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# Innovating Restaurant Inventory Management Application Enhancing Quality And Efficiency Through Extreme Programming Approach

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Inventory Management,
Extreme Programming,
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**ABSTRACT**
This research investigates the complex challenges in inventory management within the restaurant industry, including the risk of inventory calculation errors, stock shortages, and material wastage. The Extreme Programming (XP) method is utilized to develop an inventory management application to address these issues. Through user requirement analysis, XP-based application development, and user evaluation stages, this study successfully designs and implements an efficient and adaptive application. User evaluation results indicate positive feedback, with 85% of users expressing satisfaction with the application, affirming that it provides optimal value by enhancing operational efficiency and improving restaurant customer experience. This research contributes to implementing the adaptive and responsive XP method to address changes in inventory management, proving its effectiveness in dealing with the complexities of the dynamic restaurant industry..



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## INTRODUCTION

Inventory management in the restaurant industry poses a complex challenge due to the diverse range of raw materials and stocks that must be managed accurately. Restaurants often have a wide variety of menu options, necessitating them to maintain sufficient stock for each menu item. Product rotation and stock availability fluctuations are crucial factors to consider in inventory management. The primary challenges in monitoring and controlling restaurant inventory include the risk of calculation errors and stock shortages(Ferreira et al., 2021; Ho et al., 2024; Pleerux & Nardkulpat, 2023; Sularto et al., 2015). Inaccuracies in stock estimation or ineffective monitoring processes can lead to inventory depletion when needed. Delayed ordering can also be a severe issue, as it may result in inadequate product availability to meet customer demands, potentially leading to revenue loss(Abdul Aziz et al., 2023; Hakim et al., 2021; Omar et al., 2016).

Inefficient inventory monitoring and control can also lead to inventory waste. Restaurants that need to manage stocks effectively tend to have excess inventory for some items while experiencing shortages for others. This results in wasteful spending to maintain excess inventory and negatively impacts customer satisfaction due to inconsistent product

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availability. Developing an efficient and effective inventory management application is crucial for the restaurant industry. This application can help address inventory management complexities, minimize the risk of errors and stock shortages, and enhance inventory monitoring and control efficiency(A. Chen & Peng, 2023; El-Said & Al Hajri, 2022; Pilar Opazo, 2012; Staley & Jucker, 2021; Wang et al., 2017).

The importance of efficiency and quality in restaurant inventory management is not only related to operational aspects but also significantly impacts overall performance and customer experience. One key aspect of the importance of efficiency in inventory management is its impact on restaurant operational costs. With proper inventory management, restaurants can significantly reduce costs. This includes more efficient inventory management, reducing unused inventory waste, and minimizing unnecessary inventory accumulation. All of these contribute to improved operational efficiency and more controlled expenses. Furthermore, efficiency in inventory management also affects service quality and customer experience. Consistent product availability is critical to meeting customer expectations. With efficient inventory management, restaurants can ensure that products needed by customers are consistently available and not experiencing stock shortages. This helps improve customer satisfaction and build stronger relationships with them(Debasa et al., 2023; Santiago et al., 2024; Suginouchi et al., 2023; Suginouchi & Mizuyama, 2022).

Quick response to customer demands is also a crucial part of the service quality provided by restaurants. With effective inventory management, restaurants can respond to customer demands quickly and accurately. This includes adjusting inventory according to fluctuating demands and avoiding stock shortages that can disrupt the customer experience. Thus, the importance of efficiency and quality in inventory management affects restaurant operations and plays a crucial role in providing a satisfying customer experience. The role of technology in transforming the restaurant industry has been a significant focus on efforts to improve operational efficiency and customer experience. One of the primary roles of technology applications is automating restaurant administrative processes. With suitable applications, restaurants can reduce manual administrative workload, such as order recording, inventory, and financial management. This improves operational efficiency and allows for greater focus on customer service.

Technology adoption is also evident in integrating Point of Sale (POS) systems with restaurant inventory management. Integrated POS systems allow direct sales information linkage with inventory, enabling restaurants to monitor inventory in real time and optimize ordering processes. Additionally, the potential use of new technologies like IoT sensors and extensive data analysis opens up new opportunities in inventory management, such as demand prediction, waste reduction, and optimizing inventory management. Thus, technological evolution in restaurant management brings benefits in operational efficiency and provides potential for improving customer experience through better and more responsive services. Restaurants that can adopt technology effectively can win in a competitive market. Traditional approaches in restaurant inventory management often rely on manual methods and spreadsheets as primary tools. However, these methods have

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significant limitations. One central area for improvement is in data monitoring and analysis. Manual processes in recording and managing inventory data can be time-consuming and prone to errors. Additionally, spreadsheets also risk errors and inaccuracies in inventory information, especially when data needs manual updates and coordination.

Another challenge with traditional approaches is scalability and flexibility. Large-scale restaurants often need help with manual inventory management due to the large volume and variety of inventory. This process becomes complex and susceptible to errors affecting customer product availability. Moreover, limitations in responding to demand and inventory changes are serious issues. Manual processes adapt slowly to market demand changes, causing restaurants difficulty maintaining product availability that matches customer demand. These traditional approaches often need to be revised to address the complexities and dynamics in restaurant inventory management. With an increasingly competitive market and rapid changes, restaurants need to shift to more modern and automated approaches to ensure efficiency and flexibility in inventory management. This highlights the importance of research in developing innovative solutions and technologies that can address the challenges faced by traditional approaches in restaurant inventory management.

The potential of the Extreme Programming (XP) approach in developing restaurant inventory management applications is an exciting research subject, mainly because XP principles promote efficiency and quality in software development(Al-Saqqa et al., 2020; Bansal et al., 2023; J. Chen et al., 2020; Dingsoeyr et al., 2019; Dingsøyr et al., 2012; Fojtik, 2011; Santos et al., n.d.; Serrador & Pinto, 2015; Shrivastava & Rathod, 2014; Wood et al., 2013). One of the critical principles of XP is intensive team collaboration. In developing inventory management applications, close collaboration between the development team and restaurant stakeholders will allow a better understanding of actual needs. This can lead to developing solutions more aligned with restaurant requirements and improving operational efficiency and service quality. Furthermore, XP principles emphasize continuous testing and quick response to changes, adding value to developing inventory management applications. By continuously testing, the development team can identify problems or deficiencies early in the development process, allowing prompt fixes. Quick response to changes in customer needs and external factors affecting inventory management allows the application to remain relevant and adaptive.

The main advantages of the XP approach in developing restaurant applications lie in its adaptability to changing needs. Restaurants often face changes in customer preferences, raw material availability, and dynamic market conditions. With the XP approach, applications can quickly adapt to accommodate these changes without sacrificing quality or efficiency. Additionally, the XP approach also helps reduce the risk of errors and unexpected changes, as continuous testing and quick response to emerging issues are emphasized. Thus, the potential of the Extreme Programming (XP) approach in developing restaurant inventory management applications offers adaptive, efficient, and high-quality solutions. In an era of high business dynamics, this approach can effectively address restaurant inventory management challenges and improve overall operational performance.

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## METHODS

This study consists of three main stages: user needs analysis, application development using the Extreme Programming (XP) method, and functional testing and user evaluation. In the user needs analysis stage, stakeholder identification, and data collection are conducted to understand the primary user requirements for the restaurant inventory management application. Subsequently, in the development stage, the XP method is utilized to plan iterations and design and implement the application iteratively based on user needs. The final stage involves functional testing and user evaluation to ensure the application's functionality, responsiveness, and user satisfaction before its official launch.

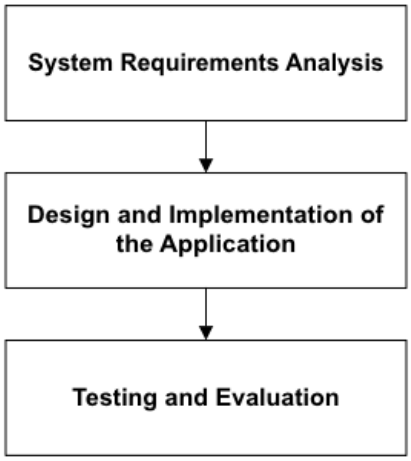


**Figure 1.** Research Stages

### User Needs Analysis

The user needs analysis stage begins with identifying stakeholders using the restaurant inventory management application. These stakeholders include restaurant owners, operational managers, inventory staff, and even customers involved in inventory management. Subsequently, data collection is conducted through various methods such as interviews, surveys, and literature reviews to understand users' needs and expectations regarding the application. The collected data is then analyzed to identify users' primary needs for the application, including desired features, optimal layout, and integration with other systems existing in the restaurant.

### Application Development

Planning iterations based on previously identified user needs are prioritized in the application development stage using the Extreme Programming (XP) method. These iterations set short-term goals and specific development stages. Next, the development team begins designing and implementing application features based on XP principles, such as intensive team collaboration, continuous testing, and quick responsiveness to changes. The development process is carried out iteratively according to the established iteration plan.

### Functional Testing and User Evaluation

In the functional and user evaluation stages, unit testing is conducted on each part of the developed application to ensure its functionality aligns with the specified requirements. Subsequently, integration testing is performed to integrate all application components and

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ensure they interact effectively. Afterward, comprehensive functional testing ensures the application can perform desired tasks according to user needs. During the testing process, user evaluation is also carried out to gather direct feedback from users regarding ease of use, performance, and satisfaction with the application. The testing and evaluation results are used to conduct in-depth analysis and make necessary improvements to the application before its official launch.

## RESULTS AND DISCUSSION

### System Requirements

The outcome of this user needs analysis stage is a comprehensive understanding of users' needs and expectations regarding the restaurant inventory management application. This stage begins with identifying stakeholders, including restaurant owners, operational managers, inventory staff, and customers. This identification is crucial as each party has different roles and interests regarding the application. Restaurant owners may desire an application that enhances efficiency and reduces operational costs, while operational managers and inventory staff may require tools that simplify inventory management and monitoring. On the other hand, customers expect an application that provides consistent and responsive service. Data collection provides a deeper insight into users' needs and expectations for the application. Through interviews with restaurant owners, it can be identified that they need robust analytical features to make better business decisions. Meanwhile, surveys with customers can provide insights into desired features to enhance their experience, such as ease of ordering and payment. The collected data is then analyzed holistically to identify users' primary needs for the application. This includes desired features, optimal layout, and integration with other systems existing in the restaurant. This research found that users want an application that integrates with Point of Sale (POS) systems to streamline sales and inventory management simultaneously. This analysis enables developers to design an application that effectively meets users' needs and expectations, thus enhancing service quality and operational efficiency in the restaurant overall.

The results of this stage are displayed in Table 1. Restaurant owners have a primary focus on operational efficiency and cost reduction, demanding an application with robust analytical features for better decision-making. Challenges faced by restaurant owners include stock calculation errors and inventory wastage, which must be addressed by the application through more efficient inventory management. Operational managers need tools that facilitate real-time inventory management and monitoring, overcoming difficulties in inventory monitoring that affect product availability for customers. Inventory staff expect integration with other systems such as Point of Sale (POS) to enhance operational alignment, while customers demand consistent service and quick response to their requests, addressing challenges of uncertain product availability that affect the customer experience. By understanding the complexity of these needs, developers can design a holistic and responsive application, integrating features that meet the needs of each stakeholder to improve restaurant performance and overall customer experience.

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**Table 1.** Data Collection Results

| Stakeholder | Key Needs Addressed | Challenges Addressed | Expectations and Desires |
|---|---|---|---|
| Restaurant Owner | Operational efficiency, cost reduction | Stock calculation errors, inventory wastage | Robust analytics features for better business decision-making |
| Operational Manager | Easier stock management | Difficulty in real-time inventory monitoring | Tools for streamlined stock management, real-time inventory monitoring |
| Inventory Staff | Effective inventory monitoring | Challenges in responding to demand changes | Efficient stock management capabilities, integration with other systems like POS (Point of Sale) |
| Customers | Consistent service, quick responsiveness | Uncertainty in product availability, inconsistent experiences | Ease of ordering and payment, quick response to customer demands, consistent product availability |

**System Requirements**

The outcome of this user needs analysis stage is a comprehensive understanding of users' needs and expectations regarding the restaurant inventory management application. This stage begins with identifying stakeholders, including restaurant owners, operational managers, inventory staff, and customers. This identification is crucial as each party has different roles and interests regarding the application. Restaurant owners may desire an application that enhances efficiency and reduces operational costs, while operational managers and inventory staff may require tools that simplify inventory management and monitoring. On the other hand, customers expect an application that provides consistent and responsive service. Data collection provides a deeper insight into users' needs and expectations for the application. Through interviews with restaurant owners, it can be identified that they need robust analytical features to make better business decisions.

Meanwhile, surveys with customers can provide insights into desired features to enhance their experience, such as ease of ordering and payment. The collected data is then analyzed holistically to identify users' primary needs for the application. This includes desired features, optimal layout, and integration with other systems existing in the restaurant. This research found that users want an application that integrates with Point of Sale (POS) systems to streamline sales and inventory management simultaneously. This analysis enables developers to design an application that effectively meets users' needs and expectations, thus enhancing the restaurant's service quality and operational efficiency overall.

The results of this stage are displayed in Table 1. Restaurant owners primarily focus on operational efficiency and cost reduction, demanding an application with robust analytical features for better decision-making. Challenges faced by restaurant owners include stock cal-

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culation errors and inventory wastage, which the application must address through more efficient inventory management. Operational managers need tools that facilitate real-time inventory management and monitoring, overcoming inventory monitoring difficulties that affect customer product availability. Inventory staff expects integration with other systems, such as Point of Sale (POS), to enhance operational alignment. At the same time, customers demand consistent service and quick response to their requests, addressing challenges of uncertain product availability that affect the customer experience. By understanding the complexity of these needs, developers can design a holistic and responsive application, integrating features that meet the needs of each stakeholder to improve restaurant performance and overall customer experience.

**Table 2.** Features

| Feature | Function |
|---|---|
| Real-Time Inventory Monitoring | Displays inventory status in real-time for easy stock monitoring and quick decision-making. |
| Analytics Dashboard | Provides analytics data related to inventory performance, sales, and demand trends to assist users in making more informed decisions based on the data. |
| Order Management System | Facilitates ordering and order management from customers, including scheduling deliveries and payments. |
| Inventory Alerts and Notifications | Sends alerts and notifications to users about inventory status, stock-outs, or other important events. |
| Integration with Point of Sale (POS) | Links with the restaurant's Point of Sale (POS) system to integrate sales data with inventory data. |
| Customizable Reports | Creates customizable reports according to users' needs, including inventory reports, sales reports, and other operational performance reports. |
| User Roles and Permissions | Assigns roles and access permissions based on user levels to control access to application features and data. |

Table 2 presents the features of the restaurant reservation system, highlighting six main features, including reservation management, customer notifications, payment integration, performance reporting, table management, and data analysis. These features facilitate reservation management, customer communication, payment transaction efficiency, operational performance analysis, table usage optimization, and data-driven decision-making. Therefore, the restaurant reservation system enhances internal efficiency, improves customer experience, and supports more strategic management based on robust data and analysis.

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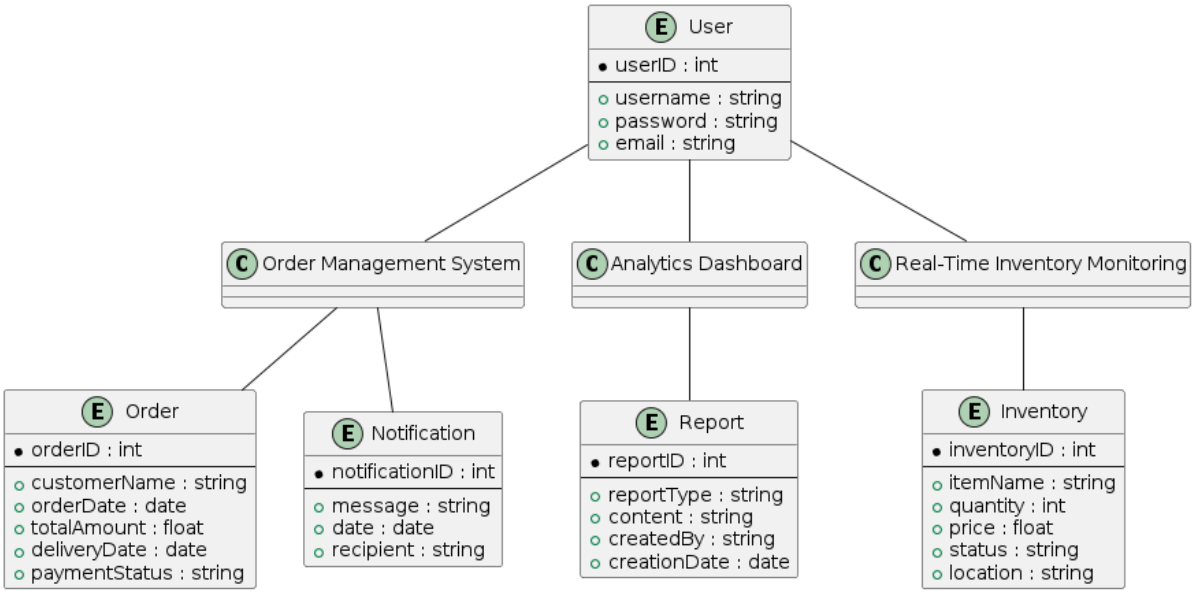


**Figure 3.** ERD

Figure 2 illustrates the main entities and their relationships in a restaurant inventory management system. The "User" entity represents system users with userID, username, password, and email attributes. The "Inventory" entity tracks inventory items with attributes like inventoryID, itemName, quantity, price, status, and location. Orders are managed through the "Order" entity, which includes order ID, customer name, order date, total amount, delivery date, and payment status. Reports are generated and stored using the "Report" entity, which contains reportID, report type, content, createdBy, and creation date. Notifications are sent to users through the "Notification" entity, with attributes like notification, message, date, and recipient. These interconnected entities reflect the system's functionality, where users can manage orders, monitor inventory in real time, view analytical reports, and receive notifications about system events.

### User Acceptance Evaluation

During the functional testing and user evaluation phase, several crucial activities are carried out to ensure the quality and suitability of the application to user needs. Integration testing is conducted by integrating all developed parts of the application, ensuring that all components work synergistically and interact well. Functional testing also assesses the application's ability to perform tasks according to user needs, including core features such as inventory management, orders, and reports. The results of functional testing showed that all features functioned correctly. User evaluation was conducted by gathering user feedback through application trials and evaluation sessions, focusing on usability, performance, and user satisfaction with the application. The evaluation results indicated that 85 percent of users found the application met their expectations for application development. These results were then analyzed to identify areas for improvement and make necessary enhancements to ensure the application delivers optimal value to users.

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## CONCLUSION

In the context of restaurant industry inventory management, this study revealed complex challenges such as the risk of inventory calculation errors, inventory shortages, and waste of materials. A practical solution to address these challenges was found through developing inventory management applications using the Extreme Programming (XP) method. Through user requirement analysis, application development, and user evaluation, the overall application development process successfully enhanced operational efficiency and improved restaurant customer experience. The use of XP demonstrated its advantages in providing adaptability to changes, development efficiency, and quality of the resulting product—positive user evaluation results aligned with expectations that the application delivers optimal value. Therefore, using XP in inventory management application development is a highly effective and responsive approach to dynamic needs in the restaurant industry.

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