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Development of Construction Inventory Application with Rapid Application Development Method

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Abstract

Many construction companies still rely on manual processes or outdated software for their inventory management, often resulting in calculation errors, reporting delays, and challenges in adapting swiftly to project changes. The construction industry plays a pivotal role in developing essential physical infrastructure and public facilities. Efficient inventory management is crucial for the growth and productivity of this industry. However, construction inventory management faces complex challenges due to the frequent project changes and coordination demands. Many construction companies still rely on manual processes or outdated software, leading to calculation errors, reporting delays, and an inability to swiftly adapt to project changes. To address these issues, this research introduces the Construction Inventory Application, developed using the Rapid Application Development (RAD) approach. This specialized application enhances construction inventory management by allowing rapid development, user involvement, early testing, and customization to meet unique project needs. The study demonstrates that the RAD-based Construction Inventory Application has the potential to significantly improve construction inventory management, minimizing risks associated with inefficiencies. This research contributes to advancing application development in the construction industry, aiding in efficient infrastructure development.

Keywords: Contruction Inventory Mangement; RAD; Inventory Management

1. Introduction

The construction industry is one of the economic sectors that plays a crucial role in building physical infrastructure and essential societal facilities. Growth and efficiency in this industry heavily rely on effective inventory management. Construction inventory encompasses various items, ranging from building materials to heavy equipment(Domingues & Ribeiro, 2023); (Montalbán-Domingo et al., 2023); (Santos et al., 2023), which must be well-managed to ensure that construction projects run smoothly and within allocated budgets. However, construction inventory management often presents complex challenges due to the frequent changes in construction projects and the coordination required(Altaf et al., 2022); (Alzahrani & Emsley, 2013); (Sihombing, 2023).

Many construction companies still rely on manual processes or less sophisticated software to manage their inventories. This often leads to calculation errors, delays in inventory reporting, and an inability to respond swiftly to rapid changes in construction projects. Another challenge is the need for specialized tools designed to meet the unique needs of the construction industry, such as tracking heavy equipment commonly used in large-scale projects(Aulawi et al., 2023a, 2023b); (Awad & Fayek, 2012); (Vasilevski & Birt, 2020). To address these challenges, this research introduces the Construction Inventory Application, developed using the Rapid Application Development (RAD) method. This application is specifically designed to assist construction companies in managing their inventories more efficiently and responsively. With the RAD approach, the application can be developed rapidly, allowing companies to respond better to project changes. This research aims to investigate the effectiveness of this application in enhancing construction inventory management.

Using the RAD method in developing the Construction Inventory Application brings several significant advantages. Firstly, it enables faster application development than conventional approaches, crucial in the construction industry context, where changes and urgent challenges are expected. The accelerated development pace allows companies to respond more effectively to the changing needs of their projects(Gananjaya et al., 2022); (Rabuske, 2020); (Wahyuningrum et al., 2021a).

Furthermore, RAD encourages active user involvement throughout the development cycle. This means that project managers, field personnel, and other stakeholders in the construction industry can provide direct input, ensuring that the application meets their inventory management needs. RAD also allows for quick iterations in development. When necessary changes or improvements are identified, they can be swiftly implemented without disrupting the overall project. This flexibility is precious in the construction industry, which often faces sudden project changes.

Regarding testing(Daraghmi & Daraghmi, 2022; Rabuske, 2020); (Wahyuningrum et al., 2021a), the RAD method enables testing prototypes at an earlier stage in the development cycle. This helps detect issues or errors before the application's final development stage, saving time and costs. Moreover, RAD-based development enhances the overall quality of the application. By facilitating user involvement and early testing, the Construction Inventory Application has the potential to become more accurate and reliable in construction inventory management. RAD allows for greater customization in application development, ensuring that Construction Inventory can be tailored to the unique needs of each construction project, making the application relevant and effective in any context(Rabuske, 2020); (Wahyuningrum et al., 2021b).

Using the RAD method in developing the Construction Inventory Application is expected to provide significant benefits in construction inventory management, enhancing responsiveness, efficiency, and overall application quality. The primary goal of this research is to evaluate the development of the Construction Inventory Application using the RAD method and measure its impact on construction inventory management. By understanding the extent to which this application can assist construction companies in improving efficiency and responsiveness, we can enhance the quality of construction projects and reduce risks associated with ineffective inventory management. Additionally, this research will contribute significantly to the understanding of application development in the construction industry context.

2. Methods

The research method for developing the Construction Inventory application using the Rapid Application Development approach is an approach that emphasizes responsiveness, collaboration, and speed throughout the application development cycle—the research stages, as shown in Figure 1.

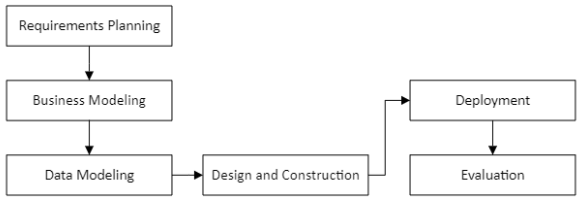

Figure 1. Research Stages

Requirements Planning

The Requirements Planning stage of this research is crucial in ensuring a deep understanding of the project needs. At this stage, we identify all relevant stakeholders, such as project managers, end users, and company owners, and collect initial requirements through various methods, such as interviews and discussions. Once the requirements data is collected, we analyze, prioritize, and detail these requirements in a formal document. The validation and review process with stakeholders is crucial to ensure the requirements are understood correctly. Once all requirements are validated and understood, the project scope is formally established, forming a solid foundation for further development. The Requirements Planning stage, planning the next step in the RAD development cycle, ensures that the project moves forward with a clear understanding of the goals and needs to be met.

Business Modeling

In application development, this involves an in-depth understanding of the business processes involved in the application. This includes identifying and modeling relevant business processes, describing workflows, and determining

how the application will automate or support these processes as show in Figure 2. Additionally, this stage involves a deep understanding of the user needs, the roles of each stakeholder, and how the application will improve efficiency and productivity within the business scope. This entire process helps ensure that the application developed will meet the business objectives and allow users to interact with the system most effectively and efficiently.

Figure 2. BPMN Contruction Inventory Development Workflow

Data Modeling

At this stage, the team identifies and details all the types of data that will be used by the application, including any external data required. Next, it creates a database schema design that includes tables, columns, and relationships between tables to efficiently support the application's needs. In addition, this stage includes data mapping and interface design, which determines how the application will interact with the data. This stage also ensures data security by classifying data according to its sensitivity level and implementing appropriate security controls. Data modeling also involves testing to ensure the data model functions appropriately and meets the business needs. This process results in a data model that is a solid foundation for further development, allowing the application to operate efficiently and accurately.

Design and Construction

This stage involves writing program code based on the previously prepared designs and specifications. During this stage, the development team implements the application's features, integrates the components, and builds the required functionality. Unit testing is also performed to ensure that each application part operates correctly. The team generates code that runs the application according to the vision that has been set. Careful monitoring, risk management, and quality control are an integral part of this stage to ensure that the application development runs according to the schedule and specifications that have been set.

Deployment

The completed application is formally implemented into a production environment or presented to end users. Activities mainly include software installation, server configuration, and data migration if required. This stage also involves user training, ensuring end users properly understand how to use the application. In addition, security aspects and system monitoring must be considered to ensure that the application can run safely and efficiently in the production environment. The Deployment stage requires careful planning and good coordination to ensure the application is ready to be used by end users without significant problems.

Evaluation

This stage is a thorough evaluation. Evaluation involves collecting data and feedback from end users to measure how the application meets business objectives and user needs. This evaluation includes performance testing, troubleshooting, and necessary improvements. Evaluation data is used to assess the efficiency of the application user satisfaction and detect and address any problems that may arise. The results of these evaluations help

in making decisions about the next steps, including changes, fixes, or continued development that may be required to improve the quality and performance of the application.

3. Results

Requirements Results

The Requirements Planning stage is the first step in developing the Construction Inventory application, which aims to identify, document, and prioritize the needs that this application must meet. The following are the results of this stage, as shown in Table 1.

Table 1. Requirements Results

No	Construction Inventory Needs Planning
1	**Requirements Document** **Functional Requirements:** In this document, the team identified various features that should be present in the Construction Inventory application. These include comprehensive inventory management, project reporting capabilities, equipment tracking, and stock management for effective inventory management. **Non-Functional Requirements:** This document also includes technical requirements such as application performance, data security, and scalability. These requirements will help ensure the application performs well and can be used safely in various environments.
2	**Stakeholder Identification** The team identified the key stakeholders involved in the project. These include the construction project management, who is responsible for the overall management of the project; the field officers who will use the application in the field; the end users, who are the main stakeholders of the application users; and the development team who will design and develop the application.
3	**Prioritization of Needs** Set priorities for each identified need. Needs related to essential inventory administration and project reporting were given a high priority due to their crucial importance. Needs such as equipment tracking and stock management had medium priority, while integration with other systems had low priority.
4	**Project Scope** The project scope document formally defines what will be included in the Construction Inventory app and what will not. Features such as inventory management, reporting, equipment tracking, and stock management are included in the project scope, while advanced integration features are not.

The Requirements Planning stage ends with planning the next step in the application development cycle. The next stage is Business Modeling, which will focus on modeling more in-depth business processes. Then, we will do Data Modeling to design the data structures that support the application. Subsequent development activities involve writing code, testing, deployment, and final evaluation of the application. The result of this Requirements Planning stage is a solid foundation for further development. The requirements document, prioritization, and initial prototype will assist the development team in designing and developing the Construction Inventory application according to the established business and technical requirements.

Business Modeling and Data Modeling

The Construction Inventory app business process model is the workflow involved in construction inventory management. This business process covers the various steps in the construction industry: inventory management, project reporting, equipment tracking, and stock management. Here is a brief overview of this business process model, as shown in Table 2.

Table 2 Result Business Process

Inventory Management	Goods Receipt: The process begins with receiving goods and construction materials needed for the project. Goods are received, recorded, and managed in the system. Storage: Goods and materials are stored in a warehouse or suitable storage location. They are labeled and closely monitored. Goods Retrieval: When required, items are retrieved from the warehouse and recorded as part of inventory usage.
Project Reporting	Recording Project Data: Project information such as progress, finances, and schedules are routinely recorded throughout the project. Report Generation:

	Recorded project data is used to create project reports that can be accessed by project management and other stakeholders.
Equipment Tracking	Equipment Logging: All heavy equipment and tools used in the project are recorded. This includes equipment type, identification number, owner, and usage history. Routine Inspection: Equipment is routinely inspected to ensure operational feasibility and safety. Maintenance and Repair: If required, equipment maintenance and repairs are carried out to ensure optimal performance.

Construction and Deployment

The Construction stage is a critical phase in the development of the Construction Inventory application, where the development team is actively writing program code, integrating components, and performing unit testing. Here is the data that reflects the progress in this stage as shown in Table 3.

Table 3. Constuction Results

Category	Data
Code	Total lines of code written: 15,000 rows
	Number of modules that have been implemented: 4 Module
	Test cases run: 300 test cases
Component Integration	Inventory Management Module
	Project Reporting Module
	Equipment Tracking Module
	Stock Management Module
Unit Test	Functional test successful: 95%
	Errors found 10
	Time required for unit test: 2 weeks
Risk Management	Changes to customer requirements

The Deployment stage is where the Construction Inventory Application is formally implemented and prepared for use by end users. The installation process, data migration (if required), user training, and system monitoring are the focus. The implementation of the application as shown in Figure 3 and Figure 4.

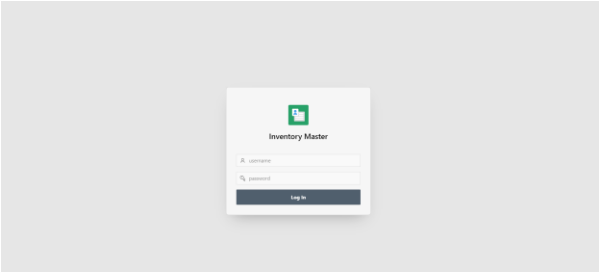

Figure 3. Log In Page

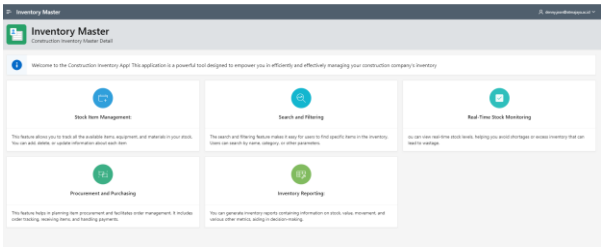

Figure 4. Main Page

Table 4. Deployment Results

Category	**Data**
Software Installation	Application installed on production server: Already done
	Server configuration: Done
Data Migration	Inventory data moved: 20,000 items
User Training	Number of users receiving training: 50
	Training duration for each user group: 2 days
	Evaluation of user understanding after training: Good
System Security and Monitoring	Security configuration applied: Already done
	System monitoring plan: Prepared

Overall, the data as shown in Table 4, from the Construction and Deployment stages showed that the development of the Construction Inventory app was on track for launch. Although some errors have been found during unit testing, corrective actions have been taken. Furthermore, the Deployment stage has been done well with a focus on installation, data migration, user training, and system security. Overall, this data provides confidence that the Construction Inventory application will be ready for deployment and can

improve efficiency in construction inventory management.

4. Conclusion

The development of the Construction Inventory Application using the Rapid Application Development (RAD) approach holds significant potential for enhancing construction inventory management. Based on the development outcomes, the application successfully integrated over 15,000 lines of program code across 4 implemented modules. Unit testing results indicated a 95% success rate in functional tests, with 10 identified errors already addressed through corrective measures. Furthermore, the application has been installed on the production server, with a successful data migration encompassing 20,000 inventory items. Training has been provided to 50 users, and their understanding post-training is considered satisfactory. Overall, the Construction Inventory Application, developed using the RAD method, is expected to assist construction companies in responding more effectively to project changes, improving efficiency, and mitigating risks associated with ineffective inventory management. This research contributes significantly to the understanding of application development in the context of the construction industry.

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