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Enhancing Village-level Inventory Management through Extreme Programming: A Case Study in Rural Empowerment

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Abstract. This research discusses analyzing and developing a village office inventory system using the Extreme Programming (XP) method. Village inventory systems are considered an essential foundation in local resource management, facilitating the recording, maintenance, and management of inventory owned by a village. This research identified limitations in the manual approach, which is prone to recording errors and data loss. The proposed village inventory system is designed to solve these limitations by emphasizing timeliness and accuracy of information. The system is expected to assist the village in responding quickly to changing conditions and needs, ensuring that the information obtained is always relevant and accurate. The application development was conducted through a series of XP stages, from overall planning system and module design to testing and implementation in a production environment. This process creates adaptive, responsive, and quality software, overcoming the limitations of manual systems that may still be dominant in many villages. User acceptance analysis highlights the importance of understanding user needs and expectations. User needs studies, user personas, prototyping, and feedback collection form the basis of system design that focuses on meeting user expectations. The results of the user performance metrics analysis showed a positive 80% satisfaction rate with the prototype, indicating that the proposed solution met the expectations of most users.

1. INTRODUCTION

Village inventory systems are an essential foundation in local resource management, facilitating the recording, maintenance, and management of inventory owned by a village. With technological development, villagers increasingly recognize the need for a structured and efficient approach to managing their assets[1]–[4]. The system serves as the administrative backbone of the village, allowing stakeholders to accurately and effectively track everything from farmland to public facilities to community inventory. A village inventory system is crucial in solving challenges villages face, such as changing land conditions, changing community needs, and the impacts of climate change. With this system, villages can manage inventory more dynamically, allowing users to continuously record, update, and monitor inventory data.

One of the critical elements in village inventory management is the timeliness and accuracy of information. The system is designed to solve the shortcomings of manual approaches that are prone to recording errors and data loss[2], [3]. With the village inventory system, villages can respond quickly to changing conditions and needs, ensuring that the information obtained is always relevant and accurate. In addition, the system provides better accessibility to inventory information for all village stakeholders, including local government, farmers, and the general public. This creates transparency in managing village resources and facilitates better data-driven decision-making. By implementing a village inventory system, villages can optimize their asset management, improve operational efficiency, and create a solid foundation for sustainable development. This innovation provides solutions to current challenges and lays the foundation for sustainable growth and development at the village level.

Manual systems in inventory management have been an integral part of many organizations, including villages, for many years. However, as technology advances, the limitations of manual systems are increasingly apparent and can become a significant obstacle to the efficiency and sustainability of inventory management. First of all, the tendency of human error is one of the main limitations of the manual system. Inventory recording, maintenance, and updating processes that rely on human input are prone to clerical errors and data omissions. This can result in information inaccuracies that can negatively impact decision-making and planning[5], [6].

Manual systems often require a lot of time and effort. Data collection processes involving form filling, manual recording, and physical storage of documents can be time-consuming and require significant human resources. Delays in inventory updates can result in data inactivity, hampering quick responses to changing conditions or village needs. Another limitation is the lack of accessibility of information. In manual systems, access to inventory data may be limited to one or two individuals directly involved in inventory management. This can hinder transparency and collaboration among village stakeholders, including local government, farmers, and the general public[2], [4].

Additionally, manual systems are prone to data loss. Physical documents can be lost or damaged due to various factors, such as natural disasters, accidents, or fire. This can lead to loss of valuable inventory data that is difficult or even impossible to recover. By identifying these limitations, villages need to consider implementing a more sophisticated and automated inventory information system to improve their inventory management's efficiency, accuracy, and sustainability.

The relevance of this research reflects its significant impact on the development of information systems, especially in the context of villages. By applying the Extreme Programming (XP) method, this research seeks to make a valuable contribution towards improving the quality and effectiveness of village inventory management, creating a resilient foundation for advancing local communities[7], [8]. The application of Extreme Programming (XP) methods in the village context explores the innovative role of XP as a software development approach that local communities can well adapt. Villages, with their unique characteristics and specific needs, require information systems that can adapt to the dynamics of change and diversity of conditions. XP offers a solution by emphasizing close team collaboration, rapid response to change, and the application of iterative development practices. In village scenarios, which often have limited resources, XP methods open the door to collaborative thinking and flexibility in information system development. By using pair programming practices, short iterations, and continuous testing, the development team can create solutions responsive to the village's needs. This opens up opportunities to effectively address changing needs, improve software quality, and speed up development time[9]–[13].

Improving the quality and effectiveness of village inventory management is an essential aspect of the relevance of this research. The information system developed with the application of XP is expected to overcome the limitations of manual systems that may still be dominant in many villages. By enabling quick and accurate data updates, the system assists villages in monitoring and managing their inventory more effectively. Real-time information allows for better decision-making, more optimized resource management, and quick reactions to changing conditions or village needs. In addition, the system provides greater accessibility and transparency to inventory information. Local governments, farmers, and the general public can easily access inventory data, facilitating better collaboration to maintain the sustainability of local resources. By engaging communities more actively, the information system can create greater awareness of the importance of village inventory management and provide opportunities for more involvement in decisions related to local resources[14]–[17].

This research's relevance is not limited to the village level itself. Contributions to the development of information systems, especially by utilizing the XP method, may provide a model that can be adopted by other villages, both regionally and nationally. As such, this research can broadly influence software development practices in rural environments, creating positive changes that many communities can feel. Through the application of XP, this research provides a strong foundation for information technology transformation at the village level, advancing quality of life and sustainable development.

The benefits of this research include,significant positive contributions to the village,focusing on improving the efficiency and transparency of inventory management,the ease of data-driven decision-making. One of the main benefits of this research is the increased efficiency in village inventory management. By adopting an information system developed through the application of the Extreme Programming (XP) method, the village was able to overcome constraints that may have occurred in a more conventional manual system. The system allows for faster and more accurate inventory data recording, updating, and maintenance. With the ability to access real-time information, village officials can monitor inventory more effectively, ensuring that inventory data is always up-to-date. This reduces the time needed for administrative tasks and avoids human error that may occur in manual processes.

In addition, increased transparency in village inventory management is an essential contribution of this research. By making inventory information more accessible to stakeholders such as local government, farmers, and the general public, villages create a more open and inclusive environment. This transparency helps build trust among community members and stakeholders, providing a clear picture of available village resources. With accurate and up-to-date inventory data, local governments can plan and implement more effective policies in village resource management. Farmers can access information on the availability of agricultural land or crop maintenance needs more efficiently, helping them make farming-related decisions. The general public can also understand the impact of decisions on village assets, creating greater participation in local resource management.

Data-driven decisions also minimize the risk of errors as they are based on accurate and up-to-date information[18]–[20]. This helps villages to plan activities better, increase effectiveness, and optimize the utilization of available resources. Overall, the benefits to villages resulting from this research create a foundation for sustainable development. With increased efficiency and transparency in inventory management and ease of data-driven decision-making, villages can achieve their development goals better. Improved quality of life, sustainable resource utilization, and empowerment through more accessible information are positive contributions of this research towards developing villages as empowered community units.

2. METHOD

In designing this research, the case study method was chosen as the most suitable approach. Case studies allow for an in-depth investigation of a phenomenon. In this context, the focus is on implementing a village inventory information system using the Extreme Programming (XP) method as shown in Figure 1. The case study method provides an opportunity to investigate in detail how the application of XP can affect inventory management in a village environment. This allowed the researcher to thoroughly understand the context, dynamics, and impact of the XP implementation. The selection of the village as the unit of analysis was a strategic decision that informed the research design. Villages were chosen because they represent local community units that reflect unique dynamics and specific needs. Within villages, relationships between residents, village government, and local resources are closely intertwined, creating an ideal environment to understand how inventory information systems adapt to the needs and dynamics of local communities. The selection of the village as the unit of analysis also provides a rich context for exploring the potential application of XP in inventory management at the local level.

Figure 1. Research Stages

Data Collection

The data collection will involve interviews with relevant parties in the selected villages. Interviews will be conducted with key stakeholders, such as members of the village government, farmers, and local communities. These in-depth interviews will allow the respondents to share their views, perceptions, and experiences regarding the current inventory management and their expectations regarding implementing the new information system. Interview questions will focus on understanding the village's needs, the challenges faced, and how implementing XP can improve the inventory management process.

In addition to interviews, data collection will involve direct observation of the current inventory management process in the village. These observations will help the researcher gain a deeper understanding of existing practices, potential changes needed, and the extent to which current efficiency and transparency can be improved. By observing first-hand, the researcher can identify the specific needs of the village and detail how the XP system can be adapted to meet those needs. Through a combination of interviews and observations, researchers will build a thorough understanding of the village context and detail the concrete steps that need to be taken to implement an XP-based inventory information system. This approach ensures that the research produces not only quantitative data but also an in-depth understanding of the perspectives and realities of life in the villages that are the focus of the research.

Application Development

Software development using the Extreme Programming (XP) method involves a series of stages performed iteratively and collaboratively. First, the team conducts overall planning, determining the features to be developed and setting priorities for each feature. Then, in iteration planning, a detailed plan is drawn up for each iteration, including the tasks to be completed and the estimated time to completion. After planning, the design stage begins, where the overall system design and the design of each module or component of the system are worked out in detail. In the programming stage, the team begins to implement the design and run unit tests to ensure the quality and functionality of the code. Testing is gradually carried out, from integration to system testing, to ensure the system runs well. Refactoring is a crucial step to improve the structure and quality of the code without changing its functionality. After that, in the selection phase, a release-ready version of the system is created, and the system is deployed in the production environment. Next, performance monitoring and evaluation are performed to ensure the system operates properly, while fault recovery takes care of any bugs or issues that may arise after implementation. Finally, the principle of continuous improvement is applied by updating plans based on evaluation and customer feedback. The development process is also continuously optimized to improve efficiency and quality. Thus, the XP stages provide a solid foundation for adaptive software development, focusing on rapid response to change and continuous process optimization.

User Acceptance Analysis

User acceptance analysis is a critical phase in software development, starting with identifying target users to understand their characteristics. A user requirements study is conducted to identify user expectations and needs, forming the basis of the system design. User personas are developed to represent potential users' characteristics, while user feedback collection helps gain direct insights from users regarding prototypes or specific features. The prototyping process tests and demonstrates features to users, allowing for customization before further development. User performance metrics, such as response time and usage efficiency, are analyzed to evaluate the comfort level and effectiveness of using the system. Through this series of steps, user acceptance analysis becomes the cornerstone of software development, focusing on user needs and expectations, resulting in a more accepted and effective product.

3. RESULTS AND DISCUSSION

User Needs

The results of this data collection stage illustrate an in-depth understanding of the state of inventory management in the selected villages. Through interviews with key stakeholders such as members of the village government, farmers, and local communities, a wide range of views, perceptions, and experiences were revealed. These in-depth interviews created a rich picture of the village's needs, challenges, and expectations regarding implementing the new information system. Direct observation of the inventory management process in the village provided additional detailed insights. Existing practices, potential changes needed, and the extent to which current efficiency and transparency could be improved were revealed through these observations. Through a combination of interviews and observations, the researcher was able to detail the specific needs of the village and formulate concrete steps to adapt the Extreme Programming (XP) system to fit the village context. This approach ensured that the research results were not limited to quantitative data alone but also created an in-depth understanding of the reality of life in the village. As such, the data collected provides information on needs and challenges and a solid foundation for designing relevant and effective XP-based solutions for the village.

Application Development

The results of the Application Development stages using the Extreme Programming (XP) method create the success of this approach in producing adaptive, responsive, and quality software. This stage begins with overall planning, where features such as inventory management and inventory data recording are prioritized, providing a clear direction for development. A detailed iteration plan allows the team to complete tasks efficiently, with estimated completion times, such as implementing the inventory recording system, which is expected to take two weeks.

Table 1. Stages of Application Development

No	Stages	Description
1	Overall Planning	Determine priority features, such as inventory management and inventory data recording.
2	Iteration Planning	A detailed inventory recording system implementation plan will be completed in two weeks.
3	System Planning	Detailed system and module design ensures a solid foundation before entering the programming phase.
4	Programming Phase	Design implementation focusing on unit testing to ensure code quality and functionality.
5	Phased Testing	Testing from integration to system, ensuring the whole system runs well.
6	Reverse Engineering Process	Improve code structure and quality without changing functionality.
7	Selection Stage	Membuat versi sistem yang siap dirilis, implementasi di lingkungan produksi.
8	Performance Monitoring	Evaluation of system performance monitoring, with data showing increased efficiency of system use.
9	Error Recovery	Handle bugs or issues that may arise after implementation.
10	Continuous Improvement	Update planning based on evaluation and customer feedback, process optimization.

The detailed system and module design, shown in Table 2, creates a solid foundation before entering the programming phase.

Table 2 System Design

Module	Description
Inventory Management	Design a module for inventory management with the required features.
Data Recording	Detailed design of the inventory data recording module, including format and validation.
Inventory Report	Module to generate inventory reports based on recorded data.
User Management	Design of modules that manage access rights and system user information
External Integration	Modules for integration with external systems or third-party services.

The team starts implementing the design, focusing on unit testing ensuring code quality and functionality. Phased testing, Table 3, from integration to system testing, ensures that the overall system operates as intended.

Table 3 Design Implementation

Jobs	Description
Module 1 Implementation	The team coded and implemented the inventory management module
Module 2 Implementation	Implementation process for inventory data recording module
Module 3	Implementation work for the inventory report module

Implementation	
Module 4 Implementation	Implementation of a user management module for access rights management
Module 5 Implementation	Implementation work for external integration modules.
Module Unit Testing	Intensive testing of each module to ensure sustainability

The integration test, table 3, covers inventory data integration with the inventory management system directly at the work stage.

Stage 3. Integration Testing

Testing Phase	**Description**
Integration Testing	Integration of inventory data with inventory management module
System Testing	System-wide testing to ensure interoperability.

The reverse engineering process is critical to maintaining code quality by improving structure without sacrificing functionality. The selection phase involved creating a release-ready version of the system, with implementation in a production environment such as the village that was the focus of the research. Performance monitoring and evaluation provided an in-depth understanding of how well the system was operating correctly, with data showing a 20% increase in system usage efficiency after implementation.

The principle of continuous improvement helps improve efficiency and quality through planning updates and process optimization. Thus, the XP stages provide a strong foundation for adaptive, change-focused software development and strive for continuous improvement, creating a quality product that meets user needs and expectations.

User Acceptance Analysis

User acceptance analysis brings crucial results in understanding and responding to users' needs and expectations of the developed software. Identifying target users is a successful first step, allowing the development team to understand potential users' characteristics deeply. By establishing who the target users of the system are, the focus can be directed towards a more measurable and relevant user experience. The user requirements study has provided a comprehensive picture of the users' expectations and needs for the software. The data generated from this study forms the basis for system design that focuses on fulfilling user expectations and needs. The developed user personas successfully created a representation of the characteristics of potential users. This helps the development team better empathize with users and understand their preferences, needs, and challenges so that the software can be designed more relevantly. Gathering direct feedback from users on prototypes or specific features is a valuable source of insight. This feedback provides an accurate view of the extent to which users are satisfied with the demonstrated features and allows for adjustments before the software reaches a more advanced stage of development. The prototyping process was successfully used to test and demonstrate features to users. Making adjustments based on user feedback helps create software that is more in line with user expectations and needs. Analysis of user performance metrics, including response time and system usage efficiency, provided further insight into the user experience. This data serves as a guide in assessing the software's comfort level and effectiveness. In measuring user satisfaction, out of 100 respondents, 80 gave positive feedback on the prototype and the features displayed. Thus, the percentage of user satisfaction is 80%. This reflects positive acceptance of the developed software and indicates that the proposed solution meets the expectations of most users.

4. CONCLUSION

This research aims to analyze and develop a village office inventory system by applying the Extreme Programming (XP) method. Through the development journey, this research resulted in an innovative solution to improve inventory management at the village level. The Extreme Programming (XP) method proved effective in overcoming system development challenges in a village environment. XP principles such as close team collaboration, rapid response to change, and iterative development provided a strong foundation for creating an adaptive and responsive system. The proposed village inventory system successfully overcomes the limitations of manual approaches prone to errors and data loss. This success lies primarily in emphasizing timeliness and accuracy of information, paving the way for improved efficiency and accuracy in village inventory management. User needs study, user persona creation, prototyping, and user feedback collection provided a solid foundation for the system design. By understanding user expectations, these systems can be designed to meet their needs, creating high user satisfaction levels. This research is relevant to the village level and can broadly influence software development practices in rural environments. The application of XP provides a solid foundation for information technology transformation at the village level, potentially improving quality of life and supporting sustainable development. As such, this research contributes valuable insights related to information systems development at the village level and highlights the importance of choosing methods appropriate to the unique context of villages. The implications of this research can serve as a guide for developers and decision-makers to improve the effectiveness of inventory management at the local level.

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