International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 13 Issue: 1
Article Received: *25 July 2025* ***Revised:*** *12 September 2025* ***Accepted:*** *20 September 2025*

Digital Transformation in Local Governance: A Blockchain Framework for Barangay Awitan

Darwin S. Pajarillo
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
dsp1896@students.uc-bcf.edu.ph

David William B. Egar
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
dbe6419@students.uc-bcf.edu.ph

Allan G. Asuncion
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
aga.3378@students.uc-bcf.edu.ph

Melinda A. Beninsig
College of Information Technology and Computer Science
University of the Cordilleras
Baguio City, Philippines
mabeninsig@uc-bcf.edu.ph

Abstract—Information is one of the most important pieces of data to process and store, but some difficulties can be faced if the processing of documents still uses a manual process. Barangay Awitan in Labo, Camarines Norte, Philippines, faces challenges like delays, errors, and disorganized information. The researchers aim to automate the services of Barangay Awitan and integrate blockchain technology into their processes. To achieve the goal of the study, the researchers conducted an interview to determine the needs of Barangay Awitan for automation and a case study to determine the previous concept of automation. The researchers also used Feature-Driven Development (FDD) under the agile methodology, which is valuable for the development of the system. Finally, the researchers successfully developed a system framework to be implemented for Barangay Awitan, enhancing administrative operations, data management, communication, service delivery, and ensuring secure community information.

Keywords-blockchain, distributed ledger, local governance, smart contract

I. INTRODUCTION

Technology in this generation is very useful in our daily lives, and wherever people go, technology is always there. Through this technology, everyone can communicate with each other through the use of different gadgets that are connected to the internet or mobile data [1]. In 2021 [2], the number of mobile devices operating worldwide stood at almost 15 billion, up from just over 14 billion in the previous year. The number of mobile devices is expected to reach 18.22 billion by 2025, an increase of 4.2 billion devices compared to 2020 levels. This could be used by many people, either by the local government or the private sector. With the use of the internet, individuals can send and receive information. Information is one of the important data that is needed to be kept and processed in the fastest way [3], but how could it be if the processing of information is done by manual input? This could be one of the challenges that Barangay Awitan, a local community located in the municipality of Labo, Camarines Norte, Philippines, faces. They face a challenge in terms of delays in delivering and receiving information, errors in input data through handwritten, disorganized resident information, and difficulties in accessing critical information written in the paper or logbook to deliver effective services in their residence.

Labo is a municipality situated in the province of Camarines Norte, which is part of the Bicol Region in Luzon. Awitan is also the smallest political and administrative unit in the Philippines and serves as the foundation of the country's local governance system. Based on the researcher's investigation, many barangays are now using technology to improve their services to their communities. Therefore, the researchers aim to enhance the process of requesting documents and storing information in barangay Awitan by identifying different processes that need improvement and developing a system framework that the barangay Awitan can use with the integration of blockchain technology.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 13 Issue: 1
Article Received: *25 July 2025* ***Revised:*** *12 September 2025* ***Accepted:*** *20 September 2025*

II. Related Literature

The paper [4] presents a conceptual framework for understanding the future of government and technology, focusing on a dynamic socio-technical system that includes societal trends, human elements, changing technology, information management, complexity, and the purpose and role of government, requiring a more holistic and flexible perspective.

The term "electronic government" emerged in the 1990s [5], coinciding with the rise of the internet. It was initially used to describe modern, future-oriented initiatives supported by information and communication technology (ICT). The term has evolved over time, with definitions aiming to modernize government, foster participation, and improve services using ICTs. The multidisciplinary study domain of e-government has grown since its inception [6], encompassing public administration, information technology, and stakeholder needs. Despite its multidisciplinary nature, the domain has been recognized by contributing disciplines like public administration, political science, management information systems research, information science, and human-computer interaction research. Despite the challenges of different standards of inquiry and publication norms, e-government has established a well-respected academic footprint and high-quality research reputation.

This paper presents a prototype of NFTs [7], which can store software applications on blockchain technology [8], allowing developers to store and utilize them decentralized while rewarding them for their achievements, addressing the challenges faced by developers in Pakistan. However, the proposed study by the researchers only stores valuable information from the community of Barangay Awitan.

CCTV cameras and black boxes are crucial for road safety and accident management [9]. However, security and data integrity [10] concerns arise due to the storage methods. Blockchain technology can address these issues, but the cost is prohibitively expensive. A decentralized IPFS [11] and blockchain-based application are proposed for distributed file storage. The application uploads files, stores hashes on the Ethereum blockchain [12], uses smart contracts [13], and includes a keyword search feature. The DApp is resilient to system failure while preserving data transparency and integrity due to blockchain's immutability. Additionally, another study proposes an Ethereum blockchain-based intellectual property authentication scheme with privacy protection [14]. It combines elliptic curve cryptography with digital signatures for selective encryption of user information. The authentication algorithm uses Zero-Knowledge Succinct Non-Interactive Argument of Knowledge, and the InterPlanetary File System (IPFS) for storage.

Lastly, this study of the Internet of Things (IoT) [15] describes a network of interconnected smart devices that communicate over the internet. However, they pose security and privacy threats. This research proposes a solution using blockchain technology [16], a decentralized technology that adds blocks at the end of the chain, ensuring a secure network without a single point of failure. All in all, the proposed system by the researchers also used blockchain technology to store the data of Barangay Awitan in a secure network that could also lead to innovation.

III. Methodology

The researcher used Feature-Driven Development (FDD) under the agile methodology. It is an agile software development framework that organizes work around product features, and FDD is known for its short iterations and frequent releases [17]. FDD has four components: Develop a model, Build a list of features, Plan out each feature, Design and build each feature.

A. Develop a model

In this stage, the researcher creates a plan for how the project is built. Based on the problems and objectives that the researchers identified, they determined the scope of the project, as shown in Fig. 1, an architecture of the proposed system. Every user is required to register or create an account through the system. After completing registration and successfully logging in to the system, users can now view the dashboard and make requests for documents that they need. The requested documents of the users are recorded in the cloud and stored on the database server. The administrator will assess the requested documents of the user, then, using blockchain, verify and store the data of the user, and each transaction will be recorded in a distributed ledger. The smart contract will perform once the requested documents of the user are successful and verified by the administrator.

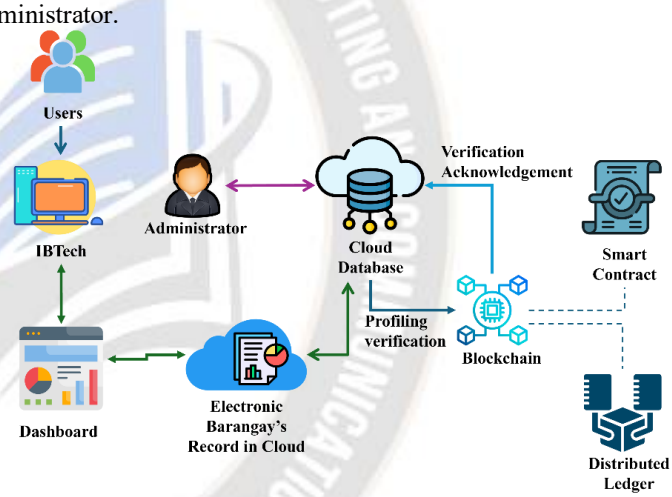

Figure 1. System architecture of the proposed system.

B. Build a list of features

This stage is a process of listing all features in the system, such as Dashboard, Resident Management, Resident Registration and Account Creation, News & Updates, Plans and Programs, Assets, Barangay ID, Certificate Issuance, Workforce, Lupon, Barangay Officials, Tanod, Workforce, 4Ps, Household, Finance, Settlement Schedule, Clearance, Health Worker, Blotters Record, Blotters Documents, Settings, Account Setting, Barangay Settings. Additionally, integrated blockchain, distributed ledgers, and smart contracts are some of the research projects contributions to the innovation of the proposed system.

C. Plan out each feature

Fig. 2 depicts how many days are spent on the development of features for the proposed system. Based on the figure below, system features consume 95 days to complete the designs and functions of the system. Additionally, the additional features also consume 21 days to accomplish the functions of blockchain technology, distributed ledger, and smart contract.

International Journal on Recent and Innovation Trends in Computing and Communication
ISSN: 2321-8169 Volume: 13 Issue: 1
***Article Received:** 25 July 2025 **Revised:** 12 September 2025 **Accepted:** 20 September 2025*

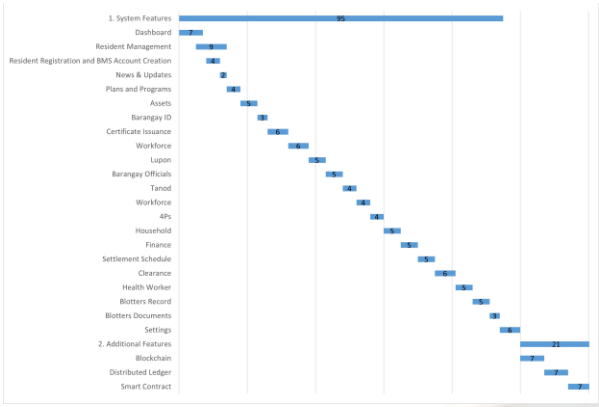

Figure 2. System design and features time allocation.

D. Design and build each feature

In this stage, the researchers provide a detailed description of the features within the framework of the proposed system:

1) Dashboard: The barangay management system's dashboard feature gives barangay authorities a convenient location to retrieve important data and carry out crucial duties effectively. In addition to providing instant access to modules like resident management and issue reporting, it provides real-time information on community activity and could have data visualizations for trend analysis. It's a complete tool that helps officials keep informed and make well-informed decisions based on facts*:*

2) Resident Management: Keep a consolidated database of all the inhabitants' personal information, contact details, and the demographics of their households, including information about their memberships in the 4Ps and Senior programs. Certificates, residency IDs, and other necessary paperwork can be produced quickly. Maintain effective records of transfers, residency status, and other relevant data system.

3) Resident Registration and Account Creation: The barangay management system allows residents to register and create accounts, requiring personal information for quick registration and setup. This process allows residents to interact with barangay services, submit permission applications, and participate in community events, ensuring easy access to resources and services while streamlining resident interaction.

4) News & Updates: Residents are kept up to date on the most recent happenings in the barangay through the "News and Updates" function of the system. Barangay leaders can disseminate vital news, forthcoming events, and community projects through this single portal. In order to encourage openness and community involvement, residents can obtain news and updates on events such as community meetings, road closures, and service interruptions.

5) Plans and Programs: The Plans & Programs feature in the system allows barangay officials to create comprehensive plans and programs for community welfare and development. It enables officials to outline objectives, allocate resources, and track progress. The feature also facilitates collaboration with stakeholders, ensuring that plans align with community needs. By utilizing this feature, barangay officials can promote sustainable development and improve the quality of life for residents.

6) Assets: The Assets feature in the system allows barangay officials to efficiently monitor and oversee their assets, including real estate and machinery. This feature allows for a thorough inventory of assets, including location, date of acquisition, condition, and depreciation. It also ensures optimal performance and longevity of assets by tracking maintenance programs and repairs. The Assets tool also allows for the creation of reports and insights on asset allocation and utilization, facilitating effective resource management and informed decision-making in the barrio. residents.

7) Barangay ID: The Barangay ID function in the system simplifies the process of providing citizens with identification cards. It allows barangay officials to create and maintain digital IDs with vital resident data, such as name, address, and unique number. These IDs serve as official proof of residency within the barrio, enabling easier access to services and amenities. The digital aspect of the ID system also enhances security and reduces the risk of fraud or manipulation compared to traditional paper-based systems.

8) Certificate Issuance: The Certificate Issuance feature of the system simplifies the process of providing official documentation to residents. It allows barangay officials to digitally create and maintain various certificates, such as permits, residence certificates, and barangay clearances. Residents can submit requests for certificates via the platform, which are then reviewed and approved by officials. The system offers easy access to digital certificates or print copies from the barangay office, reducing paperwork and saving time for both residents and officials.

9) Workforce: The Workforce feature enables barangay officials to effectively manage human resources. It offers a consolidated platform for managing employee records, including those of officials, employees, and volunteers. This component ensures effective deployment and service delivery by providing tools for work assignment, scheduling, and performance evaluation. Barrio officials can increase teamwork, optimize personnel levels, and boost overall production in the barrio by making use of this.

10) Lupon: The Lupon feature in the barangay justice system simplifies organizing and administering disputes. It provides a centralized platform for barangay officials to manage conflicts, arrange mediation sessions, handle complaints, and help parties reach agreements. The Lupon feature includes tools for case management, record-keeping, and compliance monitoring. It helps resolve problems fairly, strengthen relationships, and promote peace, harmony, and justice within the community.

11) Barangay Officials: The Barangay Officials feature of the system provides a comprehensive platform for barangay administrators to manage their elected and appointed officials, their roles, and terms of office. This feature aids in teamwork, communication, decision-making, meeting planning, responsibility allocation, and project monitoring. By utilizing this feature, administrators can ensure efficient governance,

responsibility, and transparency in fulfilling their community responsibilities.

12) Tanod: The Tanod feature of the system provides a comprehensive list of barangay tanods, community watch volunteers, and their assigned shifts. This tool enables barangay authorities to plan and coordinate patrolling and uphold law and order, ensuring adequate coverage at various times and locations. By streamlining tanod shift management, the barangay environment becomes safer and more secure.

13) Workforce: Barangay officials are assisted in effectively managing human resources using the workforce aspect of the system. It offers a consolidated platform for managing employee records, including those of officials, employees, and volunteers. The feature ensures effective deployment and service delivery by providing tools for work assignment, scheduling, and performance evaluation. This increases production, strengthens coordination, and maximizes staffing levels.

14) 4Ps: The Pantawid Pamilyang Pilipino Program (4Ps) is a barangay-based program that provides conditional cash transfers to qualifying Filipino households for health, nutrition, and education. The system's "4Ps" function allows barangay officials to manage beneficiary information, identify and validate families, handle payments, and track program participation. It also offers reporting capabilities to monitor program results and performance, ensuring accountability and efficient implementation within the barrio.

15) Household: The household function in the system centralizes data on households with multiple residents in one unit, allowing barangay officials to keep organized records of all households in the neighborhood. This data helps in understanding community needs and dynamics, organizing services, implementing initiatives, and resolving problems impacting residents. The household function also facilitates better communication and involvement with citizens, allowing barangay officials to serve and support the entire community efficiently.

16) Finance: A comprehensive solution for the effective and transparent management of barangay finances is offered by the Finance feature of the system. It enables managers to keep an eye on income collection, spending control, budget allocation, and historical data analysis. Additionally, the tool makes it possible to create balance sheets, transaction summaries, and financial reports that offer information about the barangay's financial situation. Additionally, it encourages economic responsibility and expedites income collection, guaranteeing precise financial records and wise budgetary choices.

17) Settlement Schedule: The Settlement Schedule function gives barangay authorities the ability to plan and oversee mediation sessions for the purpose of resolving disputes. Officials can use this function to set up meetings, designate mediators, and send out notifications to the parties regarding the time, date, and location. It also has tools for monitoring terms, compliance, and settlement agreements. This characteristic encourages communal harmony, peace, and reconciliation.

18) Clearance: The clearance feature of the proposed system makes it easier to give residents official clearances. Digital generation and management of several kinds of clearances, including employment, business, and barangay clearances, is made possible for barangay officials by technology. Requests for clearance can be submitted by residents, and officials will review and approve them. This ensures effective service delivery by streamlining the procedure, saving time, and minimizing paperwork.

19) Health Worker: The Health Worker feature in the system streamlines the administration of barangay-wide health worker databases, providing a single platform for barangay officials to manage and arrange health worker records. This ensures accurate and up-to-date information, improving coordination and communication with health workers, ultimately benefiting local health in the long run.

20) Blotters Record: The Blotters Record feature in the system is a central hub for recording complaints, incidents, and other significant events in the barangay. It allows officials to document the nature of incidents, the people involved, and the resolution steps. The feature also allows for case monitoring, facilitates follow-up measures, and ensures successful problem resolution. This enhances accountability, transparency, and community safety in the barangay.

21) Blotters Documents: Digital copies of incident-related papers can be centrally stored by using the system's Blotter Document feature. Barangay authorities can print tangible copies of these papers as needed, and they can access and retrieve them with ease. This feature permits authorities to keep both digital and hardcopy documents for their files or legal procedures, ensuring the integrity and accessibility of vital documentation for the efficient management of barangay affairs.

22) Settings: The platform Settings page functions as the main hub for setting up and personalizing the system to suit each user's unique requirements and preferences. This page, which is split into the Account Settings and Barangay Settings parts, gives users complete control over how the system behaves.

a) Account Setting: Users can customize their system accounts in this field by changing a variety of account-related settings. This includes changing contact information, name, and email address, among other personal data. In order to provide even more security, users can modify their account security settings, which include changing their passwords and turning on two-factor authentication. In order to improve user experience and privacy, account settings may include settings for controlling alerts, language preferences, and other account-specific parameters.

b) Barangay Settings: Administrators can modify and set up the system to meet the specific needs of their barangay through the Barangay Settings area. Setting up barangay-specific data, such as name, address, phone number, and official logo, is part of this. In addition, administrators have the ability to set up user roles, permissions, access levels, and privileges.

Users can tailor modules, workflows, and notifications to their barangay's unique requirements using the platform Settings page. This improves efficiency, transparency, and governance in the barangay by enabling effective administration and optimization of system utilization.

23) Blockchain Technology: Blockchain is a technique for storing data that makes it difficult or impossible for outside parties to alter, hack, or manipulate the system. A distributed ledger, or blockchain, is a network of computers that replicates and disperses transactions among themselves. Furthermore, a smart contract plays a significant role in the proposed system because it is a digital agreement that is signed and stored on a blockchain network. It then automatically executes when the terms and conditions of the contract are successfully verified in relation to the requested files of the residence in Barangay Awitan.

IV. Discussion

To further understand the study, it is the framework of the proposed system for Barangay Awitan located in Labo, Camarines Norte, Philippines. The researchers communicated with the barangay officials of Awitan to see the situation of their process when it comes to requesting documents for their residence and storing important data. During the process, when the residents of barangay Awitan request a document, a lot of difficulties are faced. The researchers also investigate what platforms other barangays use to enhance the process of requesting documents and storing important information about their community. Some of them use an automated system, and the other barangays are still using an old process when requesting a document and storing files, and one of them is Barangay Awitan, which still uses a manual process. Based on the investigation and analysis, the researchers decided to innovate their process with the integration of blockchain technology. The proposed system is a fully automated and innovative solution to the problems encountered by Barangay Awitan. However, the proposed system has a limitation. The proposed system requires an internet or data connection in order to store information in a blockchain.

V. Conclusions

The adoption of the barangay system has shown itself to be a revolutionary answer to the underlying reasons for inefficiency in the barrio's administrative operations. By digitizing and automating numerous operations, the suggested system can enhance data management, communication, and service delivery. Overall, the barrio system can improve the barangay's capacity to successfully serve its citizens by encouraging more structured, transparent, and responsive local government. Additionally, the information from the community of Barangay Awitan is also secure due to its integrated blockchain technology.

Acknowledgment

The author expresses gratitude to the University of the Cordilleras for the research affiliation and the support provided by CHEDRO5-SIKAP Grants is greatly appreciated.

References

[1] A. Aijaz, H. Aghvami and M. Amani, "A Survey on Mobile Data Offloading: Technical and Business Perspectives," in IEEE Wireless Communications, vol. 20, no. 2, pp. 104-112, April 2013.

[2] 1F. Laricchia, “Forecast Number of Mobile Devices Worldwide from 2020 to 2025,” https://www.statista.com/statistics/245501/multiple-mobile-device-ownership-worldwide/, Mar 10, 2023.

[3] J. M. Liberti, M. A. Petersen, “Information: Hard and Soft, The Review of Corporate Finance Studies,” vol. 8, no. 1, pp. 1-41, March 2019.

[4] S. S. Dawes, “Governance in the Digital Age: A Research and Action Framework for an Uncertain Future,” Government Information Quarterly, vol. 26, no. 2, Pages 257-264, April 2009.

[5] F. Okumura and H. Takagi, “Maglev Guideway on the Yamanashi Test Line,” http://www.rtri.or.jp/rd/maglev2/okumura.html, October 24, 1998.

[6] S. Malodia, A. Dhir, M. Mishra, & Z. A. Bhatti, “Future of E-Government: An Integrated Conceptual Framework,” Technological Forecasting and Social Change, vol. 173, pp. 1-17, 121102, December 2021.

[7] A. Kalhoro, A. A. Wagan, A. A. Khan, J. M. Lin, C. S. Ku, L. Y. Por, J. Yang, “Rewarding Developers by Storing Applications on Non-Fungible Tokens,” Mathematics, vol. 11, no. 11 pp. 1-12 May 2023.

[8] S. S. Sarmah, “Understanding Blockchain Technology,” Computer Science and Engineering, vol. 8, no. 2, pp. 23-29, August 2018.

[9] N. Sangeeta, S.Y. Nam, “Blockchain and Interplanetary File System (IPFS)-Based Data Storage System for Vehicular Networks with Keyword Search Capability,” Electronics, vol. 12, no. 7, pp. 1-23, March 2023.

[10] P. Wei, D. Wang, Y. Zhao, S. K. S. Tyagi, & N. Kumar, “Blockchain Data-Based Cloud Data Integrity Protection Mechanism,” Future Generation Computer Systems, vol. 102, pp. 902-911, January 2020.

[11] M. Steichen, B. Fiz, R. Norvill, W. Shbair and R. State, "Blockchain-Based, Decentralized Access Control for IPFS," 2018 IEEE International Conference on Internet of Things (iThings) and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom) and IEEE Smart Data (SmartData), Halifax, NS, Canada, pp. 1499-1506, July 2018.

[12] V. P. Ranganthan, R. Dantu, A. Paul, P. Mears and K. Morozov, "A Decentralized Marketplace Application on the Ethereum Blockchain," 2018 IEEE 4th International Conference on Collaboration and Internet Computing (CIC), Philadelphia, PA, USA, pp. 90-97, October 2018.

[13] Z. Zheng, S. Xie, H. N. Dai, et al. "An Overview on Smart Contracts: Challenges, Advances and Platforms," Future Generation Computer Systems, vol. 105, pp. 475-491, April 2020.

[14] S. Yuan, W. Yang, X. Tian, W. Tang, “A Blockchain-Based Privacy Preserving Intellectual Property Authentication Method,” Symmetry 2024, vol. 16, no. 5, pp. 1-21, May 2024.

[15] S. N. Swamy and S. R. Kota, "An Empirical Study on System Level Aspects of Internet of Things (IoT)," in IEEE Access, vol. 8, pp. 188082-188134, October 2020.

[16] H. A. M. Malik, A. A. Shah, A. Muhammad, A. Kananah, A. Aslam, “Resolving Security Issues in the IoT Using Blockchain,” Electronics, vol. 11, no. 23, pp. 1-14, November 2022.

[17] L. Fitzgibbons, “What is Feature-Driven Development (FDD)?” https://www.techtarget.com/searchsoftwarequality/definition/feature-driven-development, April 20, 2024.