

Inventory, Rental and Sales Management System for Surgical Equipment Using Firebase Realtime Database

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ABSTRACT

Efficient inventory management is essential for surgical equipment suppliers to ensure product availability, accurate stock monitoring, and seamless rental and sales operations. Traditional inventory management methods, which primarily rely on manual record keeping and spreadsheet-based tracking, often lead to stock inconsistencies, delayed updates, calculation errors, and difficulties in generating business reports. These challenges affect operational efficiency and customer satisfaction, particularly in organizations that simultaneously manage product sales and rental services.

This paper presents **Virutcham SMS**, a cloud-based Inventory, Rental and Sales Management System developed using **Next.js**, **React.js**, **Tailwind CSS**, and **Firebase Realtime Database**. The proposed application integrates inventory management, rental processing, sales management, customer management, and report generation into a single cloud-based platform.

Keywords: Inventory Management, Rental Management, Surgical Equipment, Firebase Realtime Database, React.js, Next.js, Cloud Computing, Sales Management, Healthcare Inventory.

duplicate records, and inefficient report generation.

Most small and medium-scale surgical equipment suppliers still rely on paper-based registers or spreadsheet applications. These traditional methods lack automation and frequently produce errors while managing product availability, rental schedules, customer information, and financial records. Rental management becomes even more challenging when organizations must calculate rental duration, security deposit refunds, damage deductions, and overdue charges manually.

To overcome these limitations, this project proposes **Virutcham SMS**, a cloud-based Inventory, Rental and Sales Management System specifically developed for surgical equipment suppliers. The application integrates product inventory, customer records, rental transactions, sales management, and analytical reporting into a unified web platform.

The system is developed using **Next.js**, **React.js**, **Tailwind CSS**, and **Firebase Realtime Database**. Firebase Authentication provides secure user login, while the realtime database ensures instant synchronization of inventory data across multiple devices.

I. INTRODUCTION

Inventory management plays a vital role in organizations dealing with medical and surgical equipment. Hospitals, clinics, rehabilitation centers, and healthcare providers frequently purchase or rent surgical devices and medical accessories. As business operations grow, maintaining inventory manually becomes increasingly difficult and often results in inaccurate stock levels, delayed updates,

II. OBJECTIVES

The primary objective of the proposed system is to develop a secure and efficient cloud-based application capable of managing surgical equipment inventory, rental services, customer records, and sales transactions within a single integrated platform.

The specific objectives include:

- To automate inventory management and eliminate manual record keeping.

- To maintain accurate product availability through real-time stock updates.
- To manage customer information efficiently.
- To automate rental processing and return management.
- To calculate rental charges, security deposits, refunds, and damage deductions automatically.
- To manage product sales and inventory simultaneously.
- To generate business reports for inventory, rentals, sales, and revenue.
- To provide secure cloud-based authentication using Firebase Authentication.
- To enable real-time synchronization of business data across multiple devices.
- To improve decision-making through dashboard analytics.

III. PROBLEM STATEMENT

Many surgical equipment suppliers continue to manage inventory using manual registers or spreadsheet applications. Such approaches create several operational problems including stock inconsistencies, delayed updates, inaccurate rental calculations, duplicate customer records, and poor business reporting.

The absence of centralized inventory management often results in overbooking rental equipment, inaccurate sales records, and difficulty in tracking returned products. Manual calculations of rental duration, refundable deposits, and damage deductions further increase the possibility of human error.

Additionally, traditional systems do not provide real-time access to business information, making it difficult for multiple employees to work simultaneously. These limitations reduce productivity and negatively affect customer service.

The proposed **Virutcham SMS** addresses these challenges by providing an integrated, cloud-based inventory and rental management

platform that automates business processes while maintaining secure and accurate data.

IV. LITERATURE REVIEW

The advancement of cloud computing and web technologies has transformed inventory management systems across multiple industries. Modern inventory solutions utilize centralized databases, cloud infrastructure, and responsive web interfaces to improve operational efficiency and data accuracy.

Several researchers have proposed web-based inventory systems using relational databases and cloud services. These systems demonstrate significant improvements in stock management, customer service, and report generation compared to manual methods.

Firebase Realtime Database has become one of the most popular backend platforms for web applications because of its ability to synchronize data instantly across connected devices. Combined with React.js and Next.js, developers can build scalable, responsive, and highly interactive business applications.

Although numerous inventory management solutions exist, few applications specifically address the requirements of surgical equipment suppliers by integrating inventory management, rental processing, customer management, sales operations, security deposit calculations, and analytical reporting within a single cloud platform.

The proposed Virutcham SMS bridges this gap by providing a complete inventory ecosystem specifically designed for healthcare equipment businesses.

V. SYSTEM OVERVIEW

The proposed **Virutcham SMS (Inventory, Rental and Sales Management System)** is a cloud-based web application designed specifically for surgical equipment suppliers. The system integrates inventory management, rental processing, customer records, sales transactions, and business reporting into a single platform.

Unlike conventional inventory systems, Virutcham SMS provides real-time

synchronization using **Firebase Realtime Database**, allowing multiple authorized users to access updated information simultaneously. The application eliminates manual record keeping and automates various business operations, including inventory updates, rental calculations, and sales management.

The application follows a modular architecture, where each functional component communicates with Firebase services independently. This approach improves maintainability, scalability, and performance while simplifying future feature enhancements.

The system has been deployed on the **Vercel Cloud Platform**, providing secure cloud access and enabling users to operate the application from any location with internet connectivity.

VI. PROPOSED SYSTEM

The proposed system introduces a centralized digital platform that manages all major business operations related to surgical equipment inventory.

The major functions include:

- Product Management
- Category Management
- Customer Management
- Rental Processing
- Return Processing
- Sales Management
- Inventory Monitoring
- Business Reports
- Dashboard Analytics

Unlike spreadsheet-based systems, inventory is automatically updated after every rental, sale, or return transaction. The administrator can easily monitor stock availability, customer history, revenue generation, and overdue rentals through a modern dashboard interface.

The proposed application minimizes paperwork while improving operational efficiency and decision-making.

VII. SYSTEM ARCHITECTURE

The overall system architecture follows a cloud-based client-server model.

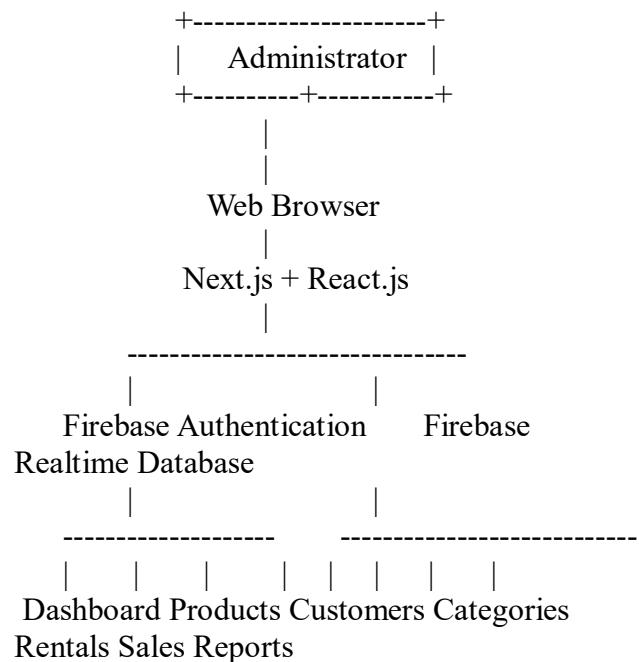


Figure 1. Overall System Architecture

The administrator accesses the web application through a browser. User authentication is handled using Firebase Authentication, while all business information is stored within Firebase Realtime Database. Each application module retrieves and updates data in real time.

VIII. FIREBASE DATABASE STRUCTURE

The Firebase Realtime Database organizes application data into separate nodes.

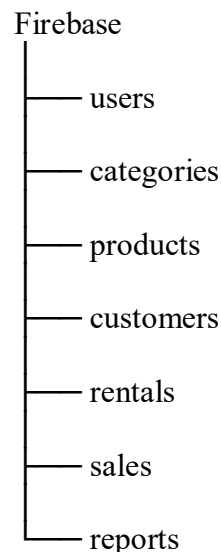


Figure 2. Firebase Realtime Database Structure

This hierarchical structure enables fast retrieval and efficient management of inventory, rental, sales, and customer information.

IX. MODULE DESCRIPTION

A. Dashboard Module

The Dashboard provides administrators with a comprehensive overview of current business activities.

Displayed information includes:

- Total Products
- Active Rentals
- Returned Rentals
- Available Inventory
- Low Stock Alerts
- Revenue Summary
- Sales Statistics
- Customer Count

The dashboard uses graphical representations and summary cards to improve business monitoring.

B. Category Management Module

This module organizes products into different categories such as:

- Wheelchairs
- Hospital Beds
- Walkers
- Oxygen Equipment
- Patient Care Accessories

Categorization improves product searching and reporting.

C. Product Management Module

The Product Module maintains complete product information.

Each product contains:

- Product Name
- Category
- Purchase Price

- Rental Price
- Selling Price
- Stock Quantity
- Product Image
- Availability Status

Whenever a rental or sale occurs, inventory quantities are updated automatically.

D. Customer Management Module

Customer records include:

- Customer Name
- Hospital Name
- Contact Number
- Address
- Rental History
- Purchase History

This centralized customer database improves transaction processing and customer relationship management.

E. Rental Management Module

The Rental Module is the core component of the proposed application.

Its functions include:

- Rental Creation
- Product Allocation
- Rental Duration Calculation
- Security Deposit Collection
- Damage Deduction
- Refund Calculation
- Return Processing
- Rental Reopen (within a limited time)

Inventory quantities decrease when products are rented and increase automatically after product return.

F. Sales Management Module

The Sales Module records completed product sales.

The module stores:

- Customer Details
- Product Details

- Quantity
- Selling Price
- Invoice Amount
- Sales Date

Inventory levels are automatically updated after each sale.

G. Reports Module

The Reports Module generates analytical reports including:

- Inventory Report
- Sales Report
- Rental Report
- Customer Report
- Revenue Report
- Low Stock Report

These reports assist management in monitoring business performance and making strategic decisions.

X. ADVANTAGES OF THE PROPOSED SYSTEM

The developed application provides numerous advantages over conventional manual inventory management.

Major advantages include:

- Cloud-Based Storage
- Real-Time Synchronization
- Responsive User Interface
- Secure Authentication
- Automatic Inventory Updates
- Rental Charge Automation
- Sales Tracking
- Customer History Management
- Business Analytics
- Reduced Paperwork
- Faster Transaction Processing
- Improved Data Accuracy
- Better Decision Making
- Easy Scalability

XI. METHODOLOGY

The development of **Virutcham SMS** followed the **Software Development Life Cycle (SDLC)** using an incremental development approach. Each module was developed independently, tested thoroughly, and integrated into the final application. This methodology ensured reliability, maintainability, and scalability while reducing development risks.

The development process consisted of the following phases:

A. Requirement Analysis

The first stage focused on understanding the operational workflow of surgical equipment suppliers. Requirements were collected through observation and discussions regarding inventory handling, rental services, customer management, and sales processing. Several limitations of manual inventory systems were identified, including inaccurate stock counts, delayed updates, duplicate records, and inefficient reporting.

B. System Design

Based on the gathered requirements, the application architecture was designed using a cloud-based client-server model. User interface layouts, database structures, and navigation workflows were planned before implementation.

The database was designed to store information regarding:

- Categories
- Products
- Customers
- Rentals
- Sales
- Users
- Reports

C. Frontend Development

The frontend was developed using **Next.js** and **React.js**. Component-based development was adopted to create reusable interfaces. Tailwind CSS was used to build responsive layouts compatible with desktops, tablets, and smartphones.

The frontend communicates directly with Firebase services to perform CRUD (Create, Read, Update, Delete) operations.

D. Backend Development

Firebase Realtime Database was selected as the backend because of its real-time synchronization capability. Firebase Authentication was integrated to provide secure user login and access control.

Whenever users perform operations such as product creation, rental processing, or sales transactions, Firebase automatically synchronizes the updated data across all connected clients.

E. Testing Phase

The completed modules were tested individually and collectively. Functional testing ensured that every feature behaved as expected, while integration testing verified smooth interaction between all modules.

The testing process included:

- Product Management Testing
- Rental Processing Testing
- Return Calculation Testing
- Sales Testing
- Customer Management Testing
- Report Generation Testing

F. Deployment

The application was deployed using **Vercel**, providing cloud hosting with automatic optimization and secure HTTPS access. Firebase Realtime Database stores all business information in the cloud, ensuring data accessibility and reliability.

XII. SOFTWARE DEVELOPMENT LIFE CYCLE

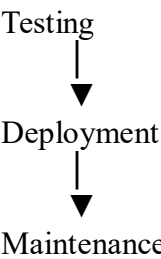
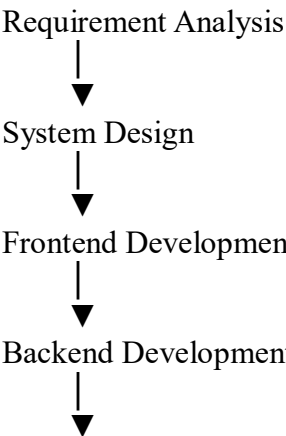


Figure 9. Software Development Life Cycle

The SDLC model adopted in this project ensures systematic development and simplifies future maintenance and enhancements.

XIII. REQUIREMENTS SPECIFICATION

A. Software Requirements

Software	Version / Description
Operating System	Windows 10 / Windows 11
IDE	Visual Studio Code
Programming Language	TypeScript
Frontend	Next.js 16
UI Library	React.js
CSS Framework	Tailwind CSS
UI Components	Shadcn UI
Database	Firebase Realtime Database
Authentication	Firebase Authentication
Charts	Recharts
Package Manager	npm
Hosting	Vercel
Browser	Google Chrome / Microsoft Edge

B. Hardware Requirements

Component Specification

Processor	Intel Core i5 or Higher
RAM	8 GB or Above
Storage	256 GB SSD
Display	Full HD Monitor
Internet	Broadband Connection
Input Devices	Keyboard and Mouse

XIV. TECHNOLOGY STACK

Layer	Technology
Frontend	Next.js
UI Library	React.js
Language	TypeScript
Styling	Tailwind CSS
Components	Shaden UI
Authentication	Firebase Authentication
Database	Firebase Realtime Database
Charts	Recharts
Deployment	Vercel

XV. FUNCTIONAL REQUIREMENTS

The proposed system provides the following functional capabilities:

1. User Login Authentication
2. Dashboard Analytics
3. Product Management
4. Category Management
5. Customer Management
6. Rental Processing

7. Rental Return Processing
8. Rental Reopen Facility
9. Sales Management
10. Report Generation
11. Low Stock Monitoring
12. Real-Time Inventory Updates

XVI. NON-FUNCTIONAL REQUIREMENTS

The application satisfies several non-functional requirements to ensure quality and reliability.

Performance

The application provides fast response times through optimized React components and Firebase real-time synchronization.

Security

Secure authentication is implemented using Firebase Authentication. Unauthorized users cannot access the application.

Scalability

Cloud infrastructure allows future expansion without major architectural changes.

Availability

The system remains available from any location with internet connectivity.

Usability

The interface follows modern UI/UX principles, making the application easy to use for non-technical staff.

Maintainability

The modular architecture simplifies maintenance and future feature additions.

XVII. IMPLEMENTATION DETAILS

The implementation of Virutcham SMS is divided into multiple independent modules.

Dashboard

Provides analytical information regarding products, rentals, sales, customers, and revenue.

Product Module

Maintains product inventory including pricing, quantity, and category information.

Category Module

Organizes products into logical categories for easier searching and reporting.

Customer Module

Maintains customer profiles along with hospital information and transaction history.

Rental Module

Handles product rentals, calculates rental charges, manages deposits, computes refunds, and supports return processing.

Sales Module

Records completed sales transactions while updating inventory automatically.

Reports Module

Generates detailed business reports to support management decisions.

Firebase Realtime Synchronization

Every transaction performed by the user is instantly synchronized with Firebase Realtime Database. This enables multiple users to access updated inventory information simultaneously without requiring manual page refresh.

The application follows CRUD operations for all modules, ensuring efficient data management and consistency across the platform.

XVIII. RESULTS AND DISCUSSION

The proposed **Virutcham SMS** application was successfully implemented and tested using various real-world scenarios involving surgical equipment inventory management, rental services, and sales operations. The testing phase verified that each module functioned accurately and maintained data consistency through Firebase Realtime Data

Compared to traditional spreadsheet-based inventory systems, the proposed application significantly reduced processing time, minimized duplicate records, and improved operational efficiency.

The overall implementation confirms that cloud-based inventory systems can effectively improve the management of surgical equipment businesses by providing centralized, secure, and scalable operations.

XX. PERFORMANCE ANALYSIS

The developed application was evaluated based on performance, usability, scalability, and data consistency.

Performance Metrics

Parameter	Observation
Login Speed	Fast
Inventory Update	Instant
Rental Processing	Efficient
Sales Processing	Accurate
Report Generation	Fast
Data Synchronization	Real-Time
User Interface	Responsive
Data Security	High

The application demonstrated excellent responsiveness during testing, with Firebase providing reliable cloud synchronization.

XXI. BENEFITS OF THE PROPOSED SYSTEM

The proposed system offers several advantages over traditional inventory management methods.

- Centralized inventory management
- Real-time stock synchronization
- Secure cloud-based authentication
- Automated rental calculations
- Automated refund and damage deduction calculations
- Automatic stock updates after rentals and sales
- Customer transaction history
- Business analytics dashboard
- Low stock monitoring
- Cloud accessibility
- Reduced paperwork
- Improved reporting accuracy

- Better customer service
- Easy future scalability

XXII. FUTURE ENHANCEMENTS

Although the current implementation satisfies the business requirements, several advanced features can further enhance the application.

Future improvements include:

- Barcode Scanner Integration
- QR Code Product Identification
- GST Invoice Generation
- WhatsApp Notification System
- SMS Reminder Service
- Email Notifications
- Multi-Branch Inventory Management
- Mobile Application (Android & iOS)
- AI-Based Inventory Prediction
- Voice Search
- Business Intelligence Dashboard
- Offline Synchronization
- Role-Based User Management
- Advanced Security Policies
- Automatic Backup and Recovery

These enhancements will improve operational efficiency while supporting future business growth.

XXIII. CONCLUSION

This paper presented **Virutcham SMS**, a cloud-based Inventory, Rental and Sales Management System developed specifically for surgical equipment suppliers. The application successfully integrates inventory management, customer management, rental processing, sales management, and business reporting into a unified web platform.

The system leverages **Next.js**, **React.js**, **Tailwind CSS**, and **Firebase Realtime Database** to deliver a modern, responsive, and scalable solution. Real-time synchronization ensures accurate inventory updates, while Firebase Authentication provides secure access to authorized users.

Automated rental calculations, inventory updates, refund processing, and report generation significantly reduce manual effort and improve operational efficiency. The centralized architecture simplifies business management and supports informed decision-making through interactive dashboards and analytical reports.

The developed application demonstrates that cloud-based web technologies provide an effective solution for modern healthcare equipment inventory management. The system can be further extended with barcode integration, AI-based inventory forecasting, and mobile application support, making it suitable for future business expansion.

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