Mountain View Community Hospital (MVCH)

Database System Proposal

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1: Introduction

1.1 Overview

Mountain View Community Hospital (MVCH) is a not-for-profit, short-term general hospital that serves the city of Mountain View and several surrounding rural areas. They are looking for an integrated system that will assist their multiple departments in various daily processes related to financial accounting, patient care and medical services. This proposal document will address their requirements and define a new centralized database that provides an accurate and timely system.

1.2 Business Problem

Presently, the information systems at MVCH are application programs and batch-oriented. They do not interact with each other and are extremely time-consuming, which have resulted in the following deficiencies:

- Lacks laboratory management - Tests and procedures are not recorded within the current system.
- Lacks immediate system-wide access to information - Processes related to Patient Accounting, Billing, Accounts Receivable and Financial Accounting are batch processed.
- Lacks detailed revenue analysis - There is no support for costs collected by departments or cost centers as the systems are not integrated.
- Lacks scalability and reporting features – There is no scalability resulting in a unresponsive system with no reporting requirements.

1.3 Approach and Solution

The approach taken to gather the proposed system requirements was an open line of communication with Ms. Baker, the hospital administrator, and a thorough document analysis of the project proposal. To begin with, we analyzed the proposal document and uncovered the four key problems of the current system, which are outlined in *section 1.2: business problem*. Additionally, Nathan Heller, the head of Information Systems, outlined the major documents, reports, and displays that were required by MVCH. Then, after a thorough discussion amongst our team, we generated a list of questions for Ms. Baker. The answers given offered clarity and filled any gaps in our knowledge, ensuring an accurate representation of the previous and proposed data structures at the hospital.

After the open dialogue and system proposal analysis, we decided that an integrated hospital management system would be the best solution to the problems the current system face. The integration would encompass all departments ensuring streamlined interactions and communication. In addition, the six subsystems required to produce this solution will address each overarching problem outlined. The result of our combined effort is detailed as follow:

- **Test and Procedure Management System** – Handles the results of lab tests and procedures and ensures data is viewed and retrieved by authorized parties.
- **Patient Management System** – Handles patient registration, patient intake with room utilization, and appointment scheduling in real time through online transaction processing to ensure system-wide access to patient information.
- **Staff Management System** – Handles staff information to demonstrate various accountability measures and monitoring capabilities.

- **Financial Management System -** Handles patient accounting, revenue analysis, cost center expenses, pharmaceutical profits and more and produces detailed reports that are informative and can be easily adjusted.
- **Cost Center Management System** – Handles the cost centers and as the system grows in volume, traffic or even complexity, the scalability features will allow various expense and revenue streams to be easily added. Also, since the systems are all integrated, cost by cost center can be easily accumulated.
- **Supply Management System** – Handles supplies and its inventory and demonstrates how easy it would be to scale up the system as supply management is directly related to the cost centers.

2: Mission Statement

The purpose of the MVCH Database System is to maintain data produced and quickly access information generated to provide an accurate, scalable system that supports all medical services, staff, and patients.

3: Requirement Gathering

The following requirements were gathered after the comprehensive analysis outlined in *section 1.3: approach and solution*.

3.1 Non-functional Requirements

1. Performance
    - Generate daily and weekly reports in under 5 seconds.
    - Store and update and view records in under 2 seconds.
    - User login in under 2 seconds.
2. Operational
    - System availability will be 24/7.
    - Compatibility with Windows, Linux, iOS, and Android.
    - MS SQL server is required.
    - Requires internet download speeds of 250mbps or higher.
    - Recommended device specs include 1 TB SSD, 16 GB RAM, and Core i7.
    - Inactive patient data will be archived after a period of two years into a separate repository.
    - Data will be fully backed up daily with an incremental backup every 6 hours.
3. Security
    - Inaccessibility to the system for unauthorized users.
    - Patient information cannot be deleted from the system.
    - Patient payment information will be encrypted and processed securely
    - Anti-Virus software will be utilized to protect against malware attacks.
4. Cultural and Political

- Multiple languages will be supported.
- Both sex and gender identities will be supported.

3.2 Functional Requirements

1. Manage Staff – *Manager Only*
   - Create staff records.
   - Update staff records.
   - Retrieve physician information.
2. Manage Patient Information – *Physicians, Lab Technicians, and Administrative Clerks Only*
   - Create patient records.
   - Update patient record.
   - Retrieve patient information.
3. Manage High Level Operations – *Director Only*
   - Retrieve data related to revenue generated.
   - Generate daily revenue reports with costs accumulated by cost center.
4. Manage Appointments – *Administrative Clerk Only*
   - Create new appointments.
   - Update appointment status.
   - Cancel appointments.
   - Generate a list of daily appointments.
   - Print list of daily appointments.
5. Manage Room Utilization – *Administrative Clerk Only*
   - Create a room record.

- Update bed availability when a patient is discharged.
- Delete room record.
- Generate a daily room utilization report.

6. Manage Patient Intake – *Administrative Clerk Only*
   - Create patient intake record.
   - Update patient intake record.
   - Assign patient to a bed within a room.
   - Assign physician to a patient.
   - Generate daily reports that display physicians and their assigned patients.
7. Manage Invoices – *Administrative Clerk Only*
   - Create invoice record.
   - Update invoice record.
   - Retrieve invoice information.
   - Generate a patient invoice with charges grouped by cost center.
8. Manage Examinations – *Physician Only*
   - Create examination record.
   - Update examination record.
   - Retrieve examination information.
9. Manage Treatments – *Physician Only*
   - Create treatment record.
   - Update treatment record.
   - Retrieve treatment information.
10. Manage Supply – *Administrative Clerk Only*

- Create supply record.
- Update supply record.
- Retrieve supply information.
- Monitor and provide order lists for supplies.
- Print supply information.

11. Manage Chargeable Items – *Administrative Clerk Only*
    - Create chargeable item records.
    - Update chargeable item records.
    - Retrieve chargeable item information.
    - Monitor and provide order lists for items.
    - Print chargeable item information.
12. Manage Cost-centers – *Administrative Clerk Only*
    - Create cost center records.
    - Assign chargeable items and supplies to cost centers.
13. Manage Diagnostic Tests – *Lab Technician and Physicians Only*
    - Lab technician can create diagnostic test record.
    - Lab technician can update diagnostic test record.
    - Lab technician and Physicians can retrieve diagnostic test information.
14. Manage Diagnostic Requests - *Lab Technician and Physicians Only*
    - Physicians can create diagnostic request record.
    - Physicians can update diagnostic request record.
    - Lab Technician and Physicians can retrieve diagnostic request information.

4: Normalization

To achieve the third normal form, we uncovered all entities during the requirement gathering stage and created an unnormalized table. Then, we worked on the first normal form by removing repeating groups, assigning primary keys, and identifying all the functional dependencies outlined in *section 5: functional dependencies*.

Next, we focused on the second normal form and achieved it by removing the partial dependencies and created the new tables. As a result, the database design was centralized, connected, and could easily enter, update, and retrieve information associated with the six subsystems outlined in *section 1.3: approach and solution*.

Finally, we further improved the design by creating the third normal form, which allowed scalability features. To accomplish this, we removed all transitive dependencies and created the new tables. Subsequently, you could clearly visualize how the database could be expanded as MVCH starts incorporating more departments (cost centers), specialties, and inventory.

3NF – Third Normal Form

- **FINANCIAL_STATUS** (FINANCIAL_STATUS_NO, FINANCIAL_STATUS_SOURCE)
- **PATIENT** (PATIENT_NO, FINANCIAL_STATUS_NO, PATIENT_FIRSTNAME, PATIENT_LASTNAME, PATIENT_STREETADDRESS, PATIENT_PROVINCE, PATIENT_ZIPCODE, PATIENT_TELEPHONE, PATIENT_SEX, PATIENT_GENDER, PATIENT_HCN, PATIENT_DOB)
- **STAFF** (STAFF_NO, STAFF_FIRSTNAME, STAFF_LASTNAME, STAFF_STREETADDRESS, STAFF_PROVINCE, STAFF_ZIPCODE,

STAFF_TELEPHONE, STAFF_SEX, STAFF_GENDER STAFF_TYPE, STAFF_DOB)

- **SPECIALTY** (SPECIALTY_CODE, SPECIALTY_TYPE)
- **PHYSICIAN** (STAFF_NO, SPECIALTY_CODE)
- **ROOM_TYPE** (ROOM_TYPE_CODE, ROOM_TYPE)
- **ROOM** (ROOM_NO, ROOM_TYPE_CODE, ROOM_LOCATION, ROOM_OCCUPIED)
- **PATIENT_INTAKE** (PATIENT_INTAKE_NO, PATIENT_NO, ROOM_NO, STAFF_NO, DATE_ADMITTED)
- **APPOINTMENT** (APPOINTMENT_NO, PATIENT_NO, STAFF_NO, APPOINTMENT_DATETIME)
- **COST_CENTER** (COST_CENTER_NO, COST_CENTER_NAME)
- **ITEM** (ITEM_CODE, COST_CENTER_NO, ITEM_QUANTITY, ITEM_DESCRIPTION, ITEM_CHARGE)
- **SUPPLY_TYPE** (SUPPLY_TYPE_CODE, SUPPLY_TYPE_NAME)
- **SUPPLY** (SUPPLY_NO, SUPPLY_TYPE_CODE, ITEM_NO, SUPPLY_CHARGE)
- **LINEITEMS** (LINEITEM_NO, PATIENT_NO, ITEM_CODE, LINEITEM_CHARGE)
- **EXAMINATION** (EXAMINATION_NO, APPOINTMENT_NO, EXAMINATION_DESCRIPTION)

- **DIAGNOSTIC_REQUEST** (DIAGNOSTIC_REQUEST_NO, STAFF_NO, PATIENT_NO, ITEM_CODE, DIAGNOSTIC_REQUEST_DATE, DIAGNOSTIC_REQUEST_COMMENT)
- **DIAGNOSTIC_TEST** (DIAGNOSTIC_TEST_NO, DIAGNOSTIC_REQUEST_NO, STAFF_NO, DIAGNOSTIC_TEST_DESCRIPTION, DIAGNOSTIC_TEST_DATE)
- **TREATMENT** (TREATMENT_NO, STAFF_NO, PATIENT_NO, SUPPLY_NO, TREATMENT_START_DATE, TREATMENT_END_DATE)
- **INVOICE** (INVOICE_NO, PATIENT_INTAKE_NO, LINE_ITEM_NO, SUPPLY_NO DATE_CHARGED, DATE_PAID, DATE_DISCHARGED)

5: Functional Dependencies

The following dependencies were identified in the first normal form and removed to create an accurate, maintainable, and scalable system.

5.1 Partial Dependencies

- PATIENT_NO → PATIENT_FIRSTNAME, PATIENT_LASTNAME, PATIENT_STREETADDRESS, PATIENT_PROVINCE, PATIENT_ZIPCODE, PATIENT_TELEPHONE, PATIENT_SEX, PATIENT_GENDER, PATIENT_HCN, PATIENT_DOB, FINANCIAL_STATUS_SOURCE
- STAFF_NO → STAFF_FIRSTNAME, STAFF_LASTNAME, STAFF_STREETADDRESS, STAFF_PROVINCE, STAFF_ZIPCODE, STAFF_TELEPHONE, STAFF_SEX, STAFF_GENDER STAFF_TYPE, STAFF_DOB
- STAFF_NO → SPECIALTY_TYPE
- ROOM_NO → ROOM_TYPE, ROOM_LOCATION, ROOM_OCCUPIED
- PATIENT_INTAKE_NO → DATE_ADMITTED
- APPOINTMENT_NO → APPOINTMENT_DATETIME
- ITEM_CODE → ITEM_QUANTITY, ITEM_DESCRIPTION, ITEM_CHARGE
- SUPPLY_NO → SUPPLY_TYPE_NAME, ITEM_NO, SUPPLY_CHARGE
- LINEITEM_NO → LINEITEM_CHARGE
- EXAMINATION_NO → EXAMINATION_DESCRIPTION
- DIAGNOSTIC_REQUEST_NO → DIAGNOSTIC_REQUEST_DATE, DIAGNOSTIC_REQUEST_COMMENT

- DIAGNOSTIC_TEST_NO → DIAGNOSTIC_REQUEST_ID, STAFF_NO, DIAGNOSTIC_TEST_DESCRIPTION, DIAGNOSTIC_TEST_DATE
- TREATMENT_NO → TREATMENT_START_DATE, TREATMENT_END_DATE
- INVOICE_NO → DATE_CHARGED, DATE_PAID, DATE_DISCHARGED

5.2 Transitive Dependencies

- FINANCIAL_STATUS_NO → FINANCIAL_STATUS_SOURCE
- SPECIALTY_CODE → SPECIALTY_TYPE
- ROOM_TYPE_CODE → ROOM_TYPE
- SUPPLY_TYPE_CODE → SUPPLY_TYPE_NAME
- COST_CENTER_NO → COST_CENTER_NAME

6: System Description Diagrams

The following diagrams are visual aids for the proposed system. They each serve their own purpose and demonstrates the various interactions that take place at MVCH.

6.1 User View Diagram

The user view diagram outlines the varying access levels for processes of the subsystems within the MVCH Database system. Overall, it incorporates the manager, director, administrative clerk, physician, and lab technician user views.

Managers are in charge of departments, so naturally, they are allowed access to staff. We also assigned access to the cost centers for the departmental costs. We realize that cost centers can cover a wide variety of functions within the hospital, and currently, there are no requirements to have them adjusted. As a result, we included a very general outline of the cost centers and who is allowed access so their current duties can be achieved. The Directors are in charge of high-level operations, which is essentially data surrounding revenue. Since revenue is generated by the cost center, they were granted access. Administrative clerks have access to cost centers because they manage chargeable items. They are also in charge of appointments, invoices, patient intake, and patient information.

Next, physicians also have access to patient information to undertake examinations and assign treatments. They also share several processes with Lab technicians, such as diagnostic tests and requests. Lab technicians can only view the primary patient information and any patient information the doctor supplied in the diagnostic request to complete the tests within the laboratory.

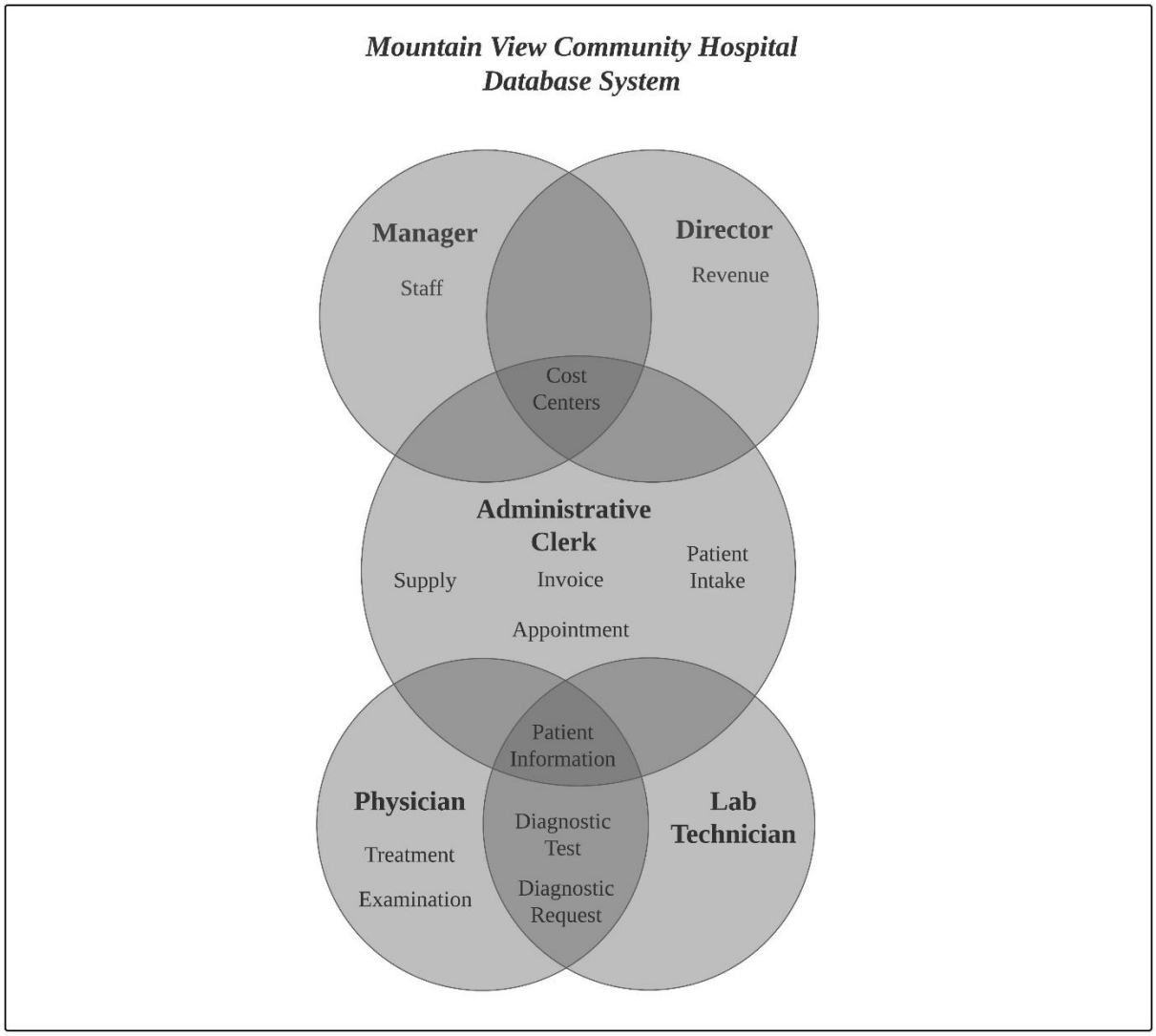

Figure 6-0-1: User View Diagram

6.2 System Boundary

The system boundary diagram outlines the various subsystems at work within the proposed database. There are 6 main components, and they combine to form an integrated hospital management system that maintains patient management, staff management, financial management, laboratory tests and procedure management, cost center management, and supply management. For each system boundary, the users within are mostly responsible for the management of the processes. Lastly, the patient does not directly communicate with the various systems, but they are crucial to their interactions, so they are included on the outside of the boundaries.

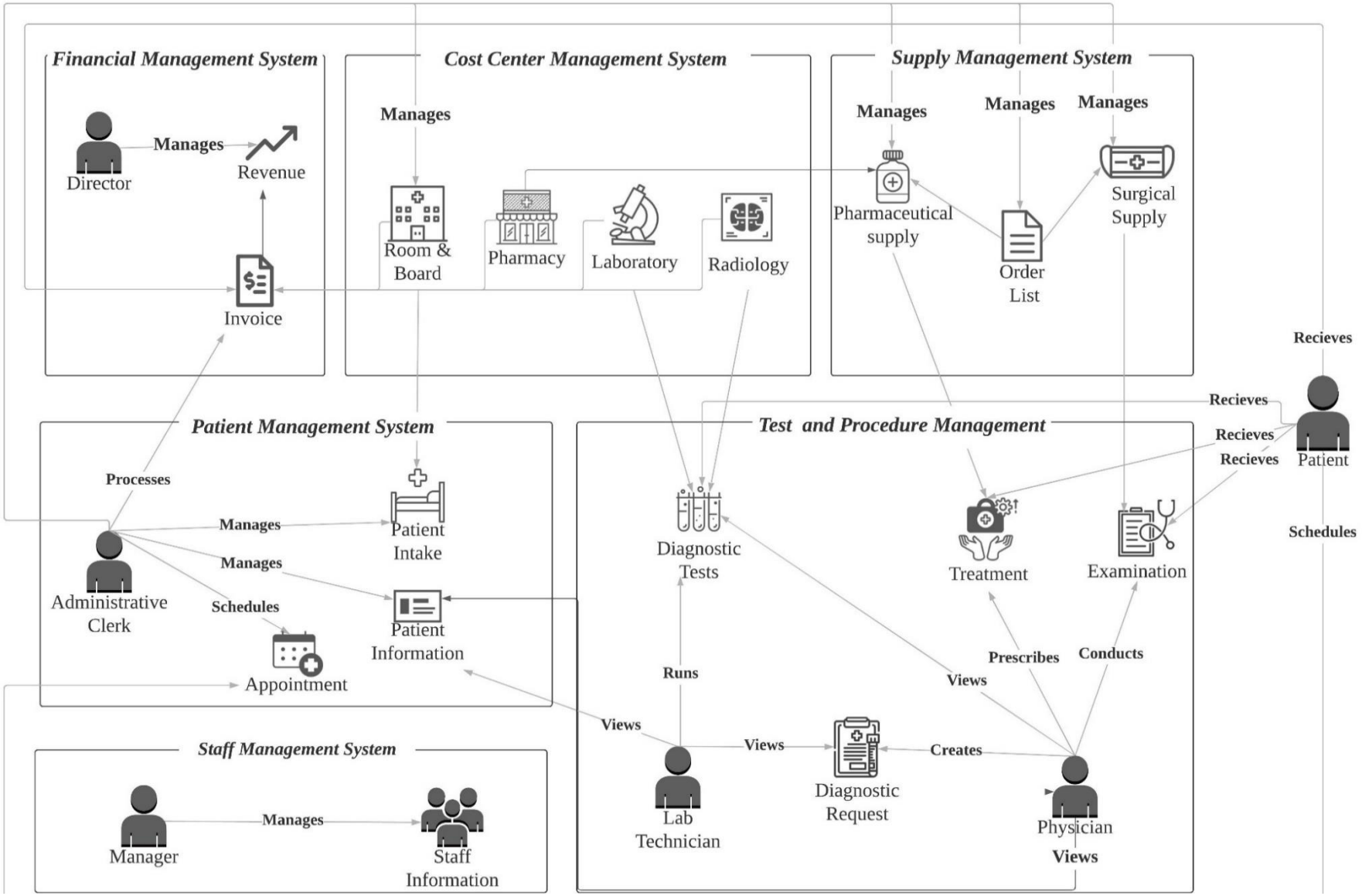

Figure 6-0-2: System Boundary Diagram

6.3 Entity Relationship Diagram

The ERD is a visual representation of all the entities within the MVCH database system. All entities in the model are related in some way. Whether it be directly (e.g., the ROOM entity takes ROOM_TYPE_CODE directly from the ROOM_TYPE entity) or indirectly (e.g., PATIENT_INTAKE is related to ROOM_TYPE through ROOM). The ERD displays which entities are reliant on other entities and which are self-sustained. Entities with fields that are foreign keys (FK) are reliant on other entities to provide that field data. Self-sustained entities include SPECIALTY, STAFF, SUPPLY_TYPE, COST_CENTER, FINANCIAL_STATUS, and ROOM_TYPE. All other entities rely on one or more different entities.

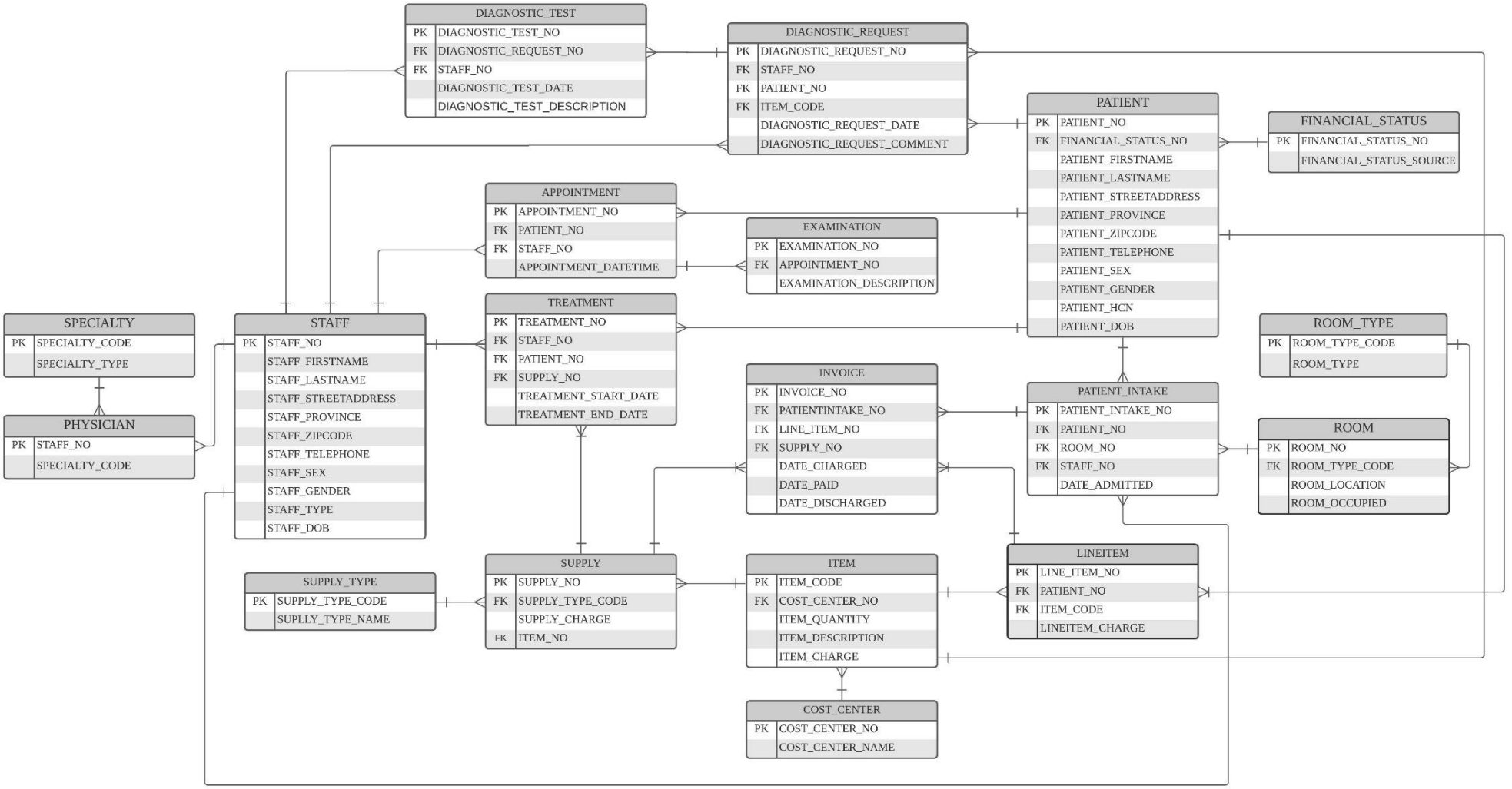

Figure 6-3: Entity Relationship Diagram

7: Data Dictionary

Table Name	Attribute Name	Contents	Type	Format	Range	Required	Pk Or Fk	Fk Referenced Table
SPECIALITY	SPECIALITY_CODE	Specialty code	INT	999999	>0	Y	PK	
	SPECIALITY_TYPE	Specialty type	VARCHAR(32)	Xxxxxxxxx				
PHYSICIAN	STAFF_NO	Staff number	INT	99999	>0	Y	PK	STAFF
	SPECIALITY_CODE	Specialty code	INT	99999	>0	Y		
STAFF	STAFF_NO	Staff number	INT	99999	>0	Y	PK	
	STAFF_FIRSTNAME	Staff first name	VARCHAR(32)	Xxxxxxxxx				
	STAFF_LASTNAME	Staff last name	VARCHAR(32)	Xxxxxxxxx				
	STAFF_STREETADDRESS	Staff street address	VARCHAR(255)	Xxxxxxxxx				
	STAFF_PROVINCE	Staff province	VARCHAR(2)	XX				
	STAFF_ZIPCODE	Staff zip code	VARCHAR(6)	X9X9X9				
	STAFF_TELEPHONE	Staff telephone	VARCHAR(16)	Xxxxxxxxx				
	STAFF_DOB	Staff date of birth	DATE	YYYY-MM-DD				
	STAFF_SEX	Staff sex	VARCHAR(1)	X				
	STAFF_GENDER	Staff gender	VARCHAR(16)	Xxxxxxxxx				
	STAFF_TYPE	Staff type	VARCHAR(16)	Xxxxxxxxx				
ITEM	ITEM_CODE	item code	INT	99999	>0	Y	PK	
	COST_CENTER_NO	cost center number	INT	99999	>0	Y	FK	COST_CENTER
	ITEM_QUANTITY	item quality	INT	99999	>0			
	ITEM_DESCRIPTION	item description	VARCHAR(255)	Xxxxxxxxx				
	ITEM_CHARGE	item charge	DECIMAL(10, 2)	99.99	<10000000000			
COST_CENTER	COST_CENTER_NO	cost center number	INT	99999	>0	Y	PK	
	COST_CENTER_NAME	cost center name	VARCHAR(32)	Xxxxxxxxx				

LINEITEM	LINE_ITEM_NO	line-item number	INT	99999	>0	Y	PK	
	PATIENT_NO	patient number	INT	99999	>0	Y	FK	PATIENT
	ITEM_CODE	item code	INT	99999	>0	Y	FK	ITEM
	LINEITEM_CHARGE	line-item charge	DECIMAL(10, 2)	99.99	<10000000000			
INVOICE	INVOICE_NO	invoice number	INT	99999	>0	Y	PK	
	PATIENT_NO	patient number	INT	99999	>0	Y	FK	PATIENT
	LINE_ITEM_NO	line-item number	INT	99999	>0	Y	FK	LINEITEM
	SUPPLY_NO	Supply number	INT	99999	>0	Y	FK	
	DATE_CHARGED	date charged	DATETIME	YYYY-MM-DD HH:mm:SS				
	DATE_PAID	Date paid	DATETIME	YYYY-MM-DD HH:mm:SS				
	DATE_DISCHARGED	date discharged	DATETIME	YYYY-MM-DD HH:mm:SS				
TREATMENT	TREATMENT_NO	treatment number	INT	99999	>0	Y	PK	
	STAFF_NO	staff number	INT	99999	>0	Y	FK	STAFF
	PATIENT_INTAKE_NO	patient intake number	INT	99999	>0	Y	FK	PATIENT_INTAKE
	SUPPLY_NO	supply number	INT	99999	>0	Y	FK	SUPPLY
	TREATMENT_START_DATE	treatment start date	DATETIME	YYYY-MM-DD HH:mm:SS				
	TREATMENT_END_DATE	treatment end date	DATETIME	YYYY-MM-DD HH:mm:SS				
SUPPLY_TYPE	SUPPLY_TYPE_CODE	supply type code	INT	99999	>0	Y	PK	
	SUPLLY_TYPE_NAME	supply type name	VARCHAR(16)	Xxxxxxxxx				
SUPPLY	SUPPLY_NO	supply number	INT	99999	>0	Y	PK	

	SUPPLY_TYPE_CODE	supply type code	INT	99999	>0	Y	FK	SUPPLY_TYPE
	ITEM_CODE	Item number	INT	99999	>0	Y	FK	
	SUPPLY_CHARGE	Supply charge	DECIMAL(10, 2)	99.99	<10000000000			
PATIENT	PATIENT_NO	patient number	INT	99999	>0	Y	PK	
	FINANCIAL_STATUS_NO	financial status number	INT	99999	>0	Y	FK	FINANCIAL_STATUS
	PATIENT_FIRSTNAME	patient first name	VARCHAR(32)	Xxxxxxxxx				
	PATIENT_LASTNAME	patient last name	VARCHAR(32)	Xxxxxxxxx				
	PATIENT_STREETADDRESS	patience street address	VARCHAR(255)	Xxxxxxxxx				
	PATIENT_PROVINCE	patient province	VARCHAR(2)	XX				
	PATIENT_ZIPCODE	patient zip code	VARCHAR(6)	X9X9X9				
	PATIENT_TELEPHONE	patient telephone	VARCHAR(16)	Xxxxxxxxx				
	PATIENT_DOB	patient date of birth	DATE	YYYY-MM-DD				
	PATIENT_SEX	patient sex	VARCHAR(1)	X				
	PATIENT_GENDER	patient gender	VARCHAR(16)	Xxxxxxxxx				
	PATIENT_HCN	patient HCN	VARCHAR(15)	Xxxxxxxxx				
FINANCIAL_STATUS	FINANCIAL_STATUS_NO	financial status number	INT	99999	>0	Y	PK	
	FINANCIAL_STATUS_SOURCE	financial status source	VARCHAR(32)	Xxxxxxxxx				
ROOM_TYPE	ROOM_TYPE_CODE	room type code	INT	99999	>0	Y	PK	
	ROOM_TYPE	room type	VARCHAR(16)	Xxxxxxxxx				
PATIENT_INTAKE	PATIENT_INTAKE_NO	patient intake number	INT	99999	>0	Y	PK	
	PATIENT_NO	patient number	INT	99999	>0	Y	FK	PATIENT
	ROOM_NO	room number	INT	99999	>0	Y	FK	ROOM
	STAFF_NO	staff number	INT	99999	>0	Y	FK	STAFF

	DATE_ADMITTED	date admitted	DATETIME	YYYY-MM-DD HH:mm:SS				
ROOM	ROOM_NO	room number	INT	99999	>0	Y	PK	
	ROOM_TYPE_CODE	room type code	INT	99999	>0	Y	FK	ROOM_TYPE
	ROOM_LOCATION	room location	VARCHAR(32)	Xxxxxxxxx				
	ROOM_OCCUPIED	room occupied	VARCHAR(3)	Xxx				
APPOINTMENT	APPOINTMENT_NO	appointment number	INT	99999	>0	Y	PK	
	PATIENT_NO	patient number	INT	99999	>0	Y	FK	PATIENT
	STAFF_NO	staff number	INT	99999	>0	Y	FK	STAFF
	APPOINTMENT_DATETIME	appointment date	DATETIME	YYYY-MM-DD HH:mm:SS				
EXAMINATION	EXAMINATION_NO	examination number	INT	99999	>0	Y	PK	
	APPOINTMENT_NO	appointment number	INT	99999	>0	Y	FK	APPOINTMENT
	EXAMINATION_DESCRIPTION	examination description	VARCHAR	Xxxxxxxxx				
DIAGNOSTIC_REQUEST	DIAGNOSTIC_REQUEST_NO	diagnostic request number	INT	99999	>0	Y	PK	
	STAFF_NO	staff number	INT	99999	>0	Y	FK	STAFF
	PATIENT_NO	patient number	INT	99999	>0	Y	FK	PATIENT
	LINEITEM_NO	line-item number	INT	99999	>0	Y	FK	LINEITEM
	DIAGNOSTIC_REQUEST_DATE	diagnostic request date	DATETIME	YYYY-MM-DD HH:mm:SS				
	DIAGNOSTIC_REQUEST_COMMENT	diagnostic request comment	VARCHAR(255)	Xxxxxxxxx				
DIAGNOSTIC_TEST	DIAGNOSTIC_TEST_NO	diagnostic test number	INT	99999	>0	Y	PK	

	DIAGNOSTIC_REQUEST_NO	diagnostic request number	INT	99999	>0	Y	FK	DIAGNOSTIC_REQUEST
	STAFF_NO	staff number	INT	99999	>0	Y	FK	STAFF
	DIAGNOSTIC_TEST_DATE	diagnostic test date	DATETIME	YYYY-MM-DD HH:mm:SS				
	DIAGNOSTIC_TEST_DESCRIPTION	diagnostic test description	VARCHAR(255)	Xxxxxxxxx				