 2: Ideate and Plan**

This phase involves primary engagement through surveys assessing ICT skills related to Society 5.0 (Community Outreach Activity A) and aspects such as mobility, accessibility, access to information, and well-being (Community Outreach Activity B). The data is processed

through research analysis and synthesis, which is more extensive compared to Phase 1's data processing activities. Outputs include two quantitative research studies based on Activities A and B and three training program modules: Community Volunteer Engagement Training Program (CVETP), Information and Communication Technology Training Program (ICTTP), and Research Training Program (RTP). These modules are used by HEIs and partner communities as prerequisites for research projects. Additional research proposals may also emerge from this sub-phase. These training modules are based on prior research conducted by De Guzman et al. (2025).

### ***Phase 3: Develop and Implement***

Engagement activities are validated through additional outreach efforts (Activities C and D), leading to the development of a community-based system for Community 5.0. This system integrates IoT devices with blockchain-enabled applications supported by wireless access points for Internet/Intranet connectivity as possible outcome. Outputs include research publications documenting implementation processes and a comprehensive book summarizing the framework's outcomes. This phase systematically builds upon previous phases to achieve technological integration and community empowerment aligned with Society 5.0 principles.

As one of the foundations for creating this framework, the insights from Kamilaris et al. (2018), emphasizing how blockchain can be combined with emerging technologies like IoT to enhance automation, transparency, and traceability. Similarly, Nabben (2021) notes that blockchain can be utilized between known parties in applications such as supply chain management, banking, or IoT systems, solidifying the design of system infrastructure illustrated in Figure 2.

## **Conclusion**

Based on the conceptual framework developed, there is significant potential for blockchain technology to be integrated with the Internet of Things (IoT) to create community-based application systems. However, Pavlović and Šarac (2021) note that integrating blockchain and IoT is not a straightforward process, necessitating further review of related literature, particularly focusing on wireless networking and Artificial Intelligence (AI).

Additionally, Design Thinking's Human-Centered Design and the Web Engineering Process Framework were successfully incorporated into the conceptual framework titled Integrating Society 5.0 in Higher Education Institution's Community Development Program (Community 5.0). This integration supports the use of emerging technologies such as blockchain, IoT, and AI within HEIs' community development programs.

Moreover, since Corporate Social Responsibility (CSR) is a requirement for HEIs, many institutions align their mission and vision statements with societal impact goals. By adopting Community 5.0 Framework and integrating Society 5.0 technologies like blockchain, IoT, and

AI into their community development programs, HEIs can establish sustainable initiatives that promote long-term societal benefits.

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