ARTICLE

Development of a records management system with GIS integration: enabling tool for disaster risk management

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Government agencies like the Bureau of Fire Protection in the municipality of Hinunangan wanted to improve their records keeping and retrieval, including disaster risk response and monitoring. Southern Leyte State University-Hinunangan responded positively to the request and developed a system purposely to properly handle records and efficiently monitor establishments for business and building compliance. The integration particularly of a geographic information system aimed at determining, locating, and monitoring establishments particularly when responding to fire or disaster risk-related incidents. The System Development Life Cycle (SDLC Framework), which employs the entire iterative waterfall approach, was used in the development process. Upon deployment, the agency conducted a month-long series of user tests utilizing test scripts to determine the system's usability and functionalities. A systems evaluation was also supplied patterned from the ISO 9126-1 software quality model standard. According to the users from the Bureau of Fire Protection, the developed system is significant and relevant for their operations. It assists in the provision of enhanced records management operations and helps improve disaster risk response and monitoring services, all of which were highly accepted by users.

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INTRODUCTION

Records are considered essential documents in government offices, agencies, establishments, or companies. These have to be appropriately and systematically organized and safely in place for easy retrieval. They serve as essential evidence in curbing corruption, safeguarding individuals' rights, and guaranteeing transparency and good governance (de Mingo and Cerrillo-I-Martínez, 2018; Katuu and Ngoepe, 2015; Mukred et al., 2019a). As such, governments need to recognize having such a sound records management system as one of the priority areas (Nyampong, 2015, Duranti, 2010). The advent of technology brings more significant advantages to record-keeping and management. Several government offices opted to use computers in storing records for easy access and retrieval in searching for specific data or files. The geographical information system (GIS) on the other hand, is a computer

KEYWORDS

Records Management System; Bureau of Fire Protection; Municipality of Hinunangan; Geographical Information System; Disaster Risk Management; Waterfall Model

system that is used to capture, store, query, analyze, and display geospatial data. It is a valuable tool that is effectively used to provide a comprehensive presentation and better visualization of details concerning analyzing spatial data useful for better planning, analysis, and monitoring relating geographical information. Thus, this has to be integrated into the records system of agencies (e.g., Bureau of Fire) to maximize its usefulness (Chang, 2017, Chang 2014, Patil and Yuvraj 2010).

There have been studies in the past, particularly in Kenya and India, relating to the GIS-Based Information and Records Management System conducted by Nyongesa (2008) and Patil (2010), which was aimed at digitizing existing land records with GIS tools to create an effective and efficient land records management system basis for better planning and decision-making of planners, landowners, land administrators, and decision-makers. There is also a GIS-based study conducted by Abbas et al. (2009) for flood mitigation and management which would help improve the disaster management process. Which when properly implemented, could help decrease the loss of life and property. Another development of a GIS-based study with embedded text-based geospatial Big Data research toolbox (BigGIS-RTX) was designed for mobile CDR (Call Details Record), which are imperative for disaster management and emergency preparedness (Lwin et al. 2018). The implementation as well of the "The Electronic Records Management Systems (ERMS)" has brought an impact when it comes to efficiency and effectiveness in the government in terms of transparency, accountability in decision making, and in delivering public services to citizens (Mukred et al. 2018, Mukred et al. 2019, Zinner and Viborg 2008). It has been noticed that ERMS includes capabilities for electronic record acquisition, description, administration, storage, and distribution (Nguyen et al. 2007, Smallwood 2013). The ERMS will eliminate the present requirement for manual records management, such as invoicing, payment, and other business transactions (Ambira, 2016; Joseph et al., 2012; Meijer, 2001). Hence, taking advantage of utilizing a computerized system brings no hassle and problems when retrieving information. Moreover, integrating information technology into processes, operations and management surely raise the efficiency and cost-effectiveness of the records management operation (1989).

The traditional way of having no computer system implemented in the upkeeping and retrieval of records in government offices like in the Bureau of Fire Protection (BFP) hinders the delivery of efficient services to the clientele. These services include the issuances of documents like business and building permits, determination of establishments that are subject to renewal and inspection and producing and generating reports which are time-consuming and tedious. Mapping out of establishments for efficient monitoring of compliance-related matters and risk management purposes such as fire-related disasters could also be complicated. As a result, poor record-keeping systems have resulted in corrupt practices, a lack of accountability, and inefficient government institutions (Nyampong, 2015). A study conducted by Luyombya and Bukirwa (2014) verified that the existing records management policies, processes, and procedures utilized by Ugandan oil-marketing businesses were inadequate due to the lack of a records-management system. According to the study, because the firms had not implemented any electronic records systems, there were now equivalent problems coming from the growing reliance on electronic records. Manual records management further impedes most sectors to the cost of physical filing storage, limited portability, massive numbers of unmanaged documents, sluggish reaction time in delivering services, inaccurate data, and a lack of technological application to information and records management (Ngulube, et.al, 2011, Ngulube and Tafor, 2006).

With all of the reviews done on the relevant literature and systems, it appears that there are many recent papers on the records management system but only a few published accounts that include GIS integration that is now accessible and readily available.

These issues prompted the development of a "records management system with GIS integration as an enabling tool for disaster risk management" to serve government offices like the BFP of Hinunangan municipality as a problem-solution response upon the request of the agency. The study was on the design and development of a system that caters to the following; (1) ease in terms of keeping and retrieving records, (2) timely generation of permit issuances as needed by the clients, (3) rapid determination and location of business establishments when immediate actions are required such as in responding to fire-related incidents and doing establishments' monitoring, (4) ease in identifying compliant and non-compliant business establishments and buildings, and (5) provision of essential information of clients' establishments in a georeferenced manner. The system serves as a support tool in giving the basis to input and providing better decision-making and policy formulation.

MATERIALS AND METHODS

The records management system integrated with GIS technology was developed anchoring the system development life cycle (SDLC) architecture adopting the iterative waterfall model. The iterative waterfall model is an enhanced version that addresses the shortcomings of the traditional waterfall model. It still has its sequential processes that move downward through the phases; however, developers are free to go back into previous phases of development to make any form of adjustment or improvements, which iterations are enabled (Majumdar et al., 2021, Sharma et al., 2021). This method was chosen because everything from the start of the project must be carefully planned and clearly understood, with a formal acceptance and approval at the end (Fagarasan et al., 2021). As indicated in Figure 1, it carried out the sequence of activities, including iterations described by Shelly and Rosenblatt (2012): systems planning, systems analysis, systems design, systems implementation, and systems operation and support.

Systems Planning

In this phase, the researchers conducted preliminary investigations and interviews with BFP-Hinunangan staff to properly address the highlighted difficulties experienced by the agency. Meetings were conducted attended by both parties in the planning process. It also identified the hardware and software requirements that were needed for the system's development.

Systems Analysis

During this phase, the researchers gathered necessary data and information, including asking for sample reports and records, policies, and guidelines relative to the existing records management system of the agency based on the planned system development. Identification of establishment or building coordinates and using GPS and camera image coordinated were done to map locations for spatial analysis.

Systems Design

In this phase, the design of the user interface was created followed by coding and testing. Figures 2 and 3 show the home page of the BFP-RMSGIS system and the BFP map of establishments. During the development process, the interface design and system's functionalities were always in consultation

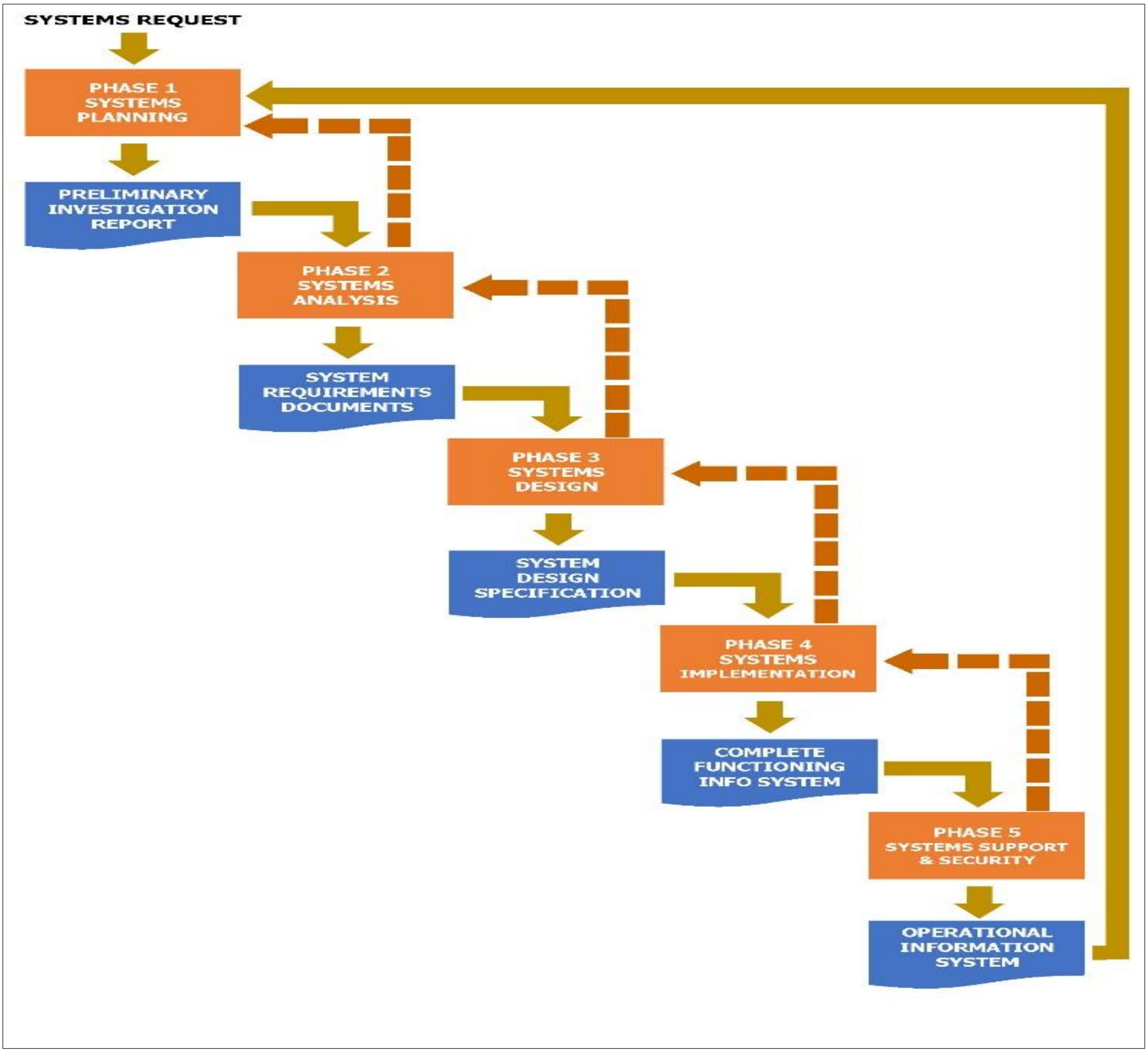

Figure 1: System development life cycle using the iterative waterfall model

with the end user to guarantee that functionalities satisfy their expectations and needs.

Systems Implementation

In this phase, a month-long series of user tests were conducted with two agency personnel using test scripts to guarantee that errors could be addressed ahead of time to ensure all system features meets the requirements and needs of the users. Questionnaires were also distributed as part of an additional assessment of the developed system to guarantee its functionality, reliability, usability, efficiency, and maintainability (Table 1). Testing activities performed by the users and the results of the system evaluation utilizing a researcher-constructed questionnaire are shown in Tables 2 and 3. These tests were patterned after the ISO 9126-1 software quality model standard. The installation and rollout of the system began only after it was approved. The users or those who will be in charge of the GIS system received enough training to ensure that they could operate, handle, and navigate the system.

Systems Operation and Support

Constant support and monitoring of the system's operational life must be carried out throughout this period through consultation between the implementing and cooperating agencies. If the system fails, it must have an immediate response to correct malfunction and errors as soon as possible. In the future, possible add-on features or system upgrades will be considered to give better solutions and services to the user.

RESULTS AND DISCUSSION

System Design

The system was developed using PHP programming language and MySQL database and QGIS software for map visualization. The home page of the system is where the navigation tabs are displayed (Figure 2). The home page is also where shortcut buttons are found. These shortcut buttons allow the user to quickly direct to a particular function. For example, clicking on the Hinunangan Map button will direct you to a page that provides maps and basic information about a specific establishment for proper monitoring and risk management (Figure 3). One may find the actual position and address of a specific company, building, or organization, as well as photographs that serve as further indications of the unique place. Other information supplied includes the kind of structure, establishments, owner, and status. The webpage also illustrates a section of the map of the establishments in Hinunangan, Southern Leyte, which served as the study's pilot area.

Table 1: Systems evaluation criteria

Criteria	Rating
Systems functionality and usability	
1. System features performed accurately.	1 to 4
2. User-friendly environment is evident.	1 to 4
3. Report generated is consistent on the recorded entries	1 to 4
4. Easily locate and search recorded entries.	1 to 4
5. Transactions can be done immediately.	1 to 4
Systems Efficiency	
1. Retrieval of records can be done immediately.	1 to 4
2. Update and correction of entries can be updated and altered.	1 to 4
3. Generation of the report done promptly.	1 to 4
4. Report can be easily interpreted.	1 to 4
5. Reports can be provided anytime as needed.	1 to 4
Systems reliability and maintainability	
1. Records are safely secured and can be retrieved by an authorized person	1 to 4
2. System is strongly secure with password	1 to 4
3. Modification of system settings can be done by an authorized person	1 to 4
4. Alteration of records can be traced and recognized.	1 to 4
5. Errors of the system can be immediately corrected.	1 to 4

1-Highly Disagree, 4- Highly Approve

Figure 2: BFP-RMSGIS home page

System Implementation

Upon the deployment of the created system, user testing was carried out to determine if system features are functional and passed and met the users' requirements and needs. A list of user testing activities and results indicated that all CRUD (create, read, update, and delete) operations were all passed (Table 2). A CRUD is an essential operation for creating and managing data elements in a database and a performance evaluation for time responses and memory usage for a developed system (Zmaranda et al., 2020). Furthermore, the evaluation results reveal that the system is highly approved and accepted by the end-user (Table 3).

Overall, we find that the created system is operational, of quality, and satisfies the expectations and requirements of the users. Accordingly, the most direct impact on user satisfaction was determined by operational effectiveness and information quality (Santa et.al, 2018). A system that satisfies its users' needs is more useful and of better quality; user participation also improves the project's outcome (Engvall, 2019, Eichhorn & Tukel, 2018). When developing a system, one of the most widely used measurements of success is user satisfaction. User satisfaction has a direct impact on whether or not the system is used (Alzahrani, Mahmud, Ramayah, Alfarraj, & Alalwan, 2019, Bergeron & Raymond, 1992, Mckeen, & Guimaraes, 1997). If the created system fails to meet its users, the users will not utilize it. As a result, the system will be unusable (Gupta, S. K., Gunasekaran, A., Antony, J., Gupta, S., Bag, S., & Roubaud, 2019, Poon & Wagner, 2001). Systems also must be customized to work practices to satisfy local demands and take into consideration local conditions (Hertzum, Simonsen, 2019). Thus, the developed system meets the demands of the users while also addressing the agency's issues.

CONCLUSIONS AND RECOMMENDATIONS

The developed system was determined to be significant and relevant to the agency's day-to-day office transactions. This is based on: 1) results of user-testing and system evaluation; 2) system features and functionalities rated as passed; and 3) acceptance by the BFP-Hinunangan agency with highly favorable

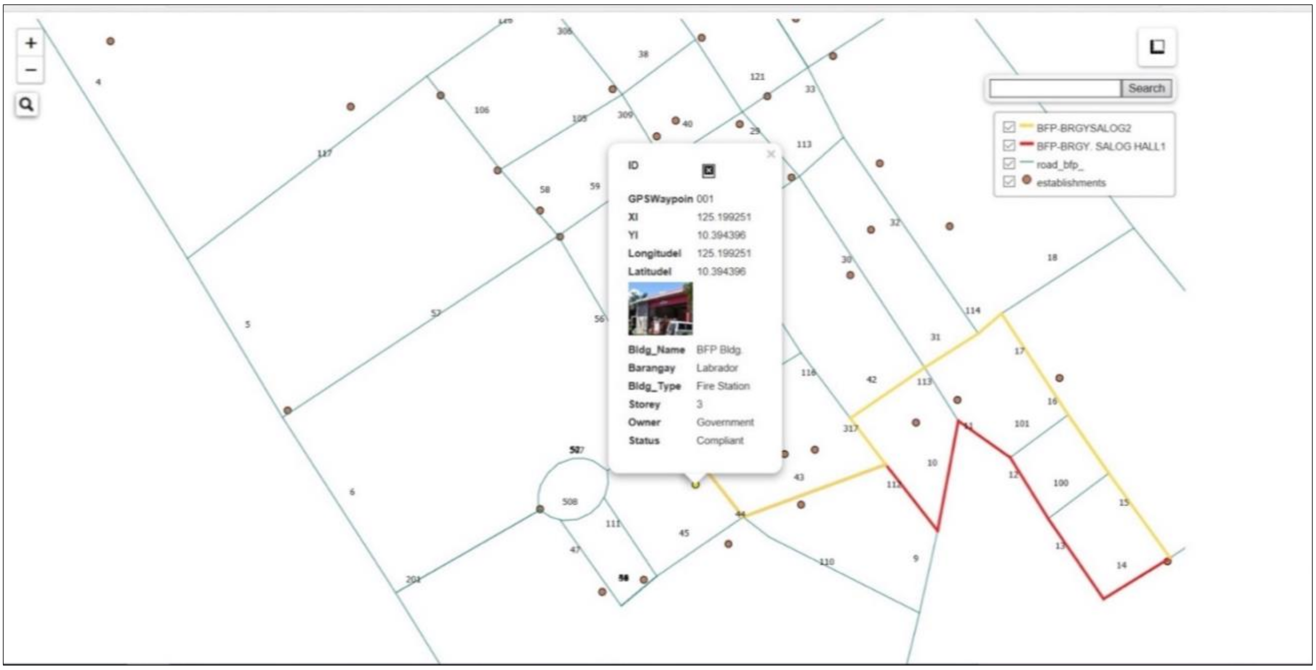

Figure 3: The BFP map of establishments

Table 2: List of user testing activities

Test ID	Description	Test Input	Test Output	Result
1	Sign-in	Username, password	Home page	Passed
2	Sign-out	-	Exit from the system	Passed
3	User data	User profile	Profile of user	Passed
4	Business permit tab	Business profile	Business Permit	Passed
5	Building permit tab	Building profile	Building Permit	Passed
6	Print blank form	Print	Printed Form	Passed
7	History logs	Logs	List of logs	Passed
8	Settings	User role	User role	Passed
9	Business clients	Business client's data	Report on business clients	Passed
10	Business renewal	Renewal data	Report on business renewal	Passed
11	Business for inspection	Inspection data	Report on business for inspection	Passed
12	Business compliant	Compliant data	Report on business compliant	Passed
13	Business non-compliant	Non-compliant data	Report on non-compliant data	Passed
14	Building clients	building clients data	Report on building clients	Passed
15	Hinunangan map	Search location	Hinunangan map	Passed

Table 3: Systems evaluation result

Criteria	Weighted Mean
Systems functionality and usability	3.58
Systems Efficiency	3.16
Systems reliability and maintainability	3.4

Note: 1:00-1.75 (Highly Disapprove), 1.76-2.50 (Disapprove), 2.51-3.25 (Approve), 3.26-4.00 (Highly Approve)

remarks. The system offers a huge advantage for the delivery of services of the BFP in Hinunangan in terms of offering rapid and efficient services to clients. The system has also simplified the process of determining and retrieving client data and records and proved helpful in monitoring and locating disaster-risk-related incidents within the municipality. We recommend that the system be replicated in all cities and municipalities of the country and if possible, with add-on features or system upgrades to give better solutions and services to the user. We also recommend the development of a mobile application for the system for portability.

CONFLICT OF INTEREST

The authors have declared no conflicts of interest.

CONTRIBUTION OF INDIVIDUAL AUTHORS

Madelyn B. Manun-og, Mondani R. Manun-og, Jake N. Togonon, and Adonis F. Wales did the planning, analyzing, designing, coding, and manuscript writing. Mondani R. Manun-og and Adonis F. Wales took establishments photos, coordinates, and plotted them into QGIS. Danilo A. Balili assisted in the manuscript writing.

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