Design Phase Report

Nalanda Patho Clinic

MAY 14

Authored by: Team 18

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Design Phase Report for Nalanda Patho Clinic

1. Executive Summary

The firm of Expert Consultants has designed an Information System for Scheduling and Reporting process at the request of the design sponsors, Nalanda Patho Lab, Bihar, India. The need for this structure comes from three sources:

- ➢ The pathology lab is facing scheduling issues at the facility as a number of customers have to wait about 30-40 minutes on average before being attended to by a lab technician. This is leading to a loss of customer goodwill and eventual revenue losses.
- ➢ As per Government of India's directive, the facility is storing all the lab reports as hard copies, which is leading to a build up of storage and maintenance costs. Additionally, there is no way for easy access to report retrieval. Manual entry of test results in the report templates often leads to a higher error rate than is desired.
- ➢ A lot of facilities are shifting to contemporary digital methods of disbursing customer reports. Nalanda Pathology Lab wants to remain competitive in the market and provide their customers with similar services.

Expert Consultants' design for this Information System addresses the constraints implicit in the project and specified by the client, including:

- ➢ Lack of technically sound resources available for building the IS.
- ➢ Availability of a very modest budget for the system implementation and maintenance.
- ➢ Time constraint of 2 months, as the client wants the system up and running by Fall 2019.

Expert Consultants, through research on the pain areas of Nalanda Patho Lab, reading their operational documents and conducting interviews with the proprietor, several lab technicians and the receptionists, have identified the following design objectives listed in order of importance to the client:

- ➢ Designing a robust application and database for easy generation and storage of the customers' reports.
- ➢ Decreasing the wait-time by 40%.
- ➢ Suggesting a plan for report delivery through WhatsApp and email.

Our design, an easy to build and use Information System for Scheduling and Reporting processes, addresses each of these objectives while meeting the constraints imposed. Our proposal is to higher an IS expert on a two months' contract to explore this design and develop an Information System that optimally satisfies all of these objectives. Process models, Entity Relationship Diagrams and other necessary information on the proposed design have been constructed and delivered in this report along with an approval letter with the client's sign-off.

2. Evaluation Letter

Dear Expert Consultants,

We would like to thank you for your system design for our scheduling and reporting systems. After a careful analysis, we have decided to grant our approval on the proposed design and look forward to implementing the same.

We believe that this is a valuable enhancement to our facility that will significantly improve the associated problems of high customer wait times and manual errors in reporting. Thanks again for the system design. It was really great working with you.

Sincerely,

Pawan Kumar Choudhary

Pawan Kumar Choudhary
Proprietor,
Nalanda Patho Labs, Bihar Sharif, India

3. Approved Statement of Work

Expert Consultants
College Park, MD-20740

SOW 02 for Agreement for Consulting Services to Nalanda Patho Centre

Date	Services Performed By:	Services Performed For:
March 27, 2019	Expert Consultants College Park MD - 20740	Nalanda Patho Centre Bihar, India

This Statement of Work (SOW) is issued pursuant to the Consultant Services Master Agreement between Nalanda Patho Centre ("Client") and Expert Consultants ("Contractor"), effective February 13, 2019 (the "Agreement"). This SOW is subject to the terms and conditions contained in the Agreement between the parties and is made a part thereof. Any term not otherwise defined herein shall have the meaning specified in the Agreement. In the event of any conflict or inconsistency between the terms of this SOW and the terms of this Agreement, the terms of this SOW shall govern and prevail. This SOW # 01 (hereinafter called the "SOW"), effective as of February 13, 2019 is entered by and between Contractor and Client and is subject to the terms and conditions specified below. The Exhibit(s) to this SOW, if any, shall be deemed to be a part hereof. In the event of any inconsistencies between the terms of the body of this SOW and the terms of the Exhibit(s) hereto, the terms of the body of this SOW shall prevail.

1.1 Period of Performance

The services shall commence on February 13, 2019 and shall continue through May 10, 2019.

1.2 Scope of Work

Closely examine the existing information system that the client uses to provide recommendations for improvements in the Scheduling, Reporting and Billing systems of the pathology lab, to reduce the average response time and reduce manual effort and manual labor time.

1.2.1 Scheduling

➢ Patient Registration - Design a system to onboard patients, capturing their name, contact information, purpose of visit and information of the source of reference, if any, on their first visit. Consecutively, designing capabilities to keep the customer information database up to date, with additional information captured for returning patients.

➢ Real time updates and response - Designing a system, while also working on the operational issues with the client, to provide patients real-time updates of the status of their appointment, waiting time and scheduling delays, if any, via text messages, phone calls and other/or WhatsApp messages.

1.2.2 Reporting

➢ Design Templates - Design digital copies of templates for each of the standardized tests that the pathology lab performs, and provide training documents on their usage and enhancement, so that they could be easily adopted and implemented by lab technicians with limited computer skills.

➢ Digital Reports - Design capabilities into the client's information system so that electronic copies of reports could be generated for each customer through data entry into the designed templates.

➢ Report Archival - A storage system must be maintained on a local database for easy retrieval of reports at any time.

1.2.3 Deliverable Materials

➢ A comprehensive design document for the scheduling and reporting systems, containing elements as talked about under the Scope of Work.

1.3 Project Objectives

Contractor shall have fulfilled its obligations when any one of the following first occurs:

➢ Contractor accomplishes the Contractor activities described within this SOW and detailed below, including delivery to Client of the materials listed in the Section entitled "Deliverable Materials," and Client accepts such activities and materials without unreasonable objections. No response from Client within 2-business days of deliverables being delivered by Contractor is deemed acceptable.

- **Scheduling:**
  - Solution to be provided to reduce patients' wait-time by 33%.
  - A plan to provide information through text messages and WhatsApp messages to give real time updates to patients.
- **Reporting:**

- Contractor has provided a solution design to reduce time spent by technician on reporting by 50%.
- Enhancements to the existing information system have been suggested with an option for the reports to be delivered to patients via e-mail and WhatsApp messages.
- System design to provide report archival feature for easy retrieval of patient history and a repository for academic research, has been delivered.

➢ Contractor and/or Client has the right to cancel services or deliverables not yet provided with 20 business days advance written notice to the other party.

1.4 Constraints
➢ Accessibility of the client's information system is limited and dependent on client's availability, due to geographical separation and difference between time zones.
➢ Unavailability of lab technicians with advanced computer skills in and around the area where the client's business is located.
➢ Client's budget is very limited and subject to financing opportunities available at any given time.
➢ Time constraint because of the hard deadline bound by the course itself.
➢ As the scope of this project is limited to only the design of the systems, actual implementation would be delivered by another party, which may lead to inconsistencies in the developed system from the actual design.

IN WITNESS WHEREOF, the parties hereto have caused this SOW to be effective as of the day, month and year first written above.

	Nalanda Patho Centre			**Expert Consultants**
By:			**By:**	
Name:	**Pawan Kumar Choudhary**		**Name:**	**Shivangi**
Title:	**Proprietor**		**Title:**	**Project Manager**

4. Approved System Analysis Report

4.1 Fact Finding and Information Gathering Techniques
Fact Finding or Requirement Gathering for the project was done keeping in mind the intention of improving and optimizing customer service at the client's pathology lab, as per our preliminary discussions with the proprietor of the lab. The methodologies used were:

- ➢ Interviews
- ➢ Questionnaires
- ➢ Document Analysis

These methodologies adopted were constrained by the fact that the client is based overseas and, by the scope of the project. Following strategies were employed for requirement gathering:
- ➢ Problem Analysis
- ➢ Root Cause Analysis
- ➢ Informal Benchmarking

4.2 Steps Followed for Information Gathering

4.2.1 Problem Analysis

Initial discussions with the proprietor of the lab helped us in formulating a problem statement as well as gain a precursory understanding of the solutions on the mind of the various stakeholders. For this the team interviewed the doctor, technicians at the lab, computer technician, receptionists and the patients. Interviewees were chosen based on their direct and indirect interaction with the system.

As is the case with problem analysis we followed an iterative process which helped us in removing ambiguity about the scope of the project.

4.2.2 Root Cause Analysis

After eliciting information from the client regarding the processes followed at the pathology lab, the team proceeded with the root cause analysis. It was necessary to gain clarity about the issues plaguing the system and shortlist the solutions necessary to streamline the processes. To perform root cause analysis, the team interviewed the technicians, receptionists and the patients who were directly affected by poor customer service.

To gain further clarity and remove conflicting viewpoints regarding the processes followed at the lab questionnaires were sent to the head technician and his subordinates. A questionnaire was also sent to the receptionist to get insights on the primary interaction of a patient at the lab.

Document analysis also helped in chalking out the solutions for improving the system.

4.2.3 Informal Benchmarking

The team studied the processes followed at similar organization in US and India to get an understanding of industry standards and best practices.

4.3 System Models of Current Systems

4.3.1 Data Flow Diagrams

4.3.1.1 Scheduling Narrative

Scope:

From client calling the lab for booking an appointment to client coming in for their test

External entities:
- Doctor
- Patient
- Receptionist
- Lab Technician

Data stores:
- Patient register – Physical register that stores patient details
- Doctor register – Physical register that stores doctor details and doctor schedule
- Appointment Register – Physical register that stores appointment details of all patients

Processes:
1. Request for appointment
2. Appointment booking
3. Record retrieval
4. Patient on-boarding/check-in
5. Sample collection

Narrative:
- A patient gives appointment details to Request for appointment process which forwards Patient Details and Test details to receptionist. Receptionist relays information to patient if appointment is confirmed via Request for appointment process
- Receptionist sends these details to Appointment booking process. This process updates doctor's schedule in Doctor register, adds appointment details to Appointment register and updates patient register with patient details. This process also sends status of appointment to receptionist
- Patient confirms arrival at Appointment date or even an Ad-hoc arrival at the Reception where the receptionist checks Appointment details from appointment register
- Patient then checks-in at the Sample collection desk which checks Test details from Appointment register. Once check in is complete, patient submits the sample from sample collection process to the technician for further processing
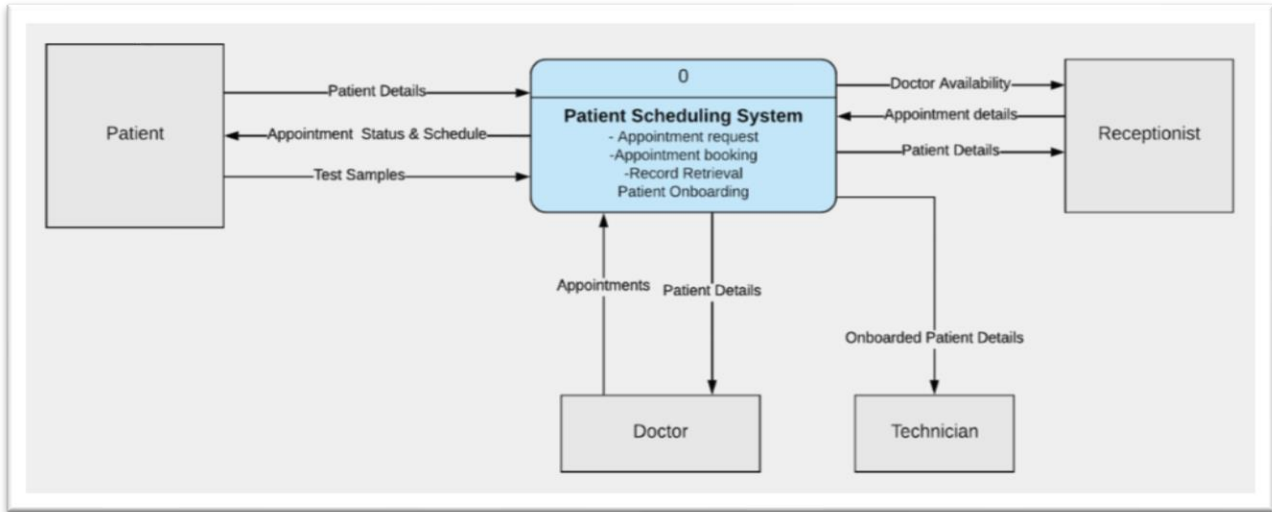
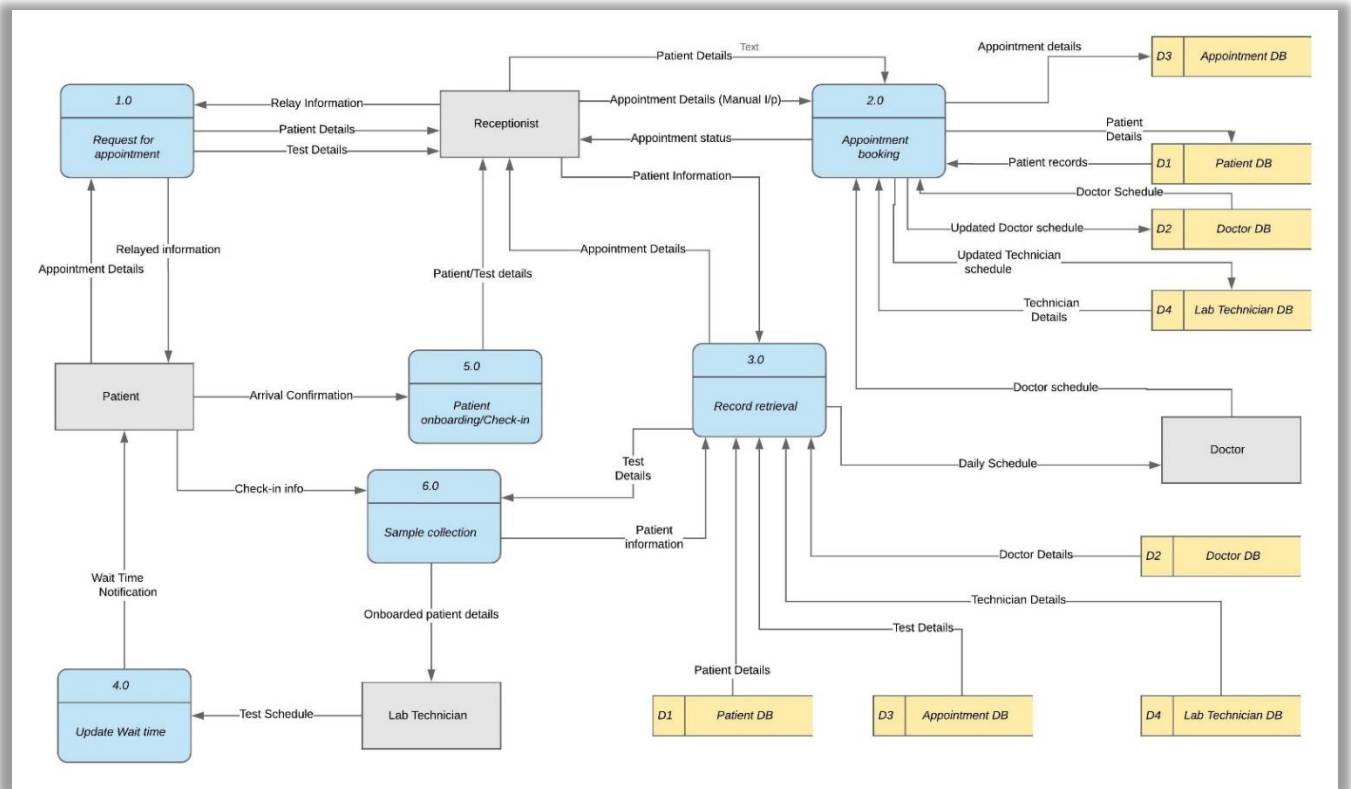*Figure 1: As-Is Context Level Diagram - Scheduling*
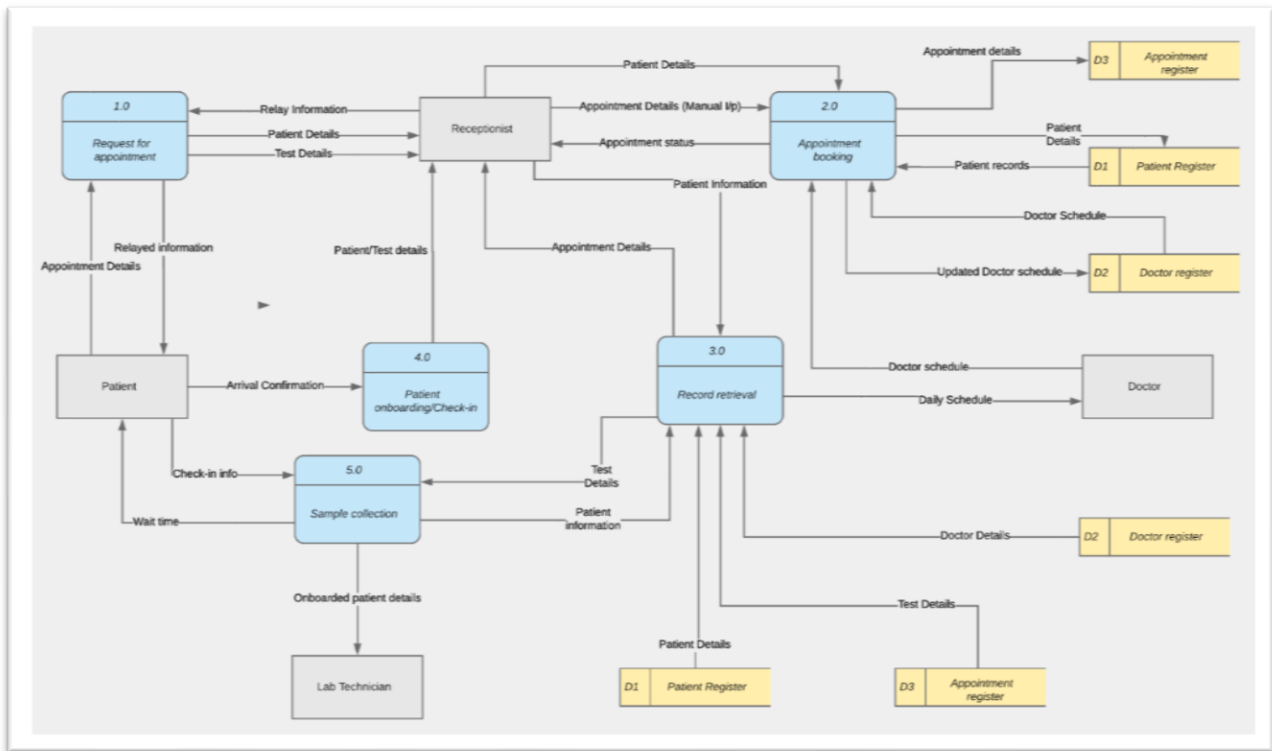
Figure 2: As-Is Level 0 DFD – Scheduling
Note: Check Image 1, Appendix A for a higher resolution image for Figure 2

4.3.1.2 Reporting Narrative

Scope:
Right from the point where a patient is attended by a technician till the point where patient receives the report.

External Entities:
- ➤ Patient
- ➤ Lab technician
- ➤ Computer technician
- ➤ Doctor

Data Stores:
- ➤ Collected samples – Physical store where all the samples are stored
- ➤ Level-1 test results – Physical register that stores hard copies of primary test (chemical test) results
- ➤ Final test results – Physical register that stores hard copies of secondary test (microscopic test) results
- ➤ Reports – Physical register that stores hard copies of final consolidated reports

Processes:

- ➤ Sample collection
- ➤ Collect required sample
- ➤ Primary analysis (Chemical tests)
- ➤ Collect required primary analysis results
- ➤ Secondary analysis (Microscopic tests)
- ➤ Computer reporting
- ➤ Dispatch reports

Narrative:
- ➤ Technician attends the patient and obtains test sample from him.
- ➤ Test sample extracted from the patient is stored in Sample Store.
- ➤ Technician fetches the required sample from the Sample Store and conducts primary analysis (Level-1 test) on it.
- ➤ Results obtained from the primary analysis are stored in the Level-1 Test Results data store.
- ➤ Doctor gets the required primary analysis results from Level-1 Test Results data store and performs secondary analysis (Final test) on it.
- ➤ Results obtained from the secondary analysis are stored in the Final Test Analysis Results data store.
- ➤ Computer technician gets the required final test results from Final Test Analysis Results data store and feeds these results into a digital report.
- ➤ Consolidated report is stored in the Reports data store.
- ➤ Report is then dispatched to the patient.
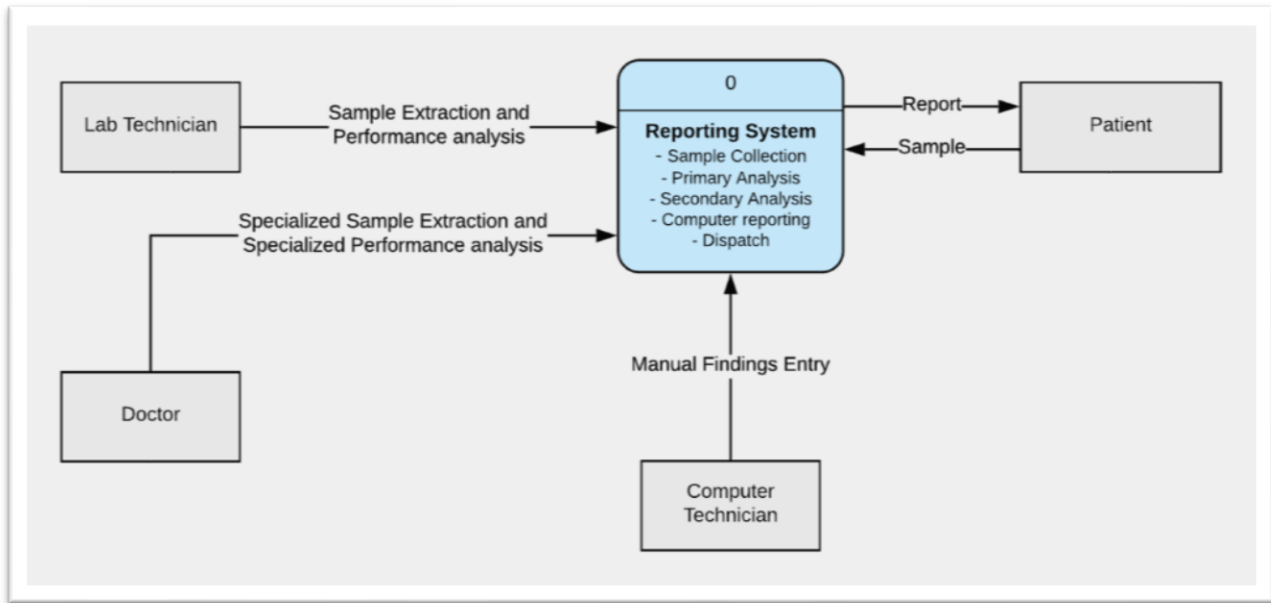
Figure 3: As-Is Context Level Diagram – Reporting
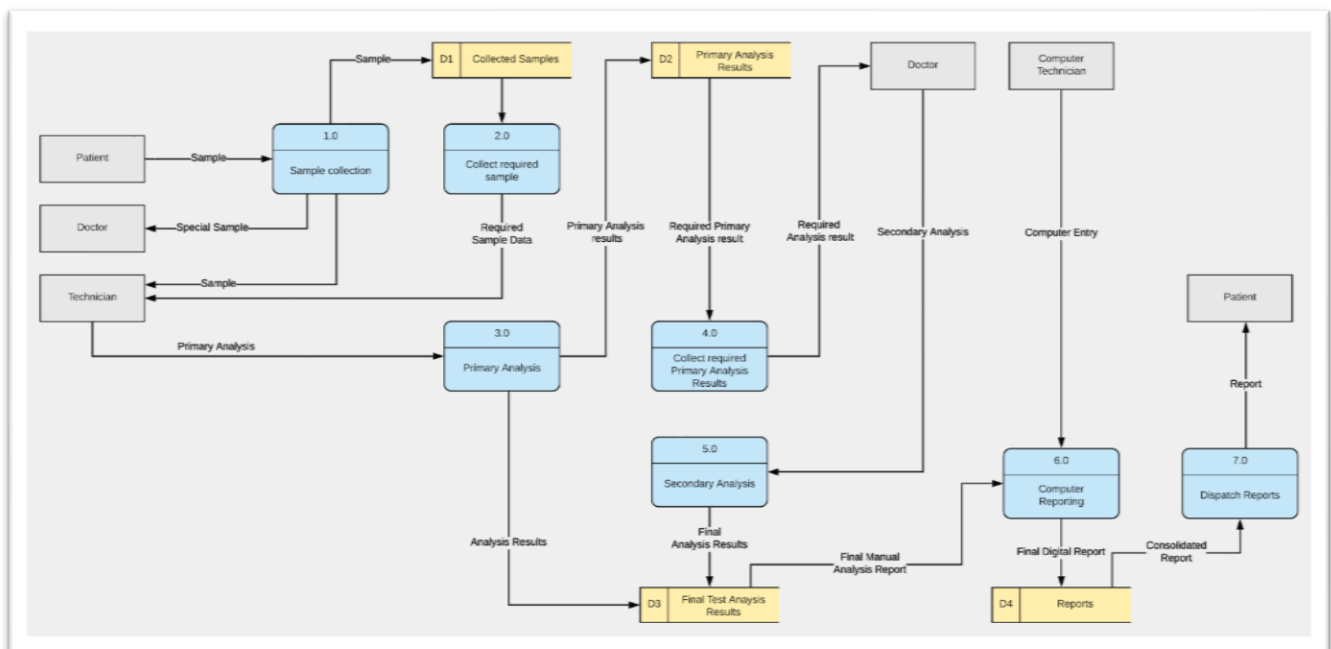
Figure 4: As-Is Level 0 DFD – Reporting
Note: Check Image 2, Appendix A for a higher resolution image for Figure 4

4.3.2 Entity Relationship Diagram
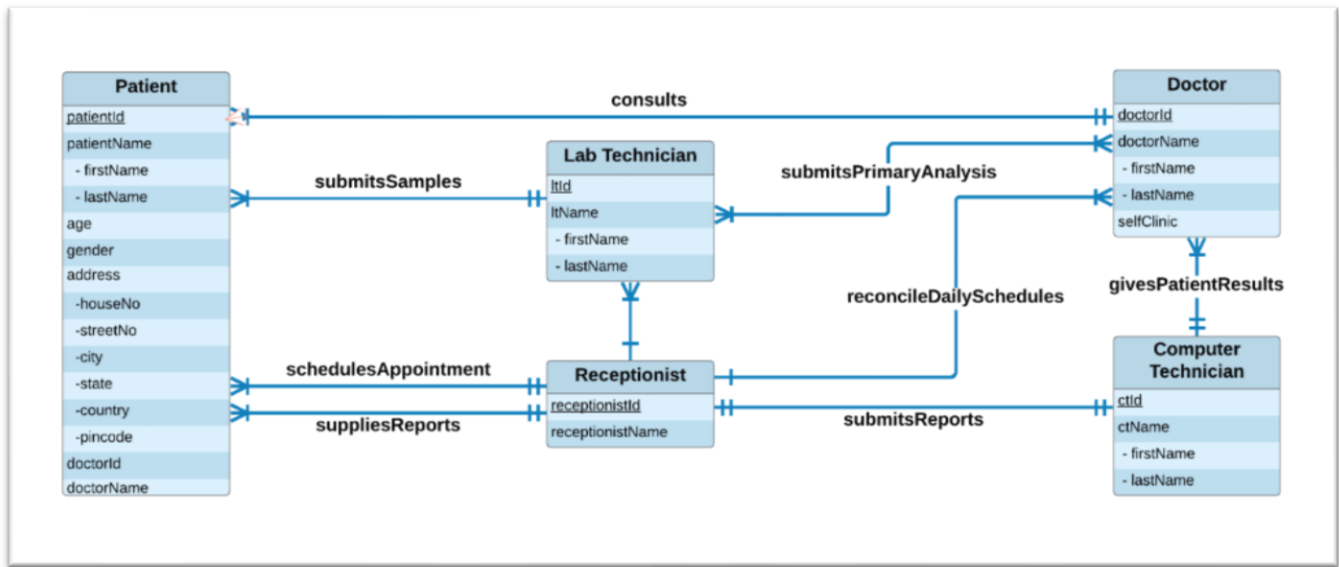
Figure 5: As-Is ERD (Scheduling and Reporting)

5. System Models – The Proposed System

5.1 Data Flow Diagrams

5.1.1 Scheduling Narrative

Scope:

From client calling the lab for booking an appointment to client coming in for their test

External entities:
- ➤ Doctor
- ➤ Patient
- ➤ Receptionist
- ➤ Lab Technician

Data stores:
- ➤ Patient DB – Database that stores patient details
- ➤ Doctor DB – Database that stores doctor details and doctor schedule
- ➤ Appointment DB – Database that stores appointment details of all patients
- ➤ Lab Technician DB – Database that stores Lab Technician schedule

Processes:
- ➤ Request for appointment
- ➤ Appointment booking
- ➤ Record retrieval
- ➤ Update Wait time

- ➢ Patient on-boarding/check-in
- ➢ Sample collection

Narrative:
- ➢ A patient gives appointment details to **Request for Appointment** process which forwards Patient Details and Test details to receptionist. Receptionist relays information to patient if appointment is confirmed via Request for appointment process
- ➢ Receptionist sends these details to **Appointment Booking** process. This process makes the following updates:
    - o Doctor's schedule in Doctor DB
    - o Technician's schedule in Technician DB
    - o Adds appointment details to Appointment DB
    - o Updates patient register with patient details
    - o This process also sends status of appointment to receptionist
- ➢ Receptionist uses the **Record Retrieval** process to view information from all the four databases
- ➢ Lab Technician uses the **Update Wait Time** process to send notification to the scheduled patients about their wait time based on the waiting queue in the clinic
- ➢ Patient confirms arrival using the **Patient Onboarding/Check-in** at Appointment date or even an Ad-hoc arrival at the Reception where the receptionist checks Appointment details from appointment register
- ➢ Patient then checks-in using the **Sample Collection** process which checks Test details from Appointment DB using thee Record Retrieval process. Once check in is complete, patient submits the sample from sample collection process to the technician for further processing
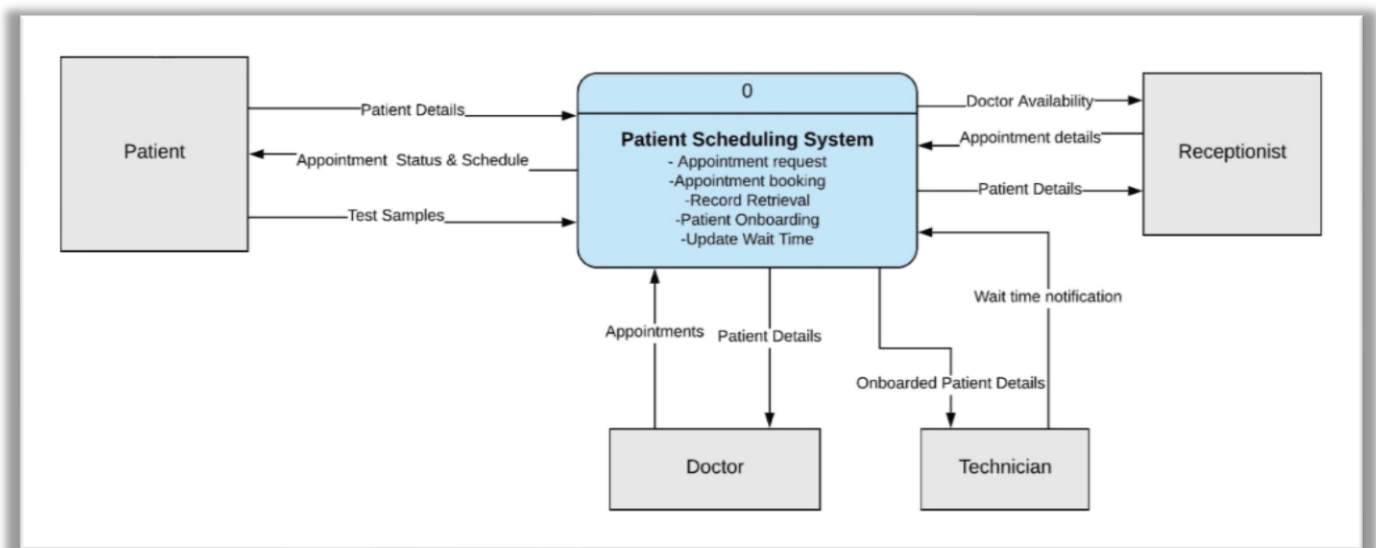
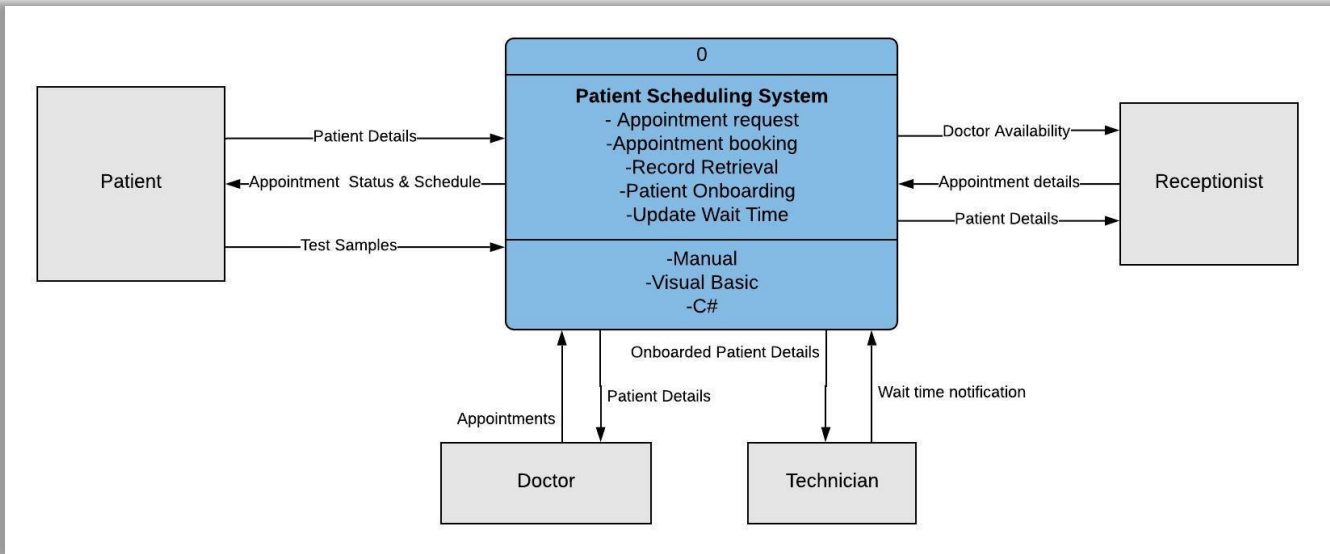*Figure 6: To-Be Context Level Diagram – Scheduling*

Figure 7: To-Be Level 0 DFD – Scheduling
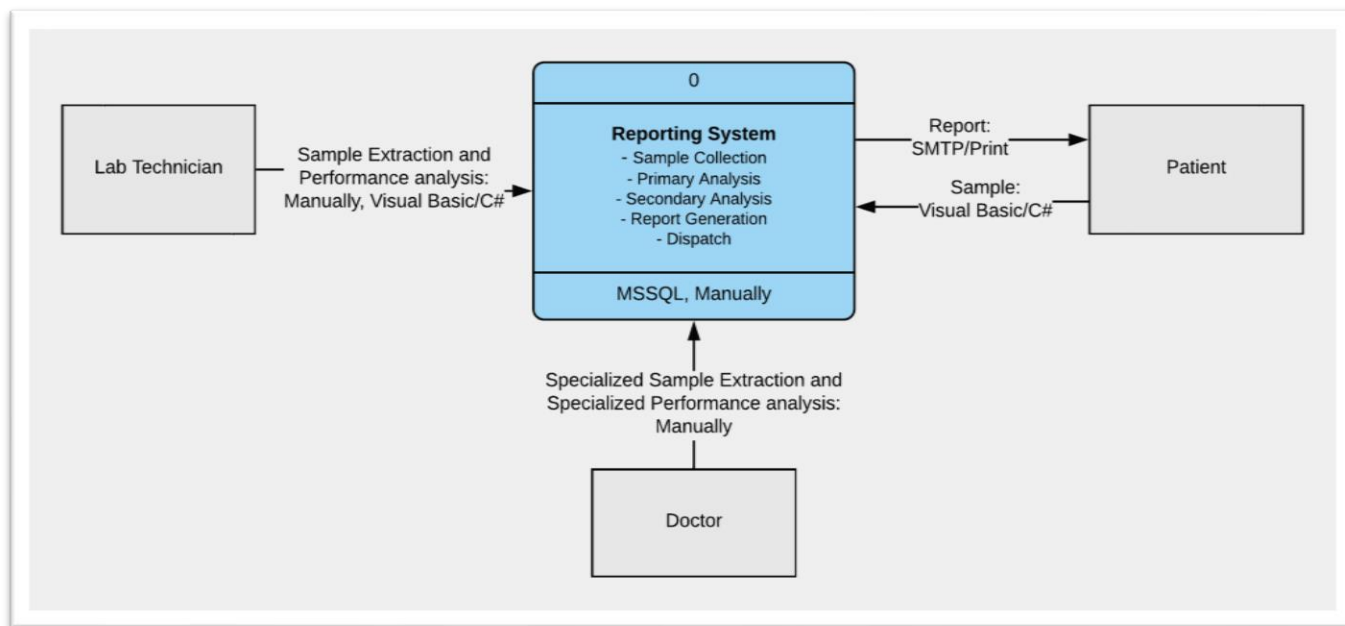*Note: Check Image 3, Appendix A for a higher resolution image for Figure 7*

5.1.1 Reporting Narrative

Scope:

Right from the point where a patient is attended by a technician till the point where patient receives the report.

External Entities:

- ➢ Patient
- ➢ Lab technician
- ➢ Doctor

Data stores:

- ➢ Collected samples – Physical store where all the samples are stored
- ➢ Sample metadata – Database that stores attributes of the sample digitally
- ➢ Test analysis results – Database that stores test (primary/secondary test) results
- ➢ Reports – Database that stores digital copy of final report

Processes:

- ➢ Sample collection
- ➢ Collect required sample

- ➢ Collect sample metadata
- ➢ Primary analysis (Chemical tests)
- ➢ Collect required primary analysis results
- ➢ Secondary analysis (Microscopic tests)
- ➢ Reporting generation
- ➢ Dispatch reports

Narrative:
- ➢ Technician attends the patient and obtains test sample from him.
- ➢ Test sample extracted from the patient is stored physically in Sample Store.
- ➢ Technician stores attributes of the sample in Sample Metadata database.
- ➢ Technician fetches the required sample from the Sample Store and conducts primary analysis on it.
- ➢ Results obtained from the primary analysis are stored in the Test Results database.
- ➢ Doctor gets the required primary analysis results from Test Results database and performs secondary analysis on it, if required.
- ➢ Results obtained from the secondary analysis are stored in the Test Results database.
- ➢ Details are drawn from the Test Results datastore and Sample Metadata database, and are consolidated to form the final digital report.
- ➢ Final digital report is saved in the Reports database.
- ➢ Report is then electronically sent to the patient.
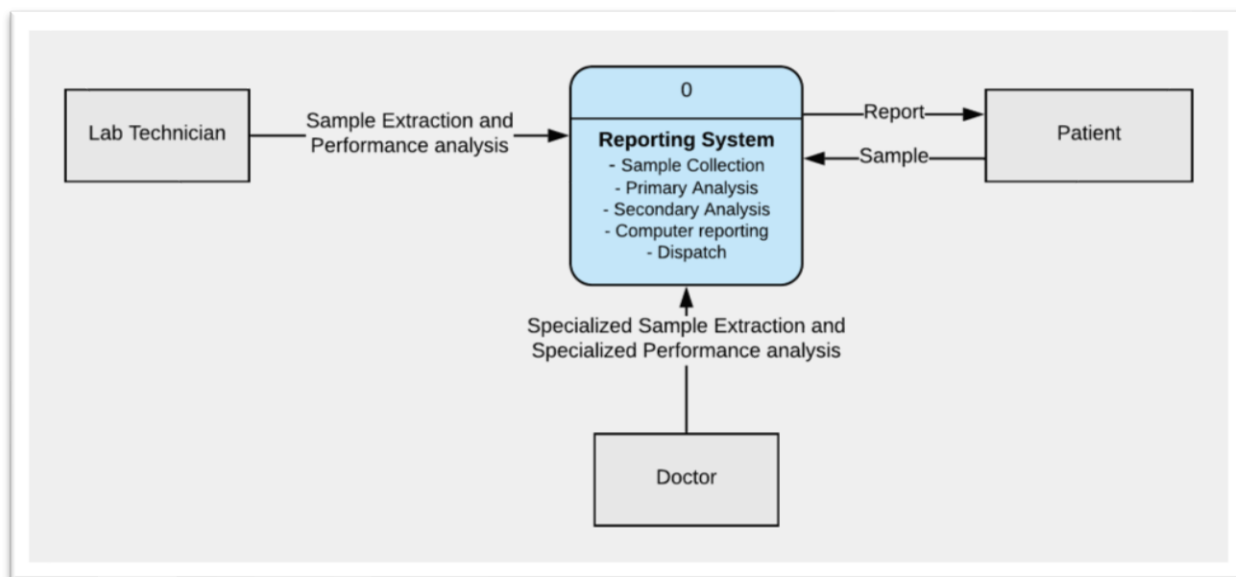
Figure 8: To-Be Context Level Diagram – Reporting
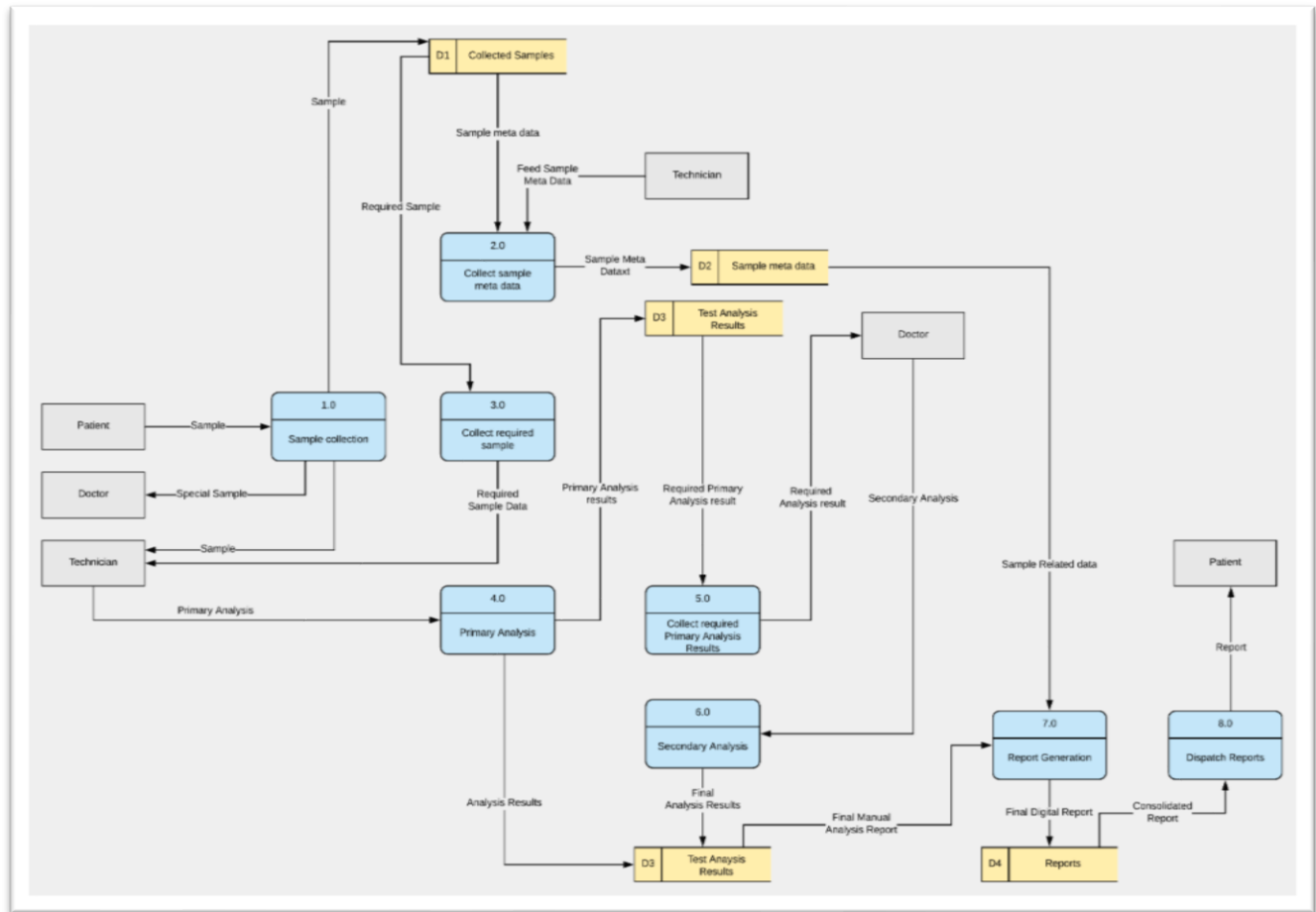
Figure 9: To-Be Level 0 DFD – Reporting
Note: Check Image 4, Appendix A for a higher resolution image for Figure 9

5.2 Entity Relationship Diagram
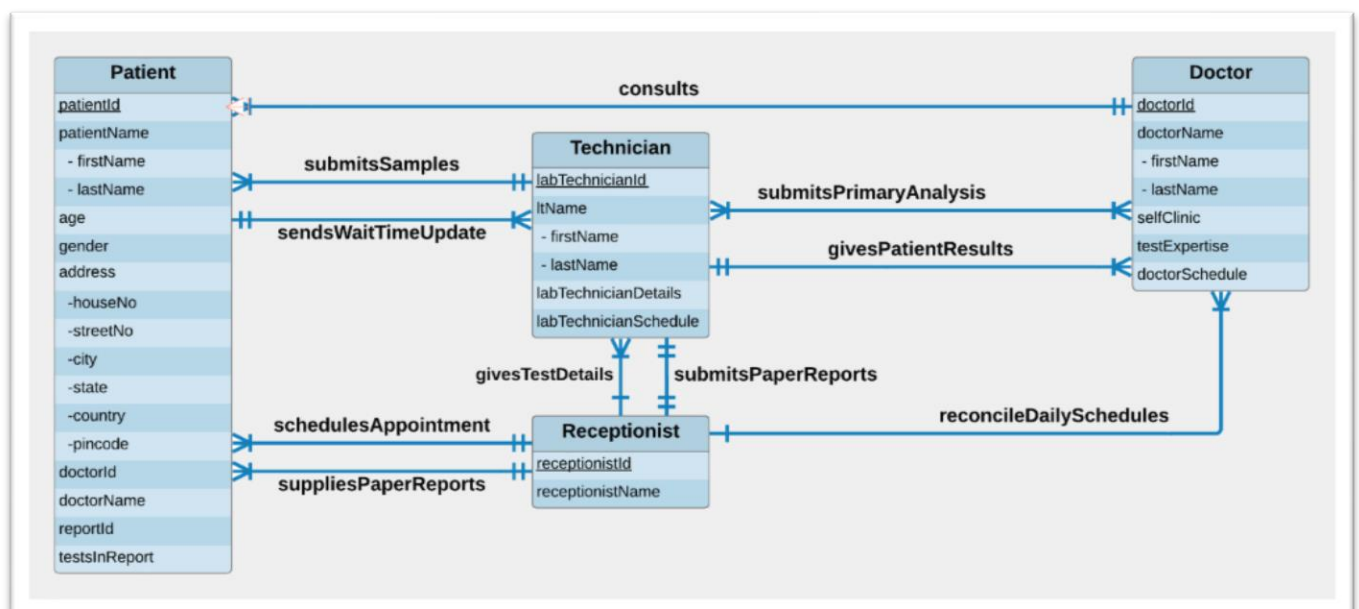
Figure 10: To-Be Entity Relationship Diagram (Scheduling & Reporting)

5.3 Synchronized System Model (CRUD Matrix)

	Process 1.0	Process 2.0	Process 3.0	Process 4.0	Process 5.0	Process 6.0
D1 Patient DB						
patientId		CRUD	R			
patientName		CRUD	R			
Age		CRUD	R			
Gender		CRUD	R			
Address		CRUD	R			
doctorId		CRUD	R			
doctorName		CRUD	R			
reportID		CRUD	R			
testsInReport		CRUD	R			
D2 Doctor DB						
doctorId		CRUD	R			
doctorName		CRUD	R			
selfClinic		CRUD	R			
testExpertise		CRUD	R			
doctorSchedule		CRUD	R			
D3 Appointment DB						
appointmentID		CRUD	R			
appointmentDate		CRUD	R			
appointmentTime		CRUD	R			
doctorId		CRUD	R			
labTechnicianID		CRUD	R			
patientId		CRUD	R			
D4 Lab Technician DB						
labTechnicianID		CRUD	R			
labTechnicianName		CRUD	R			
labTechnicianDetails		CRUD	R			
labTechnicianSchedule		CRUD	R			

Table 1: CRUD Matrix – Scheduling

	Process 1.0	Process 2.0	Process 3.0	Process 4.0	Process 5.0	Process 6.0	Process 7.0	Process 8.0
Collected Sample								
Sample Metadata								
sampleId		C						
patientId		CRUD						
Test Analysis Results								
testId				R	R	R		
testName				R	R	R		
patientId				C	R	C		
technicianId				C	R	C		
doctorId				C	R	C		
testResult				CRUD	R	CRUD		
Reports								
reportId							CRU	R
reportName							CRU	R
patientId							CRU	R
doctorId							CRU	R
testId							CRU	R
testName							CRUD	R
normalRange							CRUD	R
actualResult							CRUD	R

Table 2: CRUD Matrix – Reporting

6. Physical System Design

6.1 Candidate System Solutions Table

Characteristics`	Candidate 1 Manual System with report dispatch through email and whatsapp	Candidate 2 Pathology Lab Management System for Scheduling and Reporting
Portion of System Computerized Brief description of that portion of the system that would be computerized in this candidate.	Mostly manual , enhances the already installed Information System.	Scheduling and Reporting System built in house using the help of hired IS expert
Benefits Brief description of the business benefits that would be realized for this candidate.	Negligible changes leading to almost zero additional cost, hence no need for investment	Manual errors eliminated, archival improved, response time reduced, higher customer satisfaction, hence better long term benefits
Servers and Workstations A description of the servers and workstations needed to support this candidate.	One additional workstations required	Two workstations and one additional server which could be hosted on one of the workstations
Software Tools Needed Software tools needed to design and build the candidate (e. g., database management system, emulators, operating systems, languages, etc.). Not generally applicable if applications software packages are to be purchased.	Use of existing software tools	MSSQL, Visual Basic, Apache Tomcat, Windows
Application Software A description of the software to be purchased, built, accessed, or some combination of these techniques.	WhatsApp mobile application and email servicers	WhatsApp mobile application and email servicers, Scheduling and reporting systems built in house
Method of Data Processing Generally some combination of: on-line, batch, deferred batch, remote batch, and real-time.	Manual handelling of data and printed reports	Manual and Batch processes
Output Devices and Implications A description of output devices that would be used, special output requirements, (e.g. network, preprinted forms, etc.), and output considerations (e.g., timing constraints).	HP Inkjet Printer	HP Inkjet Printer, Smartphones and Computer All internal screens will be designed for SVGA resolution.
Input Devices and Implications A description of Input methods to be used, input devices (e.g., keyboard, mouse, etc.), special input requirements, (e.g. new or revised forms from which data would be input), and input considerations (e.g., timing of actual inputs).	Keyboard and Mouse	Keyboard and Mouse
Storage Devices and Implications Brief description of what data would be stored, what data would be accessed from existing stores, what storage media would be used, how much storage capacity would be needed, and how data would be organized.	Hardbound files and registers	MSSQL database with 20GB capacity

Table 3: Candidate System Solutions

6.2 Feasibility Analysis Matrix

Feasibility Criteria	Wt.	Candidate 1	Candidate 2
Operational Feasibility **Functionality**. A description of to what degree the candidate would benefit the organization and how well the system would work. **Political**. A description of how well received this solution would be from both user management, user, and organization perspective.	40%	Only slightly tweaks the system. No improvement on scheduling front, response time and customer service **Score: 30**	Fully supports user required functionality. **Score: 100**
Technical Feasibility **Technology**. An assessment of the maturity, availability (or ability to acquire), and desirability of the computer technology needed to support this candidate. **Expertise**. An assessment to the technical expertise needed to develop, operate, and maintain the candidate system.	20%	Could be very easily implemented, doesn't any technical training or expertise. **Score: 100**	System built keeping in mind the user requirement of very limited technical skilled labor available. Very basic technical expertise is needed on mature technologies like VB and MSSQL. Minimum retraining of available human resources **Score: 80**
Economic Feasibility **Cost to develop:** **Payback period (discounted):** **Net present value:**	30%	Approximately Rs70,000 Approximately 7 months Approximately Rs 60,000 **Score: 100**	Approximately Rs 1,50,000. Approximately 1.25 years. Approximately Rs 1,40,000 **Score: 85**
Schedule Feasibility An assessment of how long the solution will take to design and implement.	10%	Less than 1 month. **Score: 95**	1-2 months **Score: 80**
Ranking	100%	71	89.5

Table 4: Feasibility Analysis Matrix

6.3 Physical System Design

Figure 11: To-Be Physical Context Level Diagram – Scheduling
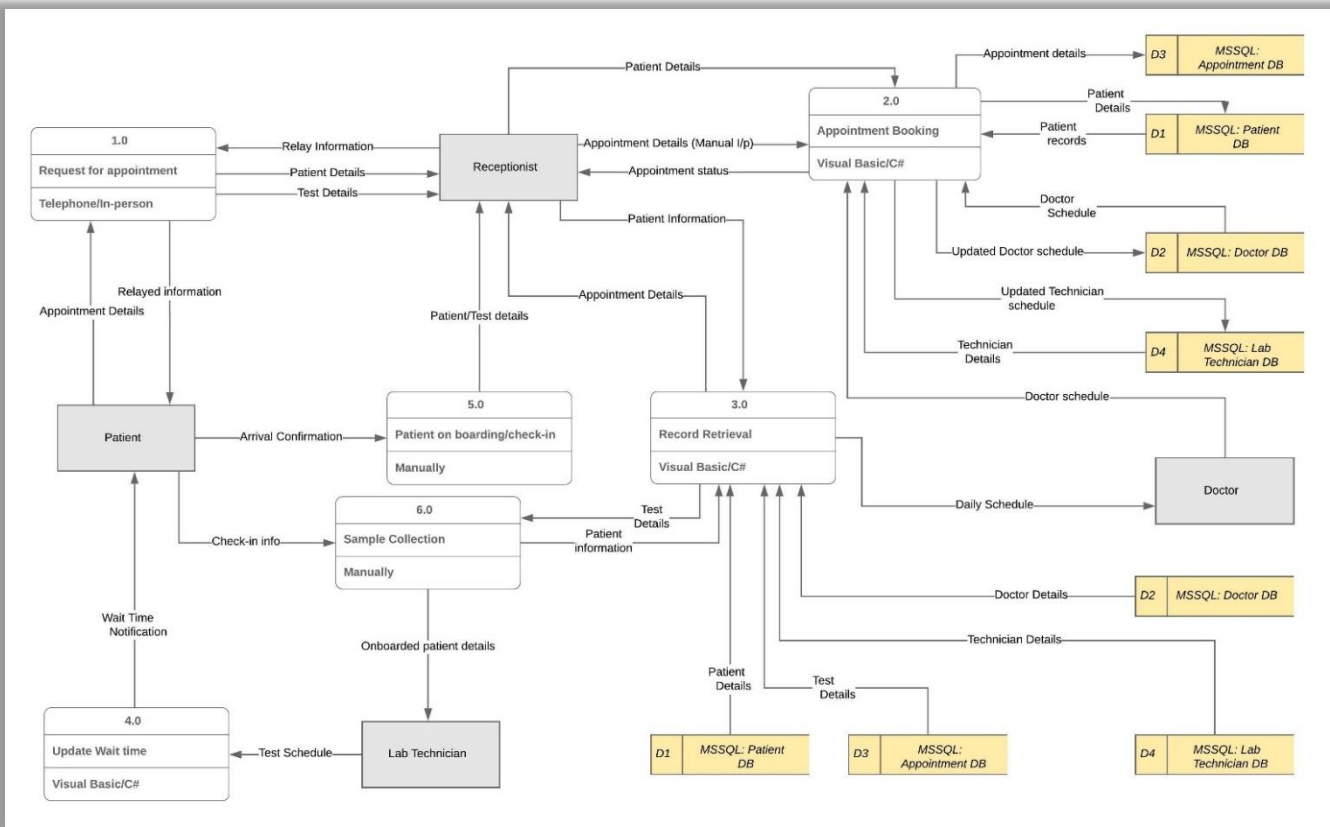
Figure 12: To-Be Physical Level 0 DFD – Scheduling

Note: Check Image 5, Appendix A for a higher resolution image for Figure 12

Figure 13: To-Be Physical Context Level Diagram - Reporting
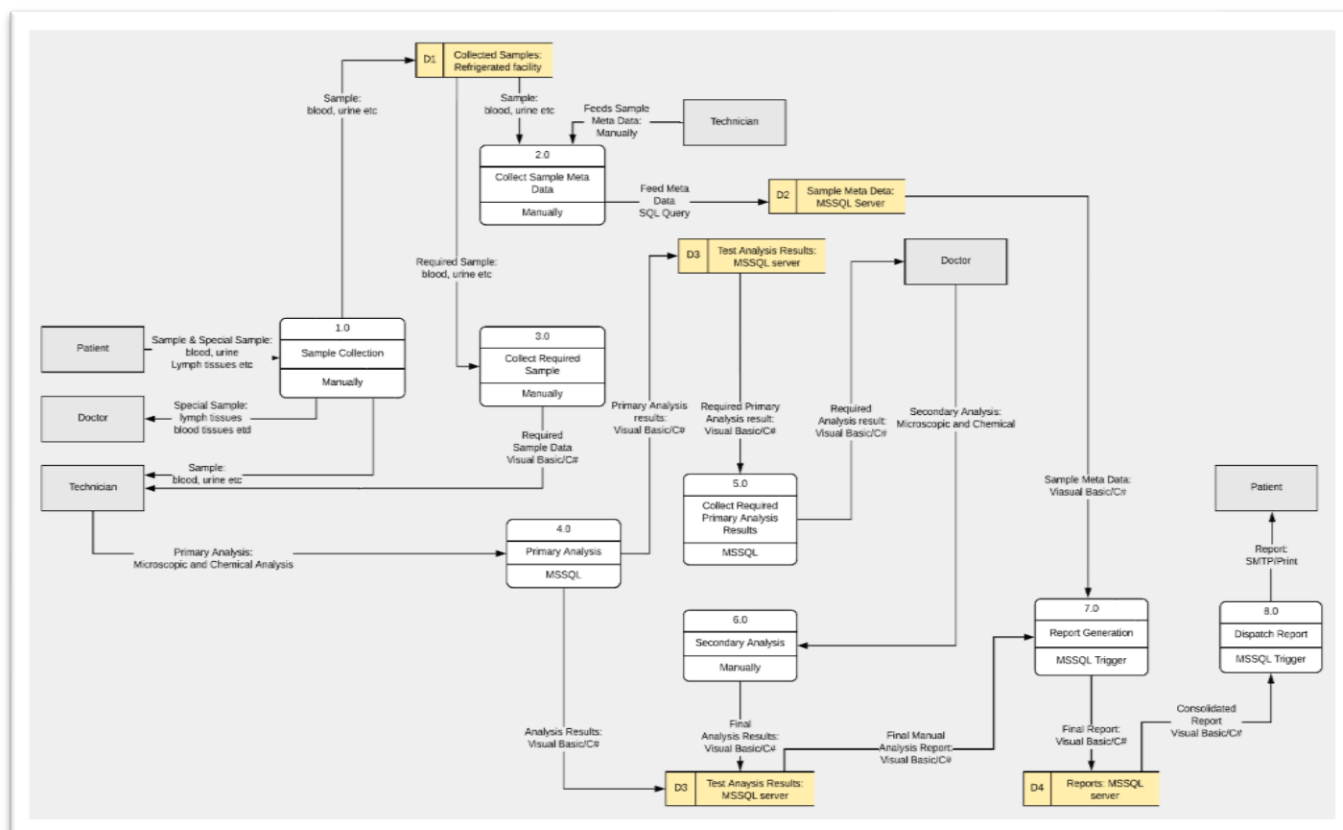
Figure 14: To-Be Physical Level 0 DFD – Reporting

Note: Check Image 6, Appendix A for a higher resolution image for Figure 14

6.4 Input and Output Design – Screen Samples

Figure 15: Patient Details Capture Screen

Figure 16: Patient Reports Database

Figure 17: Sample test result screen

Figure 18: Appointment Screen

Figure 19: Patient onboarding screen

Figure 20: Registration Screen

Figure 21: Patient Test screen for report template generation
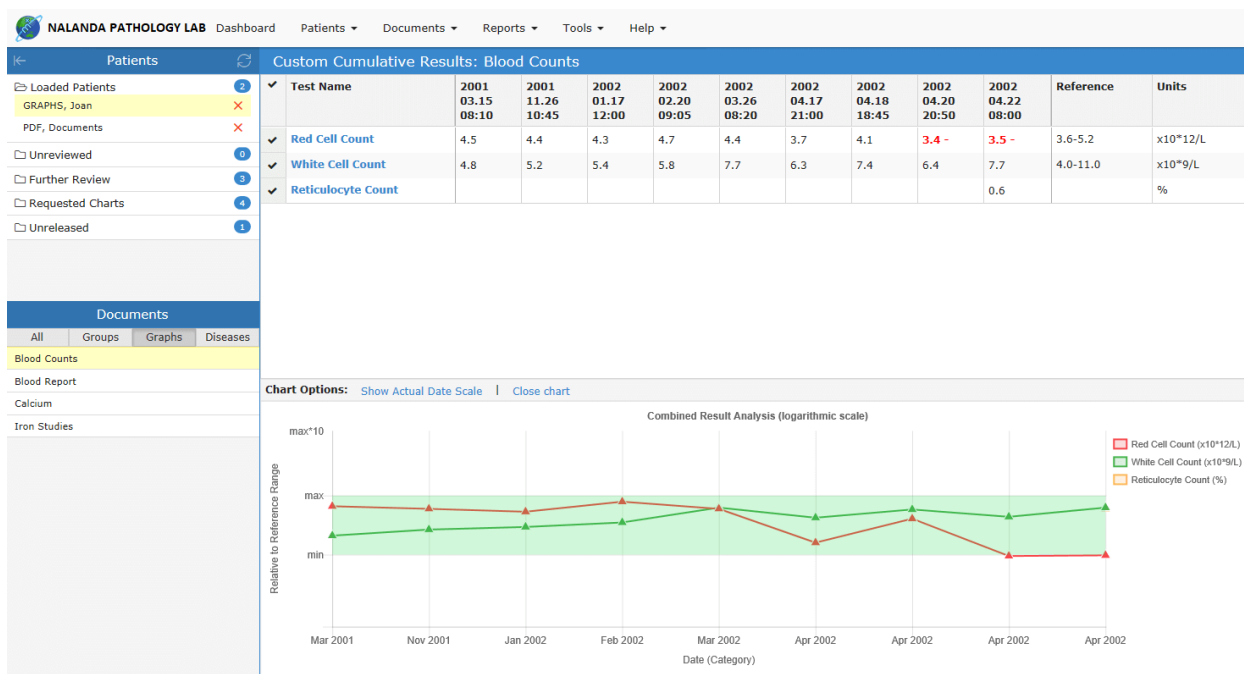

Figure 22: Sample and Test result screen

Figure 23: Analysis screen

7. System Implementation Plan

PROJECT TITLE	Pathology Lab management System for Scheduling and Reporting		

PROJECT MANAGER	PROJECT SPONSOR	DATE INITIATED
Shivangi	Pawan Kumar Chaudhary	02/01/2019

IMPLEMENTATION STRATEGY

COMPONENTS TO BE IMPLEMENTED

COMPONENT NAME	DESCRIPTION OF FUNCTION	SOURCE
Scheduling	The scheduling system has the following capabilities: 1) Onboarding patients and updates their relevant personal and test details in the database 2) Provides real-time updates to patients regarding the status of their appointments through text messages and/or WhatsApp notifications	Developed in house with the help of hired software development experts and coordinated by project manager.
Reporting	The reporting system will help the client with the following: 1) Collection and storage of samples from the patients 2) Primary and secondary sample analysis 3) Storage of test results from the primary and secondary sample analysis 4) Consolidated report generation and dispatch of reports electronically	Developed in house with the help of hired software development experts and coordinated by project manager.
Database	Sample Metadata: Holds templates for tests. Test Analysis Results: Database to hold results of analysis for tests. Patient Database: Holds data regarding patients and maintains patient profiles. Doctor Database: Holds information regarding doctor's personal details and availability. Lab Technician Database: Holds information regarding lab technicians and their availability. Appointment Database: Utilises information from the Patient, Doctor and Lab technician database to schedule patient appointments Report Database: Holds patient reports and supports report archival.	Developed in house with the help of hired software development experts and coordinated by project manager.

DEVELOPMENT APPROACH

The system can be developed using a waterfall model of development as the scope for the project is well defined, timeline is not much of a constraint as is implementation of a robust a system and experienced resources are readily available.

INTEGRATION APPROACH

New system need not be integrated with the legacy system as the requirement for the new application is to replace the legacy system.

CONVERSION STRATEGY

Direct Conversion approach will be used for system implementation.

DEPLOYMENT STRATEGY

The system can be deployed once the databases are populated with records from physical registers, followed by user acceptance testing and a training period of at least one week.

8. Lessons Learned

> Assess available resources and schedule constraints to agree on scope upfront to avoid changes mid-way and to avoid scope creep
> Depending on the client it is better to stick to proven and tested solutions and mature ways of functioning rather than to go for state-of-the-art and complex solutions
> The client may not know what they exactly want from the system or how to put it in technical terms, it often comes down to the project team to come up with the problem statement
> Interview questions - mixture of closed-ended, open-ended and probing questions
> Information gathering is an iterative process - cannot gather information about existing system, expectations and requirements all at once
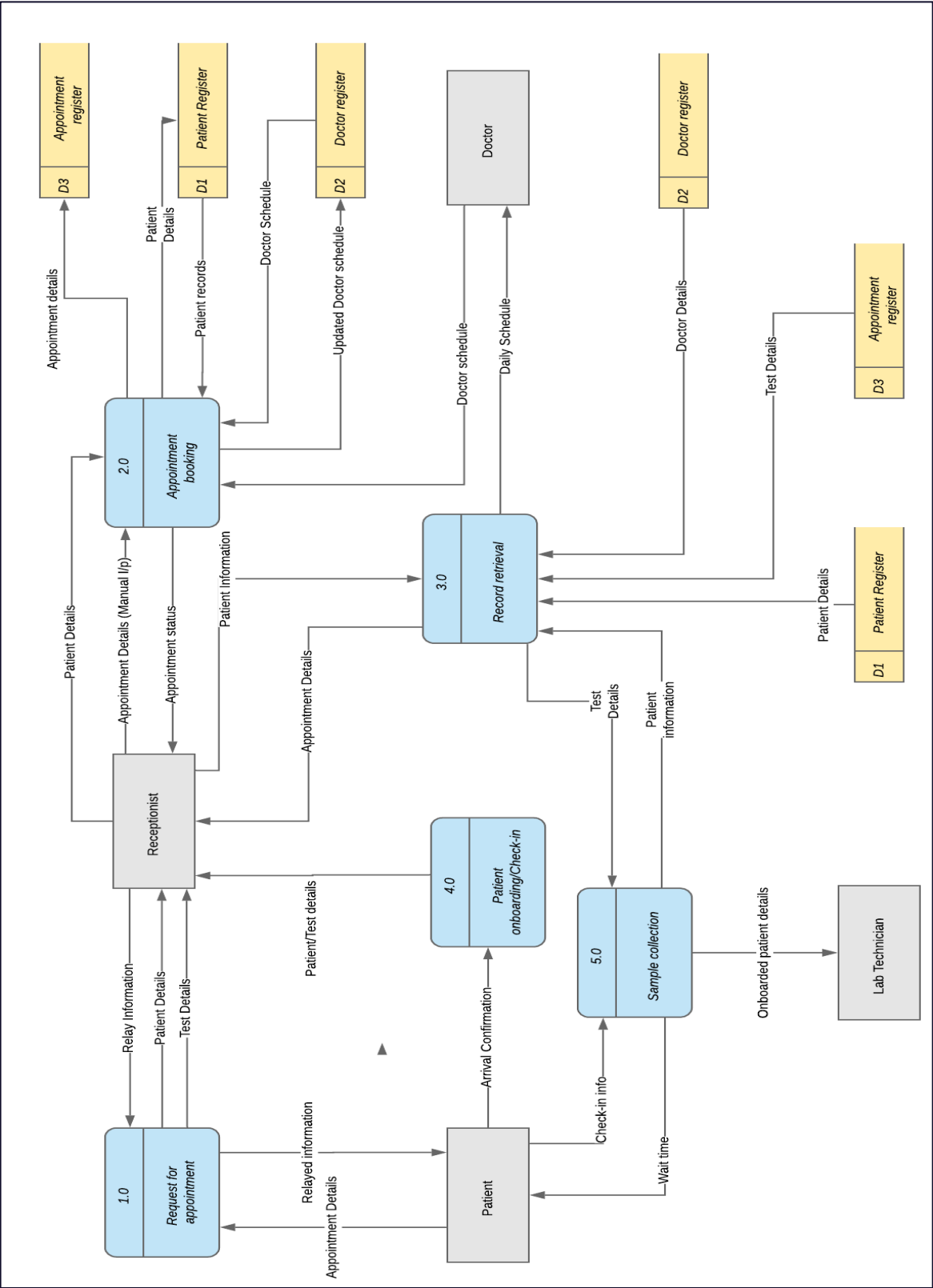
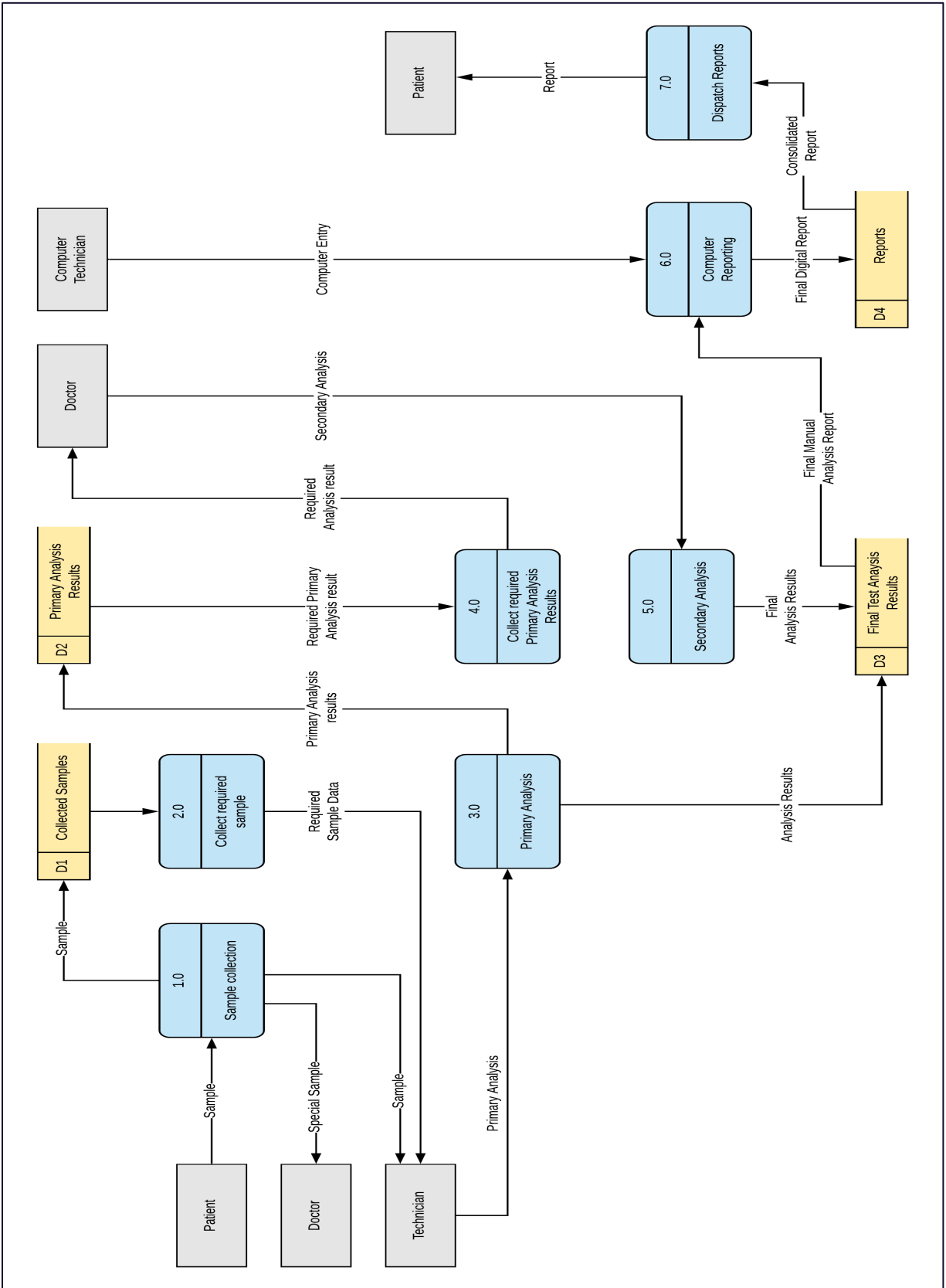# Appendix A

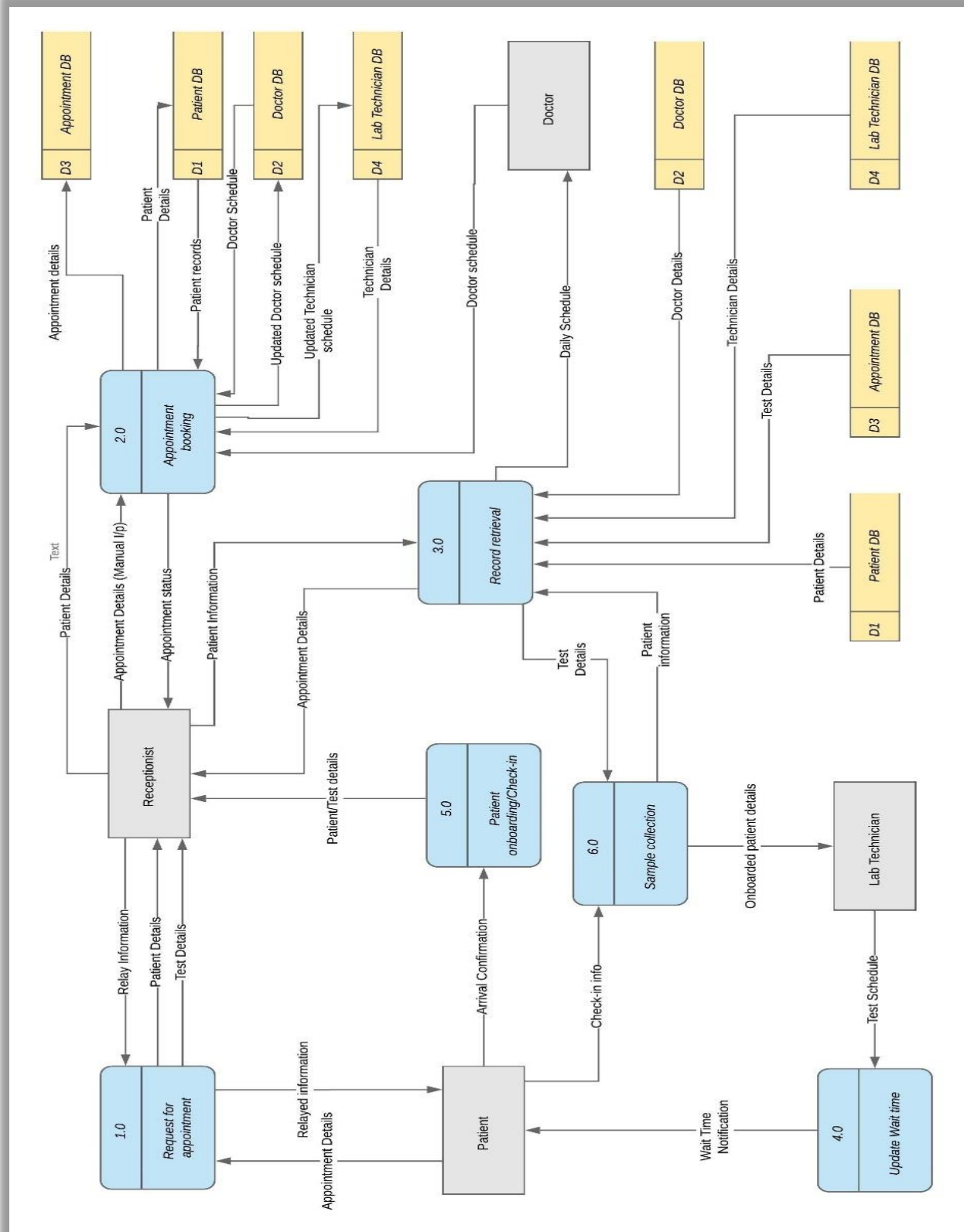*Image 1 - Level 0 - DFD - Scheduling*

Image 2 - Level 0 - DFD – Reporting
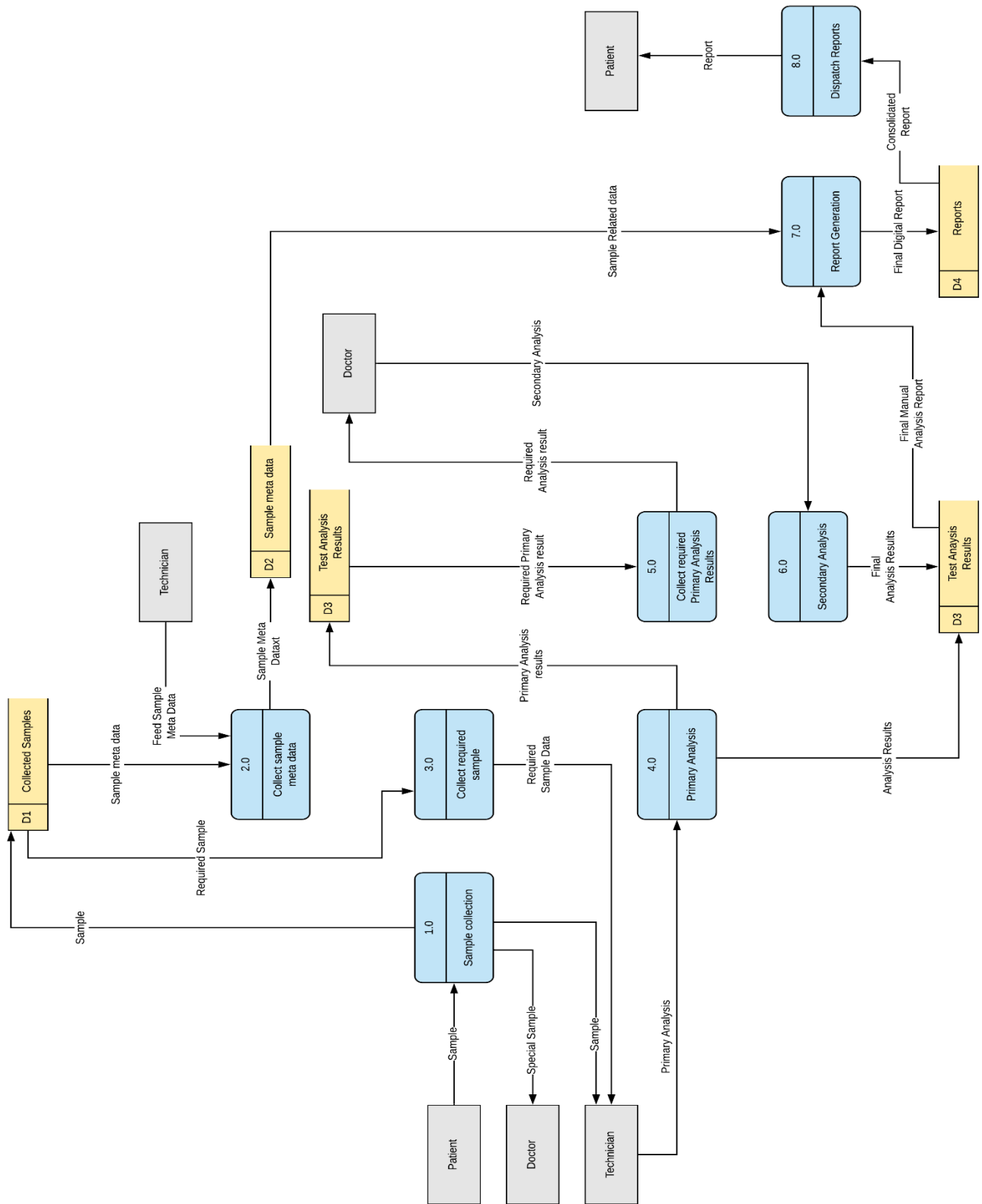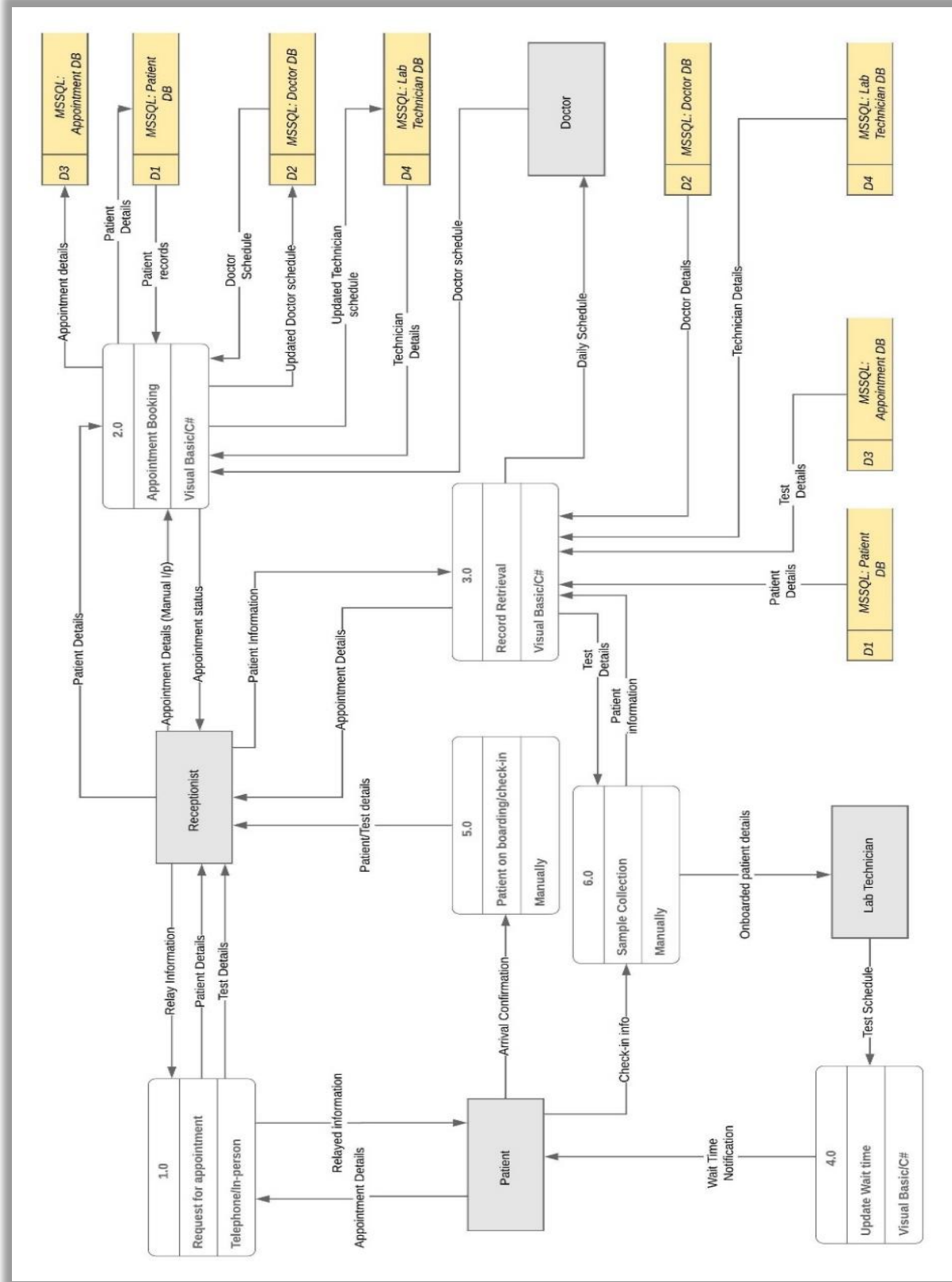
Image 3 – Level 0 DFD - Scheduling

Image 4 – Level 0 DFD – Reporting

Image 5 – Physical Level 0 DFD - Scheduling

Image 6 – Physical Level 0 DFD – Reporting