Software Engineering Term Project Proposal

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1. Problem Description for Our Topic

In the modern hospital environment, various consumables and medical supplies are continuously used, making appropriate inventory management and release flow management essential. However, many hospitals still rely on **manual records, Excel files**, or centralized approaches. Such traditional methods carry the following structural problems and risks:

1. **Excess inventory and cost waste**

    - Research indicates that inventory management and related logistics activities (storage, transportation, redistribution, etc.) account for a significant portion of healthcare institutions' overall costs. The *Just-in-time approach* paper points out that inefficient inventory management leads to waste and unnecessary cost increases.
      https://pmc.ncbi.nlm.nih.gov/articles/PMC9805965
      (PMC: U.S. National Center for Biotechnology Information open-access repository)

    - Especially unused supplies, expired items, duplicate orders, or unnecessary storage materials hinder liquidity and increase costs.

2. **Inventory shortages and service delays**

    - Conversely, if inventory is insufficient, consumables may not be available at the necessary time, delaying patient treatment or medical procedures.

    - The *Point-of-use hospital inventory management* study shows that by placing inventories at points of use within hospitals and tracking them in real time with RFID, the risk of "shortage leads to procedure delay" can be reduced.
      https://pmc.ncbi.nlm.nih.gov/articles/PMC8342273/
    - In other words, the lack of visibility, distance, and accessibility between central storage and point-of-use contributes to missed critical supply timing.

3. **Uncertainty and errors in inventory data**

- Manual input or Excel-based management carries the risk of human error, omissions, or synchronization failures.

- The *Challenges of Inventory Management in Medical Supply Chain* study indicates that “lack of automation, low turnover, and inadequate control structures” reduce inventory data accuracy. http://researchgate.net/publication/372727898_The_Challenges_of_Inventory_Management_in_Medical_Supply_Chain

- These errors prevent accurate tracking of supply usage and cause problems during approval procedures or audits.

4. **Lack of systematic approval process and records**

   - For high-cost or high-risk consumables, physician approval must be mandatory. However, in many hospitals, approval still depends on verbal or handwritten notes.

   - This creates a lack of transparency, and without systematic approval records, post-audit accountability or dispute resolution becomes difficult.

5. **Lack of integration between inventory and logistics flows**

   - For surgical tools and supplies, coordination with logistics (movement, allocation, delivery) is crucial, not just inventory control.

   - The study *A Discrete Event Simulation Model for Coordinating Inventory Management and Material Handling in Hospitals* proved through simulation that integrated management of inventory and logistics improves operational efficiency and reduces costs. Especially under JIT systems, hospitals can lower stock levels while maintaining service quality. https://arxiv.org/abs/2006.06764

2. Necessity of the Term Project

Taken together, these issues demonstrate that analog inventory management hinders both operational efficiency and patient safety. Therefore, beyond convenience, it is essential to introduce a **digital-based consumables inventory management and approval system**.

The system has the following necessities:

1. **Enhancement of patient safety**: Digitizing the approval process ensures accountability and transparency when high-risk supplies are used.

2. **Compliance with regulations and audits**: All release and approval records are electronically logged, allowing immediate response to regulators or internal audits.

3. **Improved hospital efficiency**: Real-time inventory functions prevent both over-ordering and shortages, reducing operating costs.

4. **Data reliability**: Automated records and role-based access control reduce human error and provide accurate data for decision-making.

Thus, this project is not merely for convenience but is an essential system development effort to solve structural issues in hospital supply management and to achieve the three core goals of **safety, efficiency, and transparency**.

In today's healthcare environment, patient safety and operational efficiency are increasingly critical. However, many hospitals still rely on **manual records or simple Excel files** for consumables management. This causes difficulties in real-time stock visibility, missing usage records, and a lack of approval history.

For high-cost and high-risk consumables, physician approval is mandatory, yet analog workflows often depend on verbal or handwritten approvals. This not only threatens patient safety but also disadvantages hospitals during audits or regulatory compliance.

Therefore, introducing a **digital consumables inventory and approval system** is essential, ensuring patient safety, regulatory compliance, and cost savings.

3. Goal of the Term Project

The ultimate goal of this project is to digitize consumables inventory management and design/implement a prototype system that incorporates a systematic approval process. Specifically, the project pursues the following objectives:

1. **Establish a digital inventory management system**
    - Replace manual and Excel-based methods with a real-time system for registration, tracking, and expiry date management.
    - Enable transparent sharing of inventory status across departments.
2. **Implement an electronic approval process**
    - Ensure that high-cost and high-risk supplies cannot be released without formal physician approval.
    - Record approval requests, decisions, and histories electronically for transparency.
3. **Enhance patient safety and accountability**
    - Log requests, approvals, and releases for traceability.

    - Ensure transparency in handling sensitive or high-risk consumables, protecting patients while ensuring accountability.

4. **Improve hospital operational efficiency**
    - Prevent both overstocking and shortages with real-time monitoring.
    - Reduce human errors and support accurate decision-making via role-based access control and automated records.
5. **Secure scalability**
    - While the initial project scope focuses on inventory and approval processes, the modular design allows future extensions such as automatic ordering, EMR integration, and data analytics.

In summary, this project emphasizes **safety, efficiency, and transparency** as core values, aiming to propose a lightweight consumables management solution that is practical for adoption even in small- and medium-sized hospitals.

4. Functional Scope of the System

The proposed **Orthopedic Medical Supplies Inventory and Electronic Approval System** will focus on the following technical scope. The scope has been deliberately limited to maintain a manageable level of complexity for the project.

1. Inventory Management

- Real-time monitoring of key consumables (e.g., bandages, syringes, gloves) and orthopedic-specific supplies (e.g., surgical tools, implants).
- Inbound/outbound tracking with lot numbers for traceability.
- Basic categorization by type (consumables, surgical tools, implants) and storage location (central warehouse, operating room).

2. Electronic Approval Workflow

- Request → Physician approval → Release → Automatic recording.
- Approval required for high-cost or sensitive consumables (e.g., implants, special surgical materials).
- Notification to requester and logging of approval/rejection history.

3. User Role Management

- Role-based access control with three roles:
    - **Physicians**: approve requests.
    - **Nurses/Staff**: submit requests and track progress.
    - **Inventory managers**: confirm releases and adjust stock levels.
- Access rights limited per role to ensure security and reduce human errors.

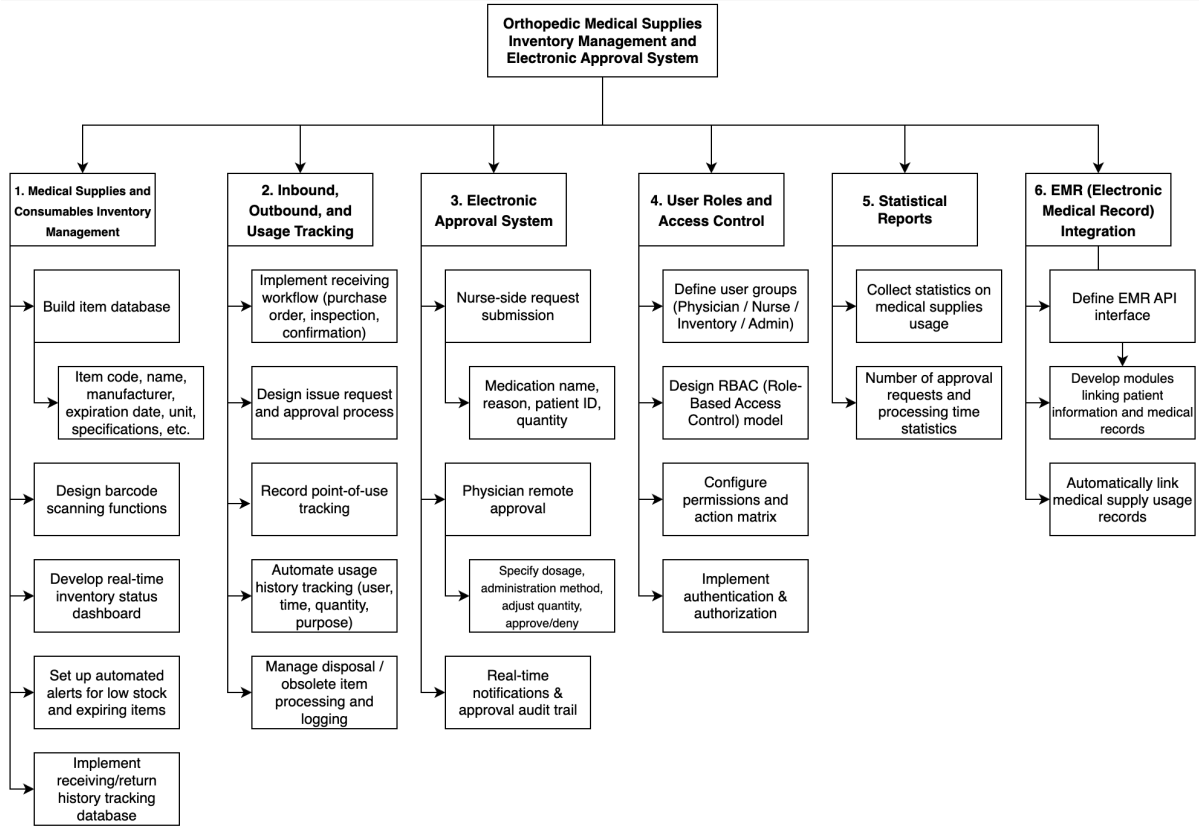
4. Barcode-based Inbound/Outbound Processing

- Use of barcode scanning for recording item usage.
- Supports real-time updates of inventory data and linkage to patient treatment records.

5. Statistical Reports

- Periodic usage statistics (monthly/quarterly consumption trends).
- Approval history reports for audit and accountability.
- Simple visualization dashboards (charts and graphs) for administrators.

5. Work breakdown structure for performing the term project.



6. Project Schedule

Week 5 (Oct 1 ~ Oct 8) — Proposal Submission

- Team formation completed
- Topic finalized: *Orthopedic Medical Supplies Inventory Management and Electronic Approval System*
- Proposal writing and submission (Problem description, necessity, objectives, WBS, role distribution included)

Week 6 (Oct 9 ~ Oct 14) — Interim Report Preparation

- Literature review and related research collection
- Detailed functional and non-functional requirements
- Draft UML Use Case Diagram

- Scenario writing (approval / inventory release / alert flow)

Week 7 (Oct 15) — Interim Report Submission

- Finalize and submit interim report including:
    - Problem description
    - Functional / Non-functional requirements
    - Domain specification
    - Scenarios
    - UML diagrams (requirements analysis)

Week 8–9 (Oct 16 ~ Oct 29)

- Expand UML design diagrams:
    - Class Diagram (Inventory, Approval, User, Log, etc.)
    - Sequence Diagram (approval process flow)
- Define system role hierarchy (Admin / Doctor / General user)
- Draft EMR integration Mock design

Week 10–11 (Oct 30 ~ Nov 12)

- Start drafting the final report
    - Expand from requirements specification → design specification
    - Structure report according to IEEE format
- Refine UML diagrams with STARUML (including Activity, State diagrams if needed)
- Draft design for statistical report module

Week 12–13 (Nov 13 ~ Nov 26)

- Finalize the final report

    - Complete all UML diagrams (Use Case, Class, Sequence, Activity, etc.)
    - Reference list (APA/IEEE style)
    - Abstract and related work
- Prepare presentation slides
- Assign presentation parts to each team member and rehearse

Week 14 (Dec 3) — Final Report & Presentation

- Submit final report
- Submit presentation materials
- Conduct rehearsal & final presentation (15 minutes, all team members participate)

7. Role of Each Team Member

To ensure systematic progress and clear accountability, the tasks outlined in the Work Breakdown Structure (WBS) have been distributed among the team members as follows:

- **Lee Jeongyun**

  Responsible for **Inventory Management, Inbound/Outbound & Usage Tracking, and Statistical Reports**.

  Specifically, this includes:

    - Designing and implementing the medical supplies inventory management module (item database, barcode integration, real-time dashboard, and alert system).
    - Developing workflows for inbound/outbound processing, approval-linked issue requests, and automated usage history tracking.
    - Building the reporting module to generate statistical summaries on medical supply consumption, approval requests, and processing time analytics.

- **Joo Youngjin**

  Responsible for **Electronic Approval System and User Roles & Access Control**.

Specifically, this includes:

- Developing the electronic approval workflow for physicians, including request submission, remote approval, dosage adjustment, and audit logging.
- Designing the role-based access control (RBAC) framework, configuring permission matrices, and implementing authentication and authorization mechanisms.

- **Kwon Daehun**

  Responsible for **Electronic Medical Record (EMR) Integration**.

  Specifically, this includes:

  - Defining EMR API interfaces for seamless integration.
  - Developing modules that link patient information and medical records with the supply management system.
  - Implementing automated synchronization of medical supply usage records into the EMR for compliance and traceability.