Dr. Batra's Pathology Lab Management System: A System's Development Project Case

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Abstract

This business case presents a systems analysis and design project. The case primarily focuses on the business, methodology, design and implementation traits of a systems development project. The case revolves around developing a laboratory management system for a fictitious pathology lab: Batra's Pathology Lab. The case describes that the company's current methods poses a threat of drastic reduction in the current clientele and outlines the requirement for a new systems solution. The new situation is presented in form of business requirements, a breakdown of the system and a question-answer session with the stakeholders. The case is developed in order to submit take-home final exam for ISTM-624: Advanced Systems Analysis and Design class.

Keywords: Systems Development, Systems Analysis and Design, Business Case, Pathology Lab Management System, User Requirements, UML, Methodology, Clinical Pathology

1. BACKGROUND

1.1 Introduction

Dr. Batra's pathology lab management systems development project is written in order to deliver take-home exam for ISTM-624: Advanced Systems Analysis and Design. The case is a fictitious representation that still requires realism and does not intend to depict an original organization.

It allowed the test-taker to apply his knowledge of object-oriented systems analysis and design in order to produce fully-dressed use cases, data flow diagram, logical and physical entity-relationship diagrams, class diagram and deployment diagram along with a critical analysis of how different software development methodologies would affect the choice of test-taker in order to develop the software.

The case context primarily demands issuance of a hassle-free and safe web and mobile platform for patients to register for various tests and in return, the system must issue timeless delivery of correct test reports. The Test-taker examined similar software applications available freely online, information systems project in the healthcare segment that resonates with the core idea of this project and textbooks (Capital *Pathology: Pathology Handbook*) with details around how pathology and lab technology co-relates. Textual knowledge is blended with personal knowledge of the healthcare industry in order to create realism In the case.

The following sections present the learning objectives for the project along with a brief overview of the fictitious Dr. Batra's Pathology Lab systems. Problem statement outlines major issues faced by the organization and how imperative it is for the organization to switch towards a sound web and mobile platform for customer satisfaction. This should grab a reader's attention and should compel a reader to visually picture themselves in the case. Major system's requirements are then outlined and further explanation is provided in the form of a question-answer series at the end. This format would help a reader to visualize the organization and its operations.

1.2 Learning Objectives

The take-home version of the test allows a test-taker to apply the knowledge of advanced systems analysis and design in a pseudo-realistic frame. The case covers various business, architectural, design and development issues in systems analysis and designs project.

1. Business Aspect

a. Business case replicates a real-world scenario with a fictitious pathology lab settings.
b. The primary motive behind the case is to rectify existing errors creeping in the business due to heavy reliance on a pen-and-paper approach. This approach is error-prone and the existing information technology no longer meets business requirements.
c. The case inclines towards increasing the business-value of the organization.
d. The case supports the idea of digitalization in the healthcare segment.
e. The case supports the idea of safe laboratory management practices.

2. Methodology Aspect
a. The case posits various artifacts for systems analysis and design in the form of different requirements and question-answer sessions.

3. Modeling Aspect
a. The case allows test-taker to create artifacts like use case descriptions, data flow diagrams, class diagrams, logical and physical entity-relationship diagrams, deployment diagrams.
b. The case allows test-taker to carefully analyse how process interact with each other in a systems analysis and design project.

4. Implementation Aspect
a. The case allows test-taker to compare between different software development methodologies: Waterfall, XP, SCRUM, RUP and make a wise decision for the implementation of the project.
b. Development of Entity-Relationship Diagrams provides a high-level understanding of how data would be captured by the system.
c. Development of deployment diagram allows the test taker to inter-relate how software and hardware components would be stacked together.

2. THE CASE

The following section provides an overview of Dr. Batra's Pathology Lab, providing a background of the organization, problems experienced in daily-business and requirements for the new system. Also, expansion plans and more details are presented in the form of a question-answer series at the end of the case.

2.1 Overview

Dr. Batra's Pathology lab is a service provider of diagnostic and healthcare tests. The lab is based in New Delhi and offers a wide range of tests on blood, urine, stool and other human body parts. The company is a family-owned business of Dr. Harsh Batra, MD, Pathology, Vardhman Medical University and has around 7 collection centres around New Delhi. All the collection centres are equipped with a laboratory which has a valid accreditation from National Accreditation Board for Testing and Calibration Laboratories (NABL), Ministry of Science and Technology, Government of India.

All the laboratories are fully-equipped with state-of-the-art laboratory machines and possess top-quality talent in the form of senior doctors, junior doctors, lab technicians, and other staff members to drive different departments within the small-scale pathology laboratory setup.

The company operates different collection centers within the capital that are open for general public daily from 6 A.M. till 8 P.M. Currently, all the laboratories/ collection centers employ a pen-and-paper approach to provide services to various patients. As pathology is the first step in the diagnosis of any disease, some of the common tests offered by the laboratory are as follows:

a. Complete Blood Count test: A complete test of red blood cells, white blood cells and platelets. Each of the cell counts can also be individually ordered.
b. Blood sugar test: Test related to diabetes
c. Electrolytes, 24 hour Urine Test: To assess acid-base balance
d. Electrolytes, Random Urine Test: To assess acid-base balance
e. Electrolytes, serum: To assess acid-base balance
f. Creatinine Clearance test: To assess the ability of kidneys to filter waste products

All the tests along with their test rates are showcased on a catalogue in the front-office, where a patient can select various tests according to doctor's prescription. Alternatively, a patient can call the front-desk office in order to know about these tests and book an appointment.

As a small-scaled private family-owned business, customer satisfaction in terms of the services offered is at the heart of Dr. Batra's Pathology Lab. The company makes sure all the patient details are carefully recorded by a trained front-desk assistant and the lab samples are carefully analysed inside the laboratory. Subsequently, all the reports are signed manually by a team of doctors and once a report is ready to be dispatched, a patient is contacted in order to receive the test report. A bill for the services provided is also handed over to the patient with test reports.

The company is currently planning to open 20 more collection centres across the country in order to make their presence in states other than New Delhi.

2.2 Organization Structure

Dr. Batra's Pathology lab has a qualified team of 25 doctors, 70 pathologists and 20 individual workers working across 8 locations within the city.

The senior management team at Dr. Batra's Pathology Lab constitutes of a chairman and managing director, chief executive officer, executive director, chief financial officer, and chief marketing and strategy officer.

Dr. Harsh Batra (Chairman and Managing Director): He is at the apex of the organizational structure and is responsible for revolutionizing laboratory medicine by introduction of new tests.

Dr. Meera Batra (Chief Executive Officer): Responsible to develop and execute organization's long-term policy.

Dr. Heena Dhankani (Executive Director): Responsible to supervise quality implementation processes in all laboratories at Dr. Batra's path lab.

Mr. Rajiv Batra (Chief Financial Officer): Responsible for handling financial risks of the organization.

Ms. Meena Sahay (Chief Marketing and Strategy Officer): Repsonsible for taking strategic decisions in terms of acquisitions or partnership with other collection centres and opening of new laboratories within the city.

2.3 Business Process

A typical day at Dr. Batra's Pathology Lab looks as following:

a. Patient calls at the front desk to book an appointment to give blood sample.
b. Front desk assistant books the appointment and marks it in a spreadsheet.
c. Patient arrives at the collection center and provides his/her name to the front desk assistant.
d. Front desk assistant validates the appointment against the date and name in the spreadsheet.
e. Patient proceeds to the collection center room.

Inside the laboratory, the lab works as per the following processes:

a. Lab technician takes the blood sample of the patient.
b. Lab technician pastes a sticker with a patient's name on the laboratory sample tube.
c. Blood sample reaches the laboratory.
d. Lab supervisor places all the blood samples in a tray.
e. Lab technician run samples in the analyzer machine.
f. The analyzer machine returns a list highlighting test results such as white blood cell count, WBC differential count and Red blood cell count.
g. Lab technician records the values in the paper report by filling the patient name along with the values obtained from the analyzer.
h. Lab Technician additionally makes an entry into the daily lab register about the same.

Dispatching Reports works as per the following process:

a. A worker helper transfers the bundle of reports to the front desk.
b. Front Desk assistant call patients to inform about test reports.
c. Patient/Guardian arrives at the collection center to collect report.
d. Front Desk assistant provides a bill for the services.

2.4. Problem Statement

Dr. Harsh Batra, along with Dr. Meera Batra was attending an international conference on 'Business Expansion Strategies in Clinical Pathology' in Tokyo, Japan when he received a call from Dr. Heena Dhankani mentioning about a sudden deteriorating test reports standards followed by Dr. Batra's Path Lab, which led to a growing resentment amongst patients. The laboratory was receiving numerous complaint calls from patients about wrong test reports handed over to them, when they reconfirmed the test reports from other pathology laboratories. As a result, guardians of few critical patients had already registered complaints on social media and the company is in increasing pressure from the Health Ministry of India to account for their services.

Dr. Batra was informed that due to a sudden outbreak of dengue and chikungunya in New Delhi, the number of reported cases has grown exponentially this year. According to a report from New Delhi Times, a local newspaper, hospitals have reported 1320 cases of dengue, which were substantially greater than 205 cases recorded in 2016, when the city experienced a severe dengue crisis. As for chikungunya, 700 new cases have been recorded by the hospitals, in comparison to 17 cases that were diagnosed last year, when New Delhi had a chikungunya outbreak. Common symptoms of dengue and chikungunya include high fever, severe headache, pain behind eyes, nausea and joint pain. Due to very common symptoms of both the diseases as compared to viral fever, people in New Delhi are terrified and want to submit their blood samples at the earliest to get a complete-blood-count report mentioning their haemoglobin levels along with the platelet count in the blood.

Fig 1. Dr. Batra's Pathology Lab Senior Management Organization Structure

Typical Problems Included:

a. Increased foot-fall of patients in the collection center and manual booking appointment. Patients are excessively frustrated due to large queues in the collection center. This leads to a lot of manual effort from the front-desk assistant to fill in paper-based forms for all the patients and hand out a token number for them to wait. As a result, many patients either leave the collection center in frustration or a patient's health deteriorates standing in queue for hours.

b. Front-desk assistant spends too much time manually coordinating a patient with a blood collector.

c. Blood samples are lost/damaged while processing the specimen as sometimes stickers bearing patient's name are damaged while working on a specimen by the laboratory technician. As a result, patients with common viral are diagnosed with dengue and patients with dengue or chikungunya are diagnosed with common viral. Sometimes, as the sticker only bears a patient name, two samples of two different patients with same name confuses the lab technician.

d. Lab Technician has to manually fill in the paper-report with certain tests yielding results for over 100+ components in a test. This leads to lesser productivity and less number of samples are processed in a day. As a result, the organization fails to keep their promise of delivering a report at the promised date.

e. Lab Technician has to additionally keep a record of patient along with the test results in a daily lab register. This also leads to lesser productivity and frustrates the lab technician at the end of the day.

f. For critical patients, there is no home collection facility to collect blood samples from a patient's home.

g. It is increasingly difficult for a patient or a guardian to visit the laboratory every time in order to collect a test report. If a patient subscribes for 2 tests with delivery reports promised at end-of-the day for one and next day for the other; a patient has to arrive at the collection center twice to collect reports.

h. Front-desk assistant sometimes forget to provide every minute details to the patient about a test. For example, improper pre-test information is provided to the patient which leads to loss of time for both the patient and the front-desk assistant.

i. Only catalogued tests displayed at the front-desk are currently in carried out by the laboratory. Senior doctors want to add new test in order to expand the business.

j. Doctors have to manually validate and sign the reports. This leads to growing frustration in doctors every time a wrong report is send to them.

Dr. Batra decided to fly back to Delhi in order to address the patients and have an emergency discussion with the senior management team. After carefully analysing the problems at hand and keeping in mind the expansion plans for the organization, the management has decided to hire an external agency that can design a distributed system for the pathology lab in order to provide a better and hassle-free user experience to their patients. The new information systems would be a mobile and web-based platform for patients to register for tests from anywhere and book appointments according to

one's condition and time suitability.

The management has decided to call this new software as 'Dr. Batra's Pathology Lab Management System'. With its implementation, the management aims to standardize the process of registering a patient, booking appointments and improve internal research effectiveness. Another key objective of this software would be to improve pathology lab test reporting system and introduce a bar-code reading mechanism in order to integrate patient data with test reports generated. This way the laboratory with comply with safety standards and practices as advocated by the Health Ministry of India.

There would be four primary users of this software:

1. Patients: People who are diagnosed with a disease and are prescribed a test by the doctor
2. Lab Technicians: Lab technicians would generate reports
3. Doctors: Doctors can validate and e-sign the reports along with adding a new test information
4. Staff: Staff admin would add new employees to the system.

2.4 Functional Requirements

Pathology Lab Management System would be rolled out in phases. Due to criticality of the condition, some of the requirements should be rolled out in the first phase and accordingly other phases should be decided.

Phase 1: Focus on Patient
Primary User: Patient, Front-Desk Assistant, lab technician, doctor

1. A patient should be able to register himself/herself using a mobile or web-based platform.
2. A patient can book hassle-free appointments using a mobile or web platform.
3. A patient can book a home collection request.
4. A patient can easily locate the nearest lab.
5. A patient can view test reports online.
6. An incoming patient should be readily registered by the front-desk assistant
7. A lab technician can generate test reports by bar-code reading of the specimen.
8. A doctor can validate and e-sign pending reports.

Phase 2: Focus on administrative tasks
Primary Actors: Staff Admin, Doctor
1. A system admin can add a new employee to the system.
2. A doctor can add new test details to the system.

Later Phases or in-future scope
1. Accounting and finance
2. Inventory Management
3. Patient Diagnosis
4. HR management
5. Logging shift timings of employees
6. Comprehensive Reporting

2.5 Interview with Dr. Harsh Batra

Q. Can you explain how a lab technician would be able to generate a report using bar-code reading mechanism?

A. Sure. Every time a new patient is registered in the laboratory, a system should assign a unique number to the patient. For example, a unique combination of first two letters of the last name, first two letter of the last name, followed by a 4 digit unique number. In my case, let's suppose it is HABA2390. We are investing in a bar code labelling technology that can be plugged with the new information systems and generate stickers of bar-code bearing the same unique number of the patient. So, every time a patient requests a blood report, the front desk assistant would generate a sticker bearing patient's unique id. The stickers would be placed on the specimen and when the specimen would reach the laboratory, our lab technician can simply scan the bar code and patient's primary details would be displayed on the screen. This was when results would be copied from our analyser machine to our system, correct test results would be linked to the correct patient.

Q. Would the front-desk assistant release all the reports to the patient? How will dispatching of test reports would work?

A. As we know different tests have different delivery period. For example, for a lipid profile basic test, reports can be delivered the same day, but certain tests require an incubation period. So, the new system should save delivery date information about a test. And based on the test submission date by a patient, system should calculate the delivery date of a test for patient. Once the doctor validates and approves a report, a report should be automatically emailed to the patient and stored in our database. This would ensure automated and timely delivery of our reports.

Q. What other information should a test store?

A. A test is typically carried out by expert lab technicians under the supervision of a doctor. That means, a lab technician would generate a test report by running the sample in the analyser machine. And the report would be validated and signed by the doctor. In order to add a new test to the system, a test would generally have common information like test type, report delivery, components, specimen details, stability room, stability refrigerated, method etc.

Q. So, that means generation and validation of reports is a two-step process?
A. Exactly, a report should reach a doctor for final validation and signatures.

Q. Can you show me a sample test information?
A. Sure, I will share one of the most common tests: complete blood count information with you. Refer to Fig 2, Fig 3.

Q. So these tests would also yield some test results. What about those results?
A. I can share a test report with you that has all the components which are tested in a test. So that means every test will have certain components based which will yield some results. For example, a complete blood count would give me a count of my haemoglobin, RBC, neutrophils, lymphocytes.

Q. Can you also share a sample report with me?
A. Yes, currently as we have our own letterhead, all the reports are generated by the lab technicians and signed by doctor using pen and paper. I will photocopy and send you a sample report. (Refer Fig 4)

Q. How will a doctor validate and sign a report?
A. All our doctors are highly qualified professionals who can look at the reports and can figure out if there are any anomalies. We don't require any technology to validate against a set of criteria. The only thing we require is e-signatures of doctor. Again, we are investing in state-of-the-art facility and planning to buy signing pads for doctors. A doctor can validate the report and sign it on the pad. System should pick in the signatures and validate against already submitted doctor's signatures and e-sign the report.

Q. In order to provide a flexible system, we would like to know about your future plans about this lab management system.
A. We are in dire need to address a critical situation at hand for now, but we would like to expand this management system by including tracking of inventory systems in near future. As we have many costly machines, we would like to keep a track of the machines and also the vendor information about it. Also a log if items would be maintained as per the usage of reagents or coagulants by lab technicians daily. This would help us to stop wastage of chemicals in the laboratory. But this requirement is not an immediate one and can be tackled in near future. We are also planning to setup ipads or kiosks at our collection centres so that a patient can register by themselves for any incoming appointment. So the system must be designed accordingly that it can fetch data from various sources like internet, mobile devices, kiosks etc.

Q. What are your expansion plans? Would the lab be only centred in Delhi?
A. although I am deeply saddened by the current situation of dengue and chikungunya in Delhi, we have analysed that the conditions would deteriorate in whole India and best diagnostic services would be imperative for a patient. We are planning to expand in other cities as well and this system would allow our team to practice telepathology.

Q. What is telepathology?

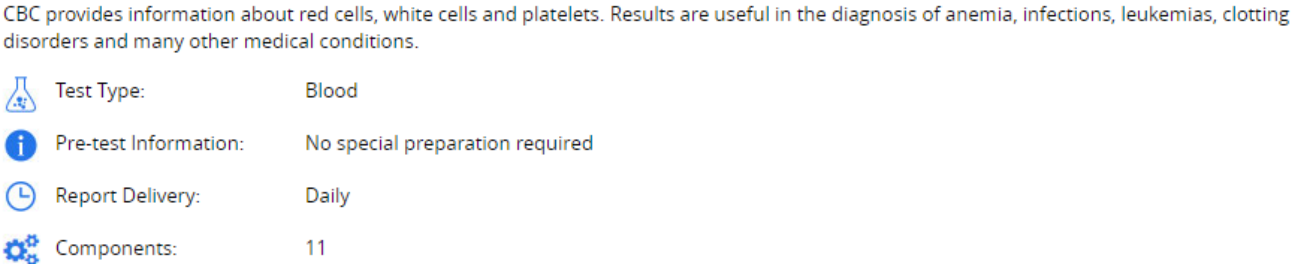


Fig 2: Complete Blood Count Test Information

A. Let's say I am a doctor based in New Delhi and there is a patient in south of India. My system would allow me to transfer image-rich pathology data from a distance so that a doctor can analyse the test and a lab technician can generate a test report. That would be high-resolution microscopic images of the specimen.

2.6 **Advantages of Pathology Lab Management System**

a. Accurate response time
b. No Manual Intervention
c. Reduced paper work
d. Better Research opportunities
e. Secure blood samples and reports
f. Preparedness for city-wise emergencies
g. Improved customer satisfaction

Test Name	COMPLETE BLOOD COUNT; CBC
Report Availability	Daily
Code	Z021
Category	Health Check Up
Specimen	3 mL (2 mL min.) whole blood in 1 Lavender Top (EDTA) tube. Ship refrigerated. DO NOT FREEZE.
Stability Room	6 hrs
Stability Refrigerated	48 hrs
Method	Electrical Impedence, VCS

Fig 3: Complete Blood Count Test Information

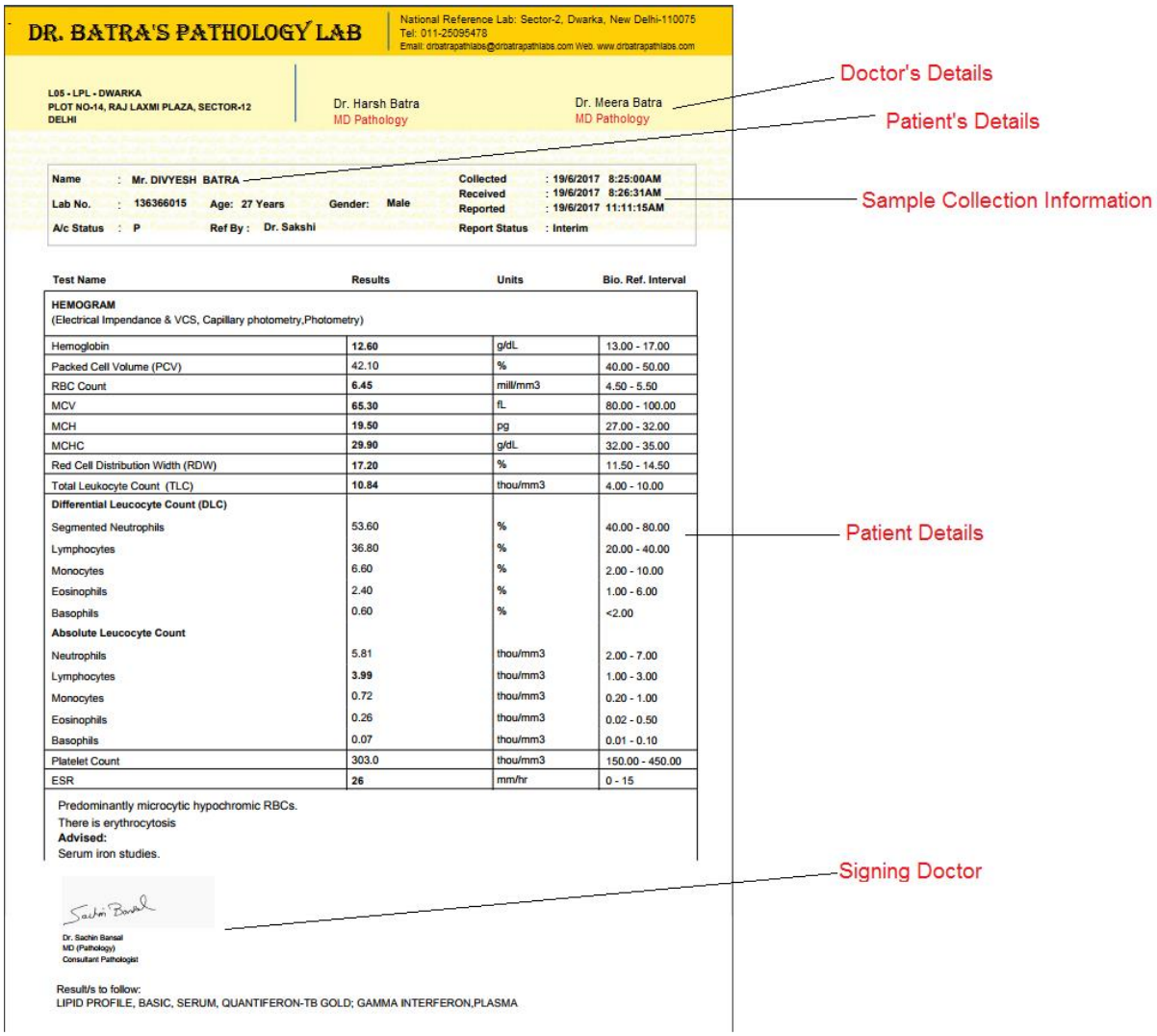


Fig 4. Sample blood test report

3. References

shareicon.net
https://www.medicinenet.com/complete_blood_count/article.htm
https://en.wikipedia.org/wiki/Dr_Lal_PathLabs
https://en.wikipedia.org/wiki/National_Accreditation_Board_for_Testing_and_Calibration_Laboratories
Capital Pathology: Pathology Handbook, Capital Pathology ABN 49 452 500 4222 Makin Place, Deakin, ACT, 2600, Australia, Published-2012
https://www.zebra.com/content/dam/zebra_new_ia/en-us/solutions-verticals/vertical-solutions/healthcare/white-paper/barcode-labeling-lab-white%20paper-en-us.pdf
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4518452/
System Analysis and Design, Fifth Edition: Alan Dennis; Barbara Haley Wixom; Roberta M. Roth
Teaching Case The Rescue911 Emergency Response Information System (ERIS): A Systems Development Project Case

4. Definitions

Clinical Pathology: Clinical Pathology is a specialised medical field that provides diagnosis of a disease on the basis of careful study of body fluids, blood samples, stains, urine, stool using hematology, microbiology, and molecular pathology.

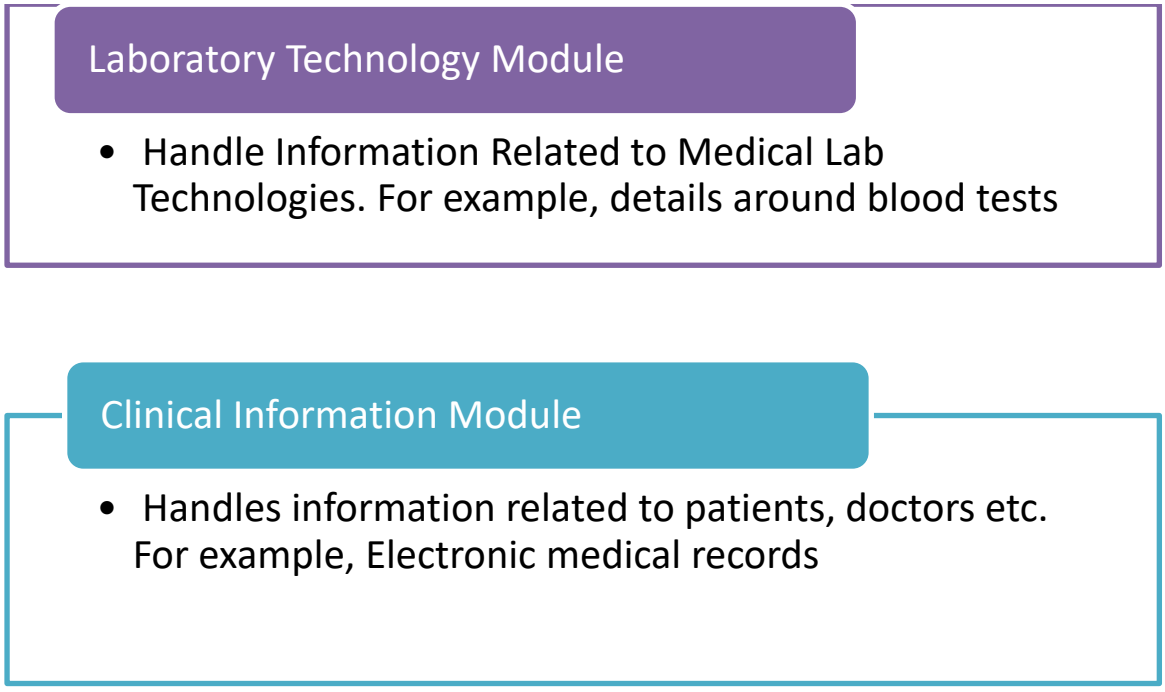


Fig 5. Software Module for business case

1.0 Use-Cases

Use Case Name	Register an incoming Patient on front-desk	**ID:** UC - 1	**Priority**	High
Actor	Front-desk Assistant			
Description	A Front-desk assistant registers an incoming patient in the system. The system registers the patient and notifies the staff member that the patient has been registered.			
Triggers	Front-desk assistant raises a request to register an incoming patient			
Type	External			

Preconditions

1. Front-desk assistant is authorized to register a patient
2. Front-desk assistant is logged into the system
3. System is up and running
4. A patient walks in to the front-desk and requests for a pathology test

Normal Course	**Information for Steps**
1. Front-desk assistant clicks on add new patient in the system	← Add Patient Request
2. System opens up a registration form	→ Registration Form
3. Front-desk assistant enter primary details like telephone number, first name, last name, email address and date-of-birth of the patient	← Patient Details
4. System validates the inputs and checks if the patient is already registered in the system (Alternate Course 1.1)	← Patients' List
5. If the patient is new, system asks for secondary details like address, secondary contact number etc.	→ Secondary Patient Details
6. Front-desk assistant enter the required details and clicks on 'Add Button'	← Add Patient
7. System stores the patient information in the database	→ Patient Information
8. System notifies Front-desk assistant that patient has been registered	→ Registration Notification
Alternate Courses	
1.1 Patient is already registered in the system	
1). The system notifies Front-desk assistant that the patient is already registered in the system and exits the flow of registration	→ Existing Patient

Post Conditions

1. The patient is added to the database
2. Two unique IDs are generated for the patient for barcode labelling of specimens.
3. Front-desk assistant assists the patient about online login in future using contact number as username and password as per the instructions emailed and texted on contact number.
4. System sends a mail and text message to the patient

Exceptions

E1) System doesn't connect to patient database
1). System displays database unavailability message to front-desk assistant
2). System asks front-desk assistant to re-try registration after sometime
3). Front-desk assistant hands out manual text-form to the patient for registration

Summary

Inputs	**Source**	**Outputs**	**Destination**
Add Patient Request	Front-desk assistant	Registration form	Front-desk assistant
Patient Details	Front-desk assistant	Secondary Patient Details	Front-desk assistant
List of Patients	Patient Database	Patient Information	Patient Database
Add Patient	Front-desk assistant	Registration Notification	Front-desk assistant

Use Case Name	Patient Registration using Mobile or Web-Platform	**ID:** UC - 2	**Priority**	High
Actor	Patient			
Description	A patient wants to register himself/herself on website or mobile application in order to avail services of the pathology lab. The system registers the patient and notifies the patient.			
Triggers	Patient clicks on sign-up link to register himself/herself			
Type	External			

Preconditions

1. System is up and running
2. Patient has a valid contact number

Normal Course	**Information for Steps**
1. System asks for contact number in order to keep patient updated on report status	Contact number ←
2. Patient enters contact number	→ Contact number
3. System validates the contact number and checks if the contact number is already registered in the system (Alternate Course 1.1)	Contact number list ←
4. System sends out a one-time-password (OTP) to patient's contact number	→ OTP
5. Patient enters the one-time password (OTP) in the system and clicks on validate OTP.	OTP ←
6. System validates the OTP and asks for patient's details	→ Patient Details Request
7. Patient enters details like First Name, Last Name, Email, Date of birth, Gender, password and confirm password and clicks on save button	Patient Details ←
8. System stores the patient information in the database	→ Patient Information
Alternate Courses	
1.1 Contact Number is already registered in the system	
1). The system notifies the patient that the contact number is already registered in the system.	→ Already registered Notification.
2.1 a). The system asks the patient for forgotten password	← Forgot Password
2.1 b) Patient clicks on forgot password link	
2.1 c) System asks the patient to enter the contact number already registered	← Contact Number
2.1 d) System sends OTP to the linked email id with the already registered contact number	→ OTP
2.1 e) Patient enters the OTP and clicks on validate OTP	→ OTP
2.1 f) System validates OTP	← Validated OTP
2.1 g) Patient enters new password and confirms new password	← Password
2.1 h) System updates the password in the database	→ UpdatedPassword
2.1 i) System sends a notification to the contact number and email address	→ Notification
2.2 a) Patient clicks on 'Register with different contact number' link	
2.2 b) System starts the normal course again	

Post Conditions

3. The patient is added to the database
4. A unique ID is generated for the patient for barcode labelling of specimens.
5. System sends a mail and text message to the patient

Exceptions

E1) Patient enters wrong OTP
1). System provides a link to re-send OTP
2). System follows normal course from step 3.

Summary

Inputs	Source	Outputs	Destination
Contact Number	Patient	OTP	Patient
Contact Number List	Patient Database	Patient Details Request	Patient
OTP	Patient	Patient Information	Patient Database
Patient Details	Patient		

Use Case Name	Book a Test using Mobile or Web-Platform	**ID:** UC - 3	**Priority**	High
Actor	Patient			
Description	A patient wants to book a test for himself/herself on website or mobile application in order to avail services of the pathology lab. The system registers the appointment and notifies the patient.			
Triggers	Patient clicks on Book-A-Test link to schedule appointment			
Type	External			

Preconditions

1. System is up and running
2. Patient is logged into the system
3. Patient has a valid prescription from the doctor
4. Patient is aware of the test(s) to book

Normal Course	**Information for Steps**
1. System shows a list of tests along with details like test information, report delivery, pre-test information, parameter(s) covered	Test Lists ←
2. Patient selects the test from the list and clicks on 'Add-to-cart' link (Alternate Course 1.1)	Selected Test ←
3. Patient clicks on continue to cart link	
4. System displays order preview with test name and price	
5. Patient clicks on confirm booking link	← Confirmation
6. System asks for patient details	← Patient details
7. Patient enter details for self or another patient	← Patient details
8. Patient enters preferred date for test	← Preferred date
9. Patient clicks on Make Payment link and makes payment (Alternate Course 1.2)	← Payment
10. System books the appointment in the appointment database	→ Booked appointment
11. System saves the billing information in the billing database	→ Billing Information
Alternate Courses	

1.1 Patient selects a test twice 1). System notifies the patient about duplicate tests found 2). Patient clicks on OK button on the warning pop-up 3). Normal Course starts from Step 3 1.2 Patient chooses 'Cash on collection' payment type 1). System updates the billing database for the patient.	→ Duplicate Test ← Payment Type → Billing Information

Post Conditions

1. Appointment database is updated.
2. Billing database is updated
3. According to the number of tests booked, system generates stickers with unique barcode information of patient for labelling of specimens.
4. System emails and texts the appointment schedule
5. System emails the computed bill.

Exceptions

E1) If the holiday calendar is not up-to-date, and patient books an appointment on that date
1). System generates an email notifying the user of the glitch
2). System allows rescheduling of the appointment (Step 7→ Step9→Step 11)

Summary

Inputs	Source	Outputs	Destination
Tests list	Test Database	Booked Appointment	Appointment database
Selected Test	Patient	Billing Information	Billing database
Confirmation	Patient		
Patient Details	Patient		
Preferred Date	Patient		
Payment	Patient		

Use Case Name	Book home collection service using Mobile or Web Platform	**ID:** UC - 4	**Priority**	High
Actor	Patient			
Description	A patient wants to book a home collection appointment for test. The system registers the request and notifies the lab technician about the home collection request.			
Triggers	Patient clicks on book 'home collection appointment link'			
Type	External			

Preconditions

1. System is up and running
2. Patient has a valid prescription from the doctor
3. Patient is aware of the test(s) to book

Normal Course	Information for Steps
1. System displays a home collection query form	← Query Form

2. Patient enter details like telephone number, first name, last name, email address and date-of-birth, address, preferred home collection date and presses next button (Alternate Course 1.1)	← Patient Details
3. System stores patient information in the patient database.	Patient Information →
4. System shows a list of tests along with details like test information, report delivery, pre-test information, parameter(s) covered	← Test list
5. Patient selects the test from the list and presses submit form button (Alternate Course 1.2)	← Selected Test
6. System updates the appointment database	→ Updated Appointment
7. System updates the billing database	→ Billing Information
Alternate Courses	
1.1 No Lab Technician is available on the preferred date	
1). System displays a warm apology about no available technicians on the preferred date. 2). System asks for rescheduling of appointment. 3). Patient enters a new preferred date and re-schedules the appointment.	→ Apology ← Appointment date ← Appointment date
1.2 Patient selects a test twice	
1). System notifies the patient about duplicate tests found 2). Patient clicks on OK button on the warning pop-up 3). Normal Course starts from Step 4	→ Duplicate Test

Post Conditions

1. Patient database is updated.
2. Appointment Database is updated.
3. Concerned Staff is notified of a home collection request
4. Billing database is updated and bill is generated for cash-on-collection.
6. System send a confirmation mail and text message to the patient with appointment schedule, lab technician name, best time slot according to the test(s) chosen.
5. A unique ID is generated for the patient for barcode labelling of specimens.

Exceptions

E1) If the web platform is down, system displays a message saying: " We are experiencing some technical difficulties, please try re-scheduling your home collection appointment or call our toll-free number xxx-xxx-xxxx for hassle free booking"

Summary

Inputs	Source	Outputs	Destination
Query Form	Patient	Patient Information	Patient Database
Patient Details	Patient	Updated Appointment	Appointment Database

Test List	Test Database	Billing Information	Billing Database
Selected Test	Patient		

Use Case Name	View Test History using Mobile or Web Platform	**ID:** UC - 5	**Priority**	High
Actor	Patient			
Description	A wants to view a history of test reports. The system displays a history of test reports of patient.			
Triggers	Patient clicks on My Reports link			
Type	External			

Preconditions

1. System is up and running
2. Patient is logged into the system

Normal Course	**Information for Steps**
1. System asks for from-date and to-date parameter from patient	Date range
2. Patient enters from-date and to-date parameter and clicks on fetch button	Date Range
3. System displays a list of report with date, test details and details link in a tabular form (Alternate Course 1.1)	Test List
4. Patient clicks on details link to any one of the report	Test details
5. System displays a comprehensive report of the test.	Test Details
Alternate Courses	
1.1 If a recent report is missing	
1). System asks for specific test name 2). Patient enters test name 3). System finds the lab number for the test name, registered email and contact number. 4) System notifies the patient that the report is in progress and would be emailed in next 3 working days.	Test Name Test Name Test results detail Notification
1.2 In case of no report history	
1). System notifies user that there are no available reports for the patient.	

Post Conditions

1. System generates test history of patient successfully.

Exceptions

E1) Error while clicking the fetch button
1). System displays a custom message “Something went wrong on our side. Please try again after sometime”.

Summary

Inputs	**Source**	**Outputs**	**Destination**
Date Range	Patient	Test Details	Patient
Test List	Test Database		
Test Details	Patient		

Use Case Name	Add a new test to the test catalogue	**ID:** UC - 6	**Priority**	High
Actor	Doctor			

Description	A senior doctor wants to add a new test to the test catalogue. The system adds the test in the database and notifies the concerned department.
Triggers	Doctor requests to add a new test to the catalogue
Type	External

Preconditions

1. Doctor is logged into the system
2. Doctor is authorized to edit the test catalogue
3. New test information and setup is peer-reviewed by the Head of the department of the specialty/department
4. System is up and running

Normal Course	**Information for Steps**
1. Doctor selects specialty from the drop down list.	Specialty
2. Doctor clicks on add new test button	Add test Request
3. System displays a form to add test details	Test Form
4. Doctor add test details like test name, test type, pre-test information, report availability, specimen details, stability room, stability refrigerated, test method	Test Details
5. System validates the inputs and checks if the test matches with an existing test in the database (Alternate Course 1.1)	Test List
6. System stores the test details in the test database	New Test Details
7. System shows a success message to doctor	Confirmation
Alternate Courses	
1.1 Similar test is already registered in the system	
1). The system notifies the doctor that a similar test is already registered in the system 2a). Doctors approves of another test to be added to the system 2b) Doctor cancels the new test 3a). System stores the test details in the test database	Already registered Notification Cancellation New Test Details

Post Conditions

1. System mails a notification to all the doctors related to particular specialty about new test addition along with details.

2. Test database is updated accordingly.

Exceptions

E1) Error message while adding a new test
1). System displays database unavailability message to the doctor
2). System asks doctor to re-try registration after sometime

Summary

Inputs	**Source**	**Outputs**	**Destination**
Specialty	Doctor	Test Form	Doctor
Add test request	Doctor	New Test Details	Test Database
Test Details	Doctor	Confirmation	Doctor
Test List	Test Database		

Use Case Name	Find a lab	**ID:** UC - 7	**Priority**	High
Actor	Patient			
Description	A patient searches for a collection center according to convenience			
Triggers	Patient clicks on ‘Find-a-Lab’ link			

Type	External
Preconditions	
1. System is up and running 2. All collection center's information is up-to-date in the database	
Normal Course	**Information for Steps**
1. Patient enters the zip code of the area	Zip Code
2. Patient clicks on search labs links	Nearest Labs List
3. System displays a list of labs nearest to the zip code entered (Alternate Course 1.1)	Nearest Labs List
Alternate Courses	
1.1 If no lab is found for the zip code entered	
1). The system notifies the patient that no lab is found for the zip code entered 2). Patient drags the radius button to increase the area of search near the zip code entered. 3). Normal Course is followed from step 3.	No lab notification radius
Post Conditions	
1. A list of labs is displayed along with address and contact number.	
Exceptions	
E1) Search functionality doesn't work 1). System displays a message that something went wrong and would be fixed by the technical team. 2). System displays all the list for the city.	
Summary	

Inputs	**Source**	**Outputs**	**Destination**
Zip Code	Patient	Nearest Labs List	Patient
Nearest Labs List	Labs Database	Exists Notification	Staff

Use Case Name	Validate and E-Sign Test Reports	**ID:** UC - 8	**Priority**	High
Actor	Doctor			
Description	A doctor validates and signs pending reports. The system acknowledges signatures and forwards the report for final dispatch.			
Triggers	A pending validation request reaches the doctor			
Type	External			
Preconditions				
1. Doctor is authenticated to validate the reports 2. Doctor is authenticated to E-Sign the reports. 3. System is up and running 4. Doctor is logged into the system.				
Normal Course			**Information for Steps**	
1. Doctor clicks on pending reports link			Pending reports request	
2. System displays a list of pending reports			Pending Reports List	
3. Doctor clicks on view details link				
4. System opens the report containing test values			Pending Report	
5. Doctor validates the test results and clicks on validate report link. (Alternate Course 1.1)			Validated Report	

6. System displays an area to sign along with doctor's initials and date.	Signature request
7. Doctor signs and enters initials.	Signatures
8. System validates the signature and initials.	Validated Signatures
9. Test Results database is updated	Signed report
10. System displays 'Report successfully validated and Signed' message.	Confirmation
Alternate Courses	
1.1 Doctor is not satisfied with the test results	
1). Doctor clicks on re-examine test results link 2). System allows doctor to edit the report 3). Doctor enter comments in the report and clicks on send 4). System sends a notification to the central lab for re-examination of test results. 5). System exits the flow of events.	Re-examine results Comments Notification

Post Conditions

1. Validated and signed report is forwarded for final dispatch to patient

Exceptions

E1) View Details link doesn't yield anything
1). System displays database unavailability message to doctor
2). System asks doctor to re-try after sometime

E2) Doctor's signatures are not validated by the system
1). System displays an error message: " Signatures doesn't match with signatures in the record"
2). System advises doctor to talk to system administrator or retry signatures after wiping the screen.

Summary

Inputs	Source	Outputs	Destination
Pending Reports Request	Doctor	Pending Report	Doctor
Pending Reports List	Test Result Database	Signed Report	Test Result Database
Validated Report	Doctor	Confirmation	Doctor
Signature	Doctor		
Validated Signature	Doctor		

Use Case Name	Add Employee	**ID:** UC - 9	**Priority**	Medium
Actor	Staff(Admin)			
Description	A new employee joins the Pathology lab and administrator will add his information in the employee database and grants him the required access			
Triggers	A new employee joins the Pathology Lab			
Type	External			

Preconditions

1. Staff Administrator is authorized to add a new employee
2. Staff Administrator is logged into the system
3. System is up and running

Normal Course	Information for Steps
1. Employee requests for his/her profile and required access to system.	
2. Staff administrator asks for employee details like first name, last name, designation, address, qualification, gender, joining date, contact number etc.	Employee details

3. Staff administrator enters all the details into the system	Employee Details
4. System asks for confirmation of details.	Request for confirmation
5. Staff administrator confirms the details and clicks on set active link.	
6. System enters the detail in the employee database	Employee Details
7. System generates access credentials for the employee	Access Credentials

Post Conditions

1. Employee's details are added in the employee database.
2. Default access is granted to employee on common modules.
3. System sends a mail and text message to employee

Exceptions

E1) System is unable to add employee's details in database
1). System displays message that database is currently unavailable
2). System asks staff administrator to re-try after some time

Summary

Inputs	Source	Outputs	Destination
Employee Details	Staff(Admin)	Employee Details	Employee Database
Request for confirmation	Staff(Admin)	Access Credentials	Employee

Use Case Name	Generating Test Results using bar-code reader	**ID:** UC - 10	**Priority**	High
Actor	Lab Technician			
Description	A lab technician runs the sample in the machine and generates a report bearing test results. The system stores test results.			
Triggers	Specimen reaches the laboratory			
Type	External			

Preconditions

1. Lab technician is adept to run sample in the analyser machine
2. Front-desk assistant is logged into the system
3. System is up and running
4. A specimen reaches the laboratory with a sticker bearing unique barcode for patient is placed on the specimen and the other
5. Analyser machine is up and running
6. Analyser machine is connected with the system
7. All the reagents are prepared with full knowledge of the test by the lab technician
8. Sample is ready to be fed in the analyser machine

Normal Course	Information for Steps
1. Lab technician places the sample in the analyser machine and selects the type of test.	Selected Test
2. Lab Technician runs the test in the analyzer	
3. Analyzer calculates the results and displays it on the analyzer screen	Calculated Results

4. Lab Technician takes out the sample and scans it with a bar code.	
5. System displays pre-filled patient details in the report displayed on system	Patient Details ←
6. Lab Technician verifies the results and clicks on copy results on the analyzer display screen. (Alternate Course 1.1)	Verified results ←
7. Analyzer machine copies test results to patient's report on the system screen	Copied Results ←
8. Lab Technician confirms test results on patient's report on the system screen	Requestfor Confirmation →
9. System shows a confirm message and stores the results in the test result database	Test Results →
10. Lab Technician closes both the analyser machine and the reporting system.	
Alternate Courses	
1.1 Copy functionality of analyser machine doesn't work	
1). Lab Technician manually fills the test results into various specified fields in the system 2). Normal course starts from step 8	Test Results ←

Post Conditions

1. Test Result database is updated
2. Lab Technician dispatches the report to the concerned doctor for review.
3. Concerned doctor receives a notification of a new report for review.

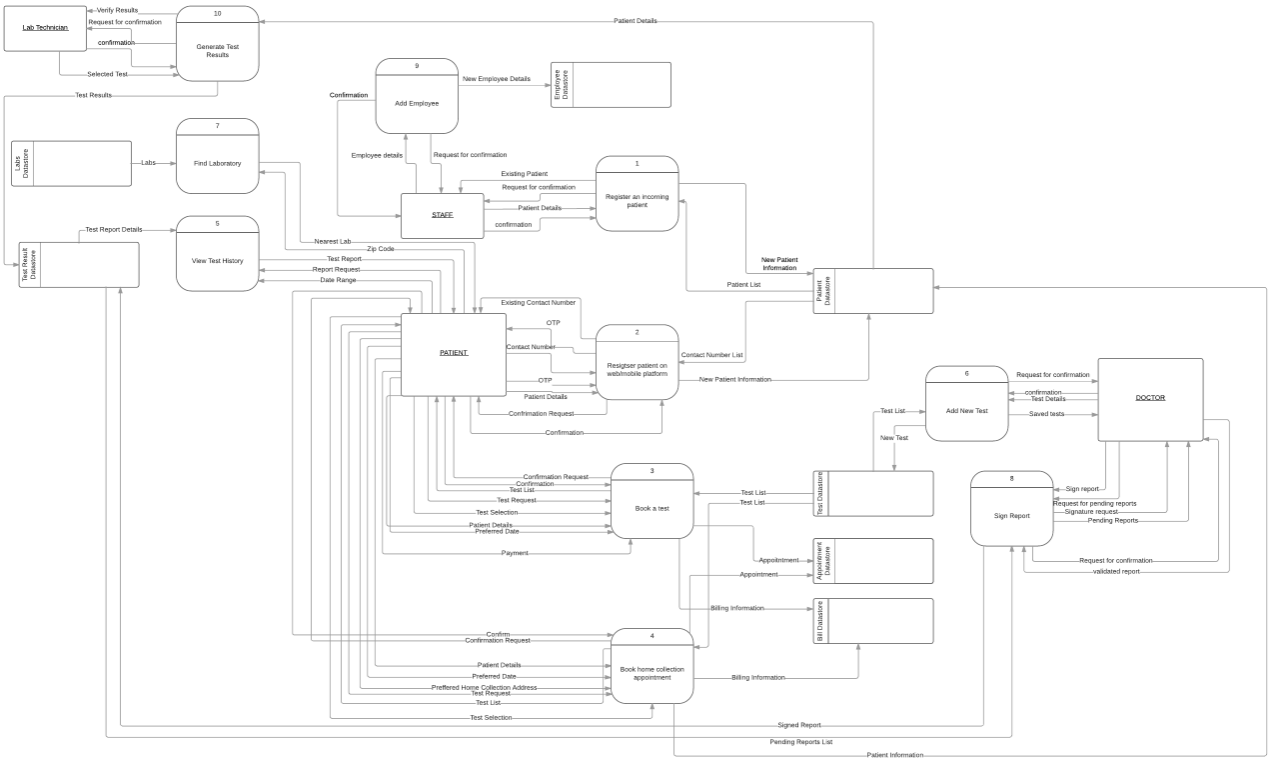
Exceptions

E1) Analyzer machine is not computing test results
1). System displays unavailability message to lab technician
2). Lab technician re-runs the specimen after sometime.

Summary

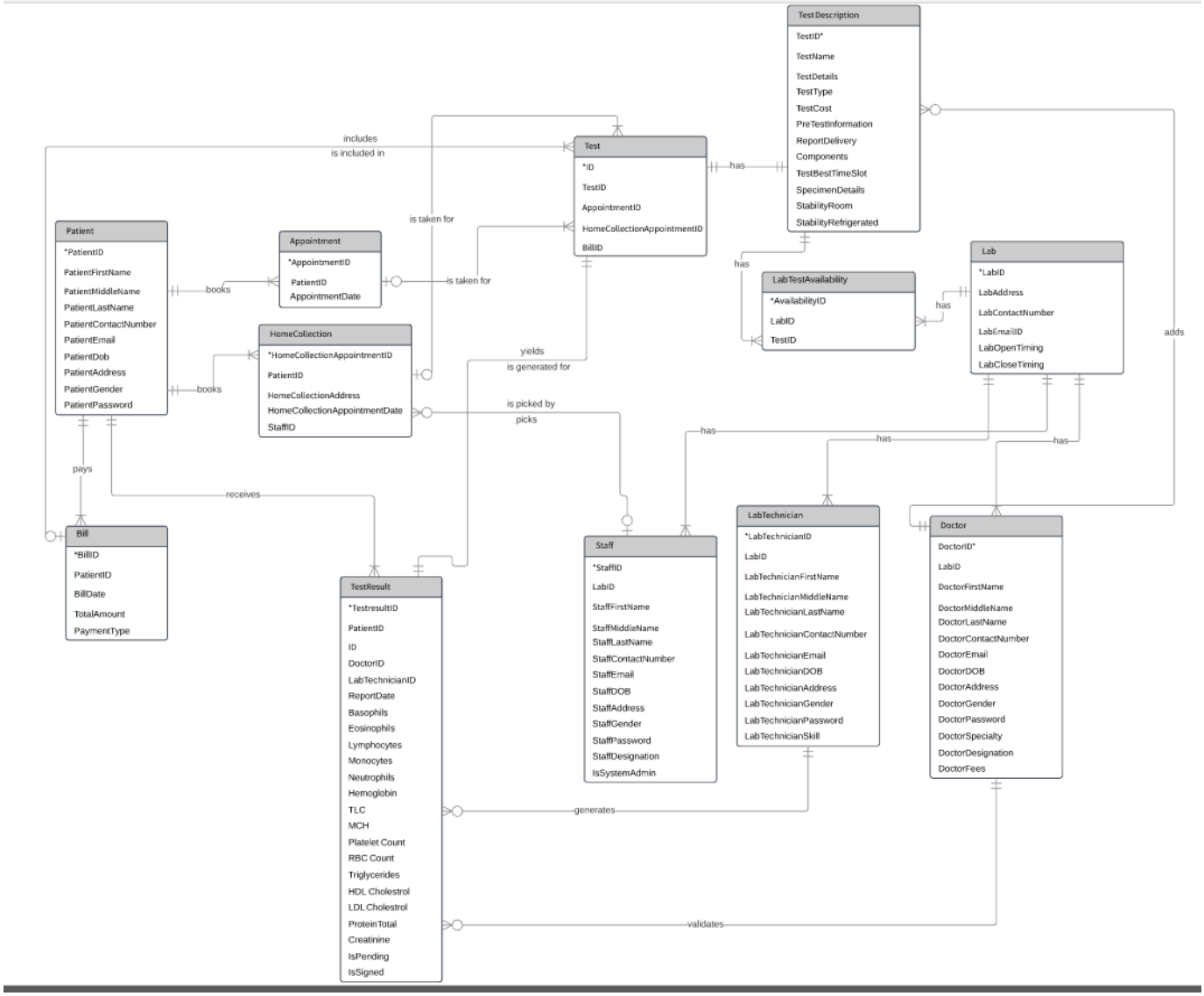
Inputs	Source	Outputs	Destination
Selected Test	Lab Technician	Test Results	Test Result database
Calculated Results	Analyzer Machine		
Patient Details	Patient Database		
Verified Results	Lab Technician		
Copied Results	Analyzer machine		
Request for confirmation	Lab Technician		

2.0 Data Flow Diagram



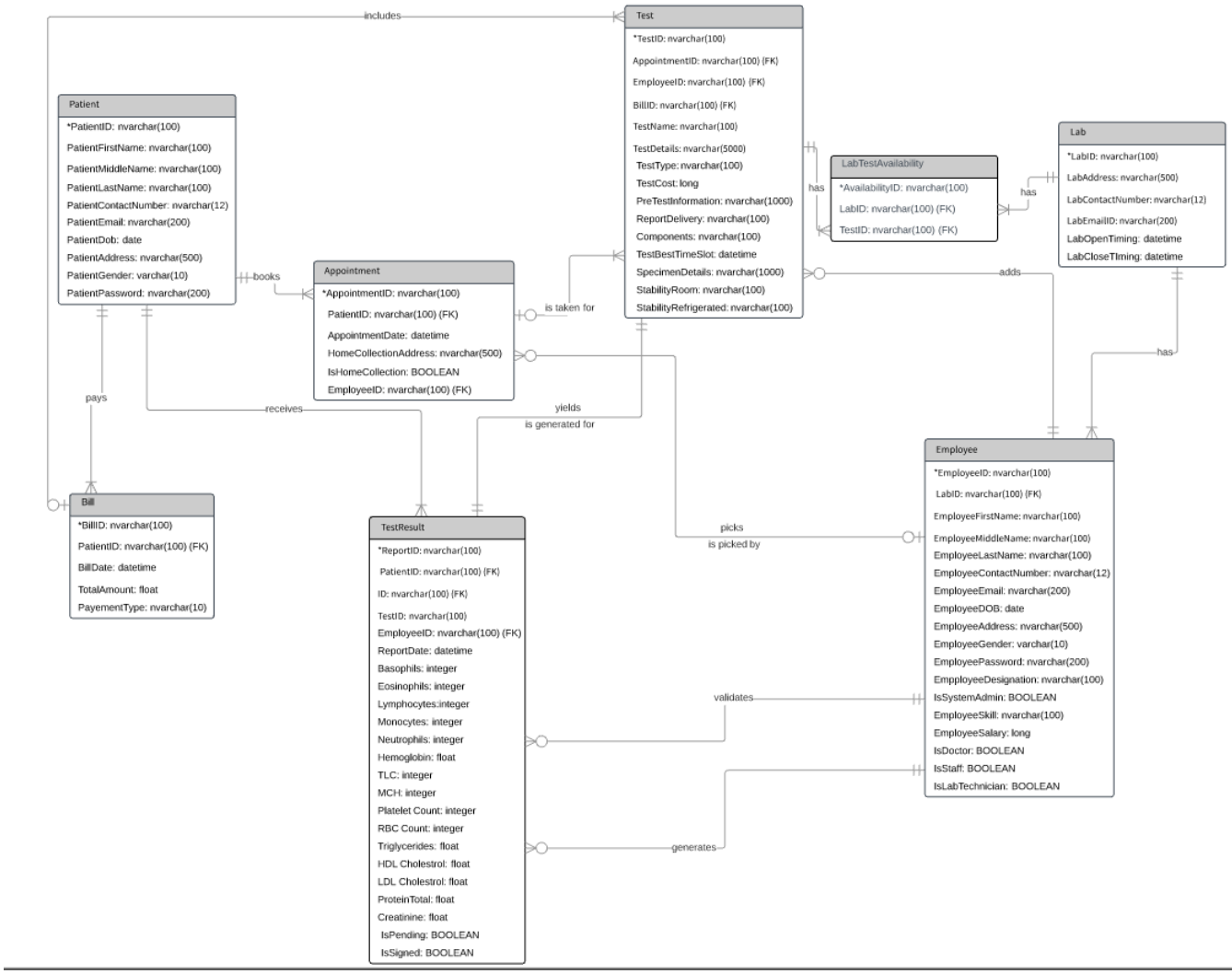
Zoom in full-diagram available at:
https://www.lucidchart.com/documents/embeddedchart/5777546e-5683-40f6-bcda-f0ee6fa6bbf1

3.0 Logical Entity-Relationship diagram



Zoom in full diagram available at:
https://www.lucidchart.com/documents/embeddedchart/c997ba97-f5ad-4e18-a519-43e83996cf0f

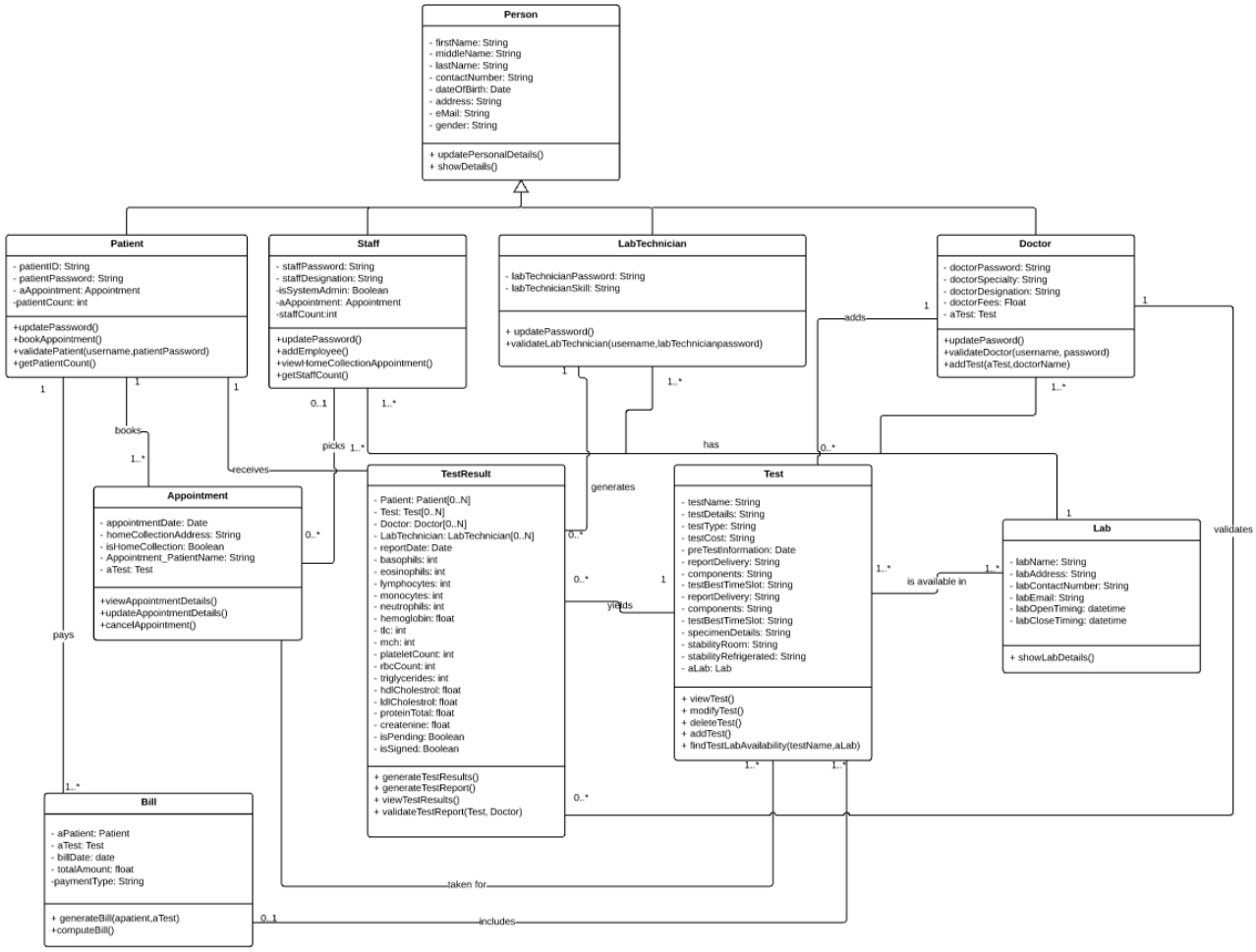
4.0 Physical Entity-Relationship Diagram



Zoom in full diagram available at:

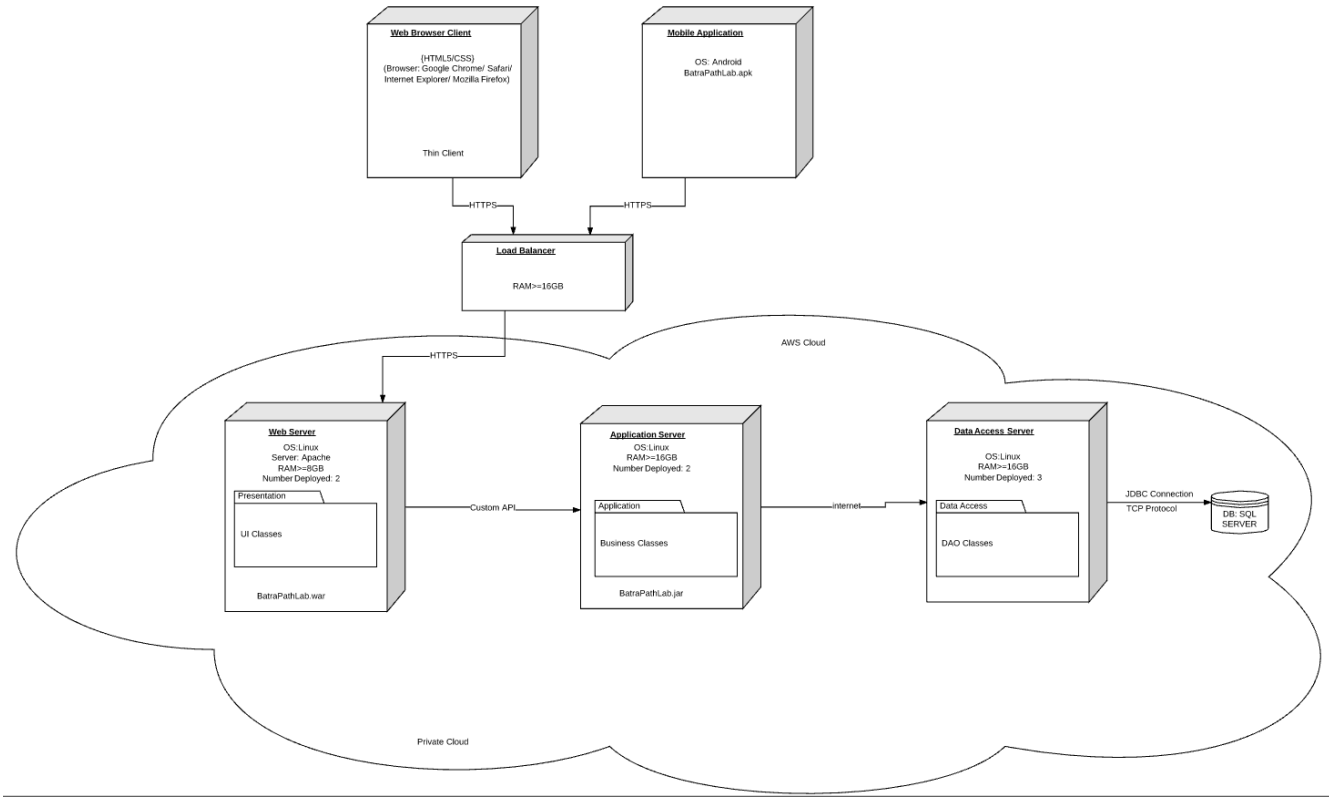
https://www.lucidchart.com/documents/embeddedchart/572218e7-7390-4d9b-958a-192baa60d4e9

5.0 UML Class Diagram (Sketch)



Zoom-in full diagram available at:
https://www.lucidchart.com/documents/embeddedchart/a65c53e1-c598-4932-8fcd-7f87f88458dc

6.0 UML Deployment Diagram



Zoom-in full diagram available at:
https://www.lucidchart.com/documents/embeddedchart/4cf165c4-60e9-4a91-b0f4-5f1399c58186

The Essay Questions

You will also provide a sample solution to the following short essay questions (answers are to be no more than 250 words):

1. Your boss has asked for a brief memo explaining how this project will add value. Provide a memo of no more than 250 words explaining how the project adds value. Be sure to use options thinking in your response.

Memo

To: Dr. Meera Batra, Chief Executive Officer

From: Divyesh Batra, Systems Analyst, Dr. Batra's Pathology Lab

Date: December 12, 2017

Subject: Dr. Batra's Pathology Lab Management System

In order to address the deteriorating standards of test reporting by our pathology lab, it is imperative to invest in a new information systems project that would not only allow a hassle-free way for patients to book appointments, but also provide a safe and automated way to link correct test reports with patients. To develop a pathology lab management system, our organization would require considerable amount of IT investment and hence we should think about real options to manage the project effectively.

In order to develop a cost-effective yet flexible model, we should employ options-thinking and carry out the development of this project in staged phases. Since customer satisfaction is at the heart of the organization, the first phase of the project should roll out a patient registration system that allows patients to book appointments online and get test reports via email. Once the system captures patient medical history, it opens a plethora of opportunities for the organization to grow. For example, by using the initial baseline created, system can be expanded to offer health packages to patients. This would be an extension to our existing project and would add additional revenue for the organization.

Additionally, owing to the generic nature of this project, that is, developing a data management system in the healthcare sector, the software can be sold to similar diagnostic centres around the city. Hence, by using staged, growth and switch options, the project can be managed effectively and would add significant value to the organization.

Reference: https://owl.english.purdue.edu/owl/owlprint/590/

1. What is the ideal methodology for the development of the information system you are planning? (250 words each, be sure to cite any resources you use)

Provide a sample answer choosing the waterfall method

a. Although the waterfall methodology has diminished over the years, it still implements a logical advancement of steps crucial for software development. It would be ideal to build the pathology lab management system using waterfall approach as the requirements are well-known and each phase does not overlap with other.

Waterfall approach forces disciplined approach to software development because the requirements are well outlined before the beginning of the development phase. As most of the processes at Batra's Pathology Lab were either formulated using spreadsheets or a pen-and-paper approach, it is relatively easier to incorporate waterfall methodology owing to stable project requirements. In other words, it requires replication of simple tasks like registering a patient or booking an appointment from a pen-

and-paper approach to a technology portal. Other use cases like finding a lab or viewing test history simply requires retrieval of data from a data-store and displaying it on a user interface.

As the scope of the project is simple, different phases of a waterfall model doesn't overlap with each other. That means, even before the integration of different components of a system, we are well-aware of the system behaviour. For example, patient registration using a web platform or a mobile platform or through a front desk assistant requires a simple one page form to store the details and save it into the database. Thus, there is high visibility after each step that seldom requires a developer to go back to a previous step to incorporate any new change into the system.

References:

https://airbrake.io/blog/sdlc/waterfall-model

http://istqbexamcertification.com/what-is-waterfall-model-advantages-disadvantages-and-when-to-use-it/

Provide a sample answer choosing XP

b. As we know that patients were receiving faulty reports due to degraded test-reporting standards followed by Dr. Batra's pathology lab, a new lab-management system should provide a hassle-free and trustworthy user-experience to end-users. That means, user should be at the heart of the software development system. Extreme programming precisely advocates the same and would be an ideal methodology for this business case as it saves cost, time and code.

Extreme programming has the shortest iterative cycle as compared to other agile methodologies. As Dr. Batra's pathology chain is a small setup, the management would be more inclined towards hiring a smaller team of developers who are experienced enough to vision the problem at-hand and spend more time coding the functionality rather than documenting it. So, a team of 4-5 developers who can collaborate within themselves for development and testing would be more cost-effective than employing a team with system's analyst, developers and testers. Moreover, it would also save time for each deliverable as extreme programming advocates cutting-off paperwork and provides concrete commitment by developers. Demonstrating the functionality of a software earlier would allow developers to incorporate customer feedback and that would ultimately lead to customer satisfaction.

By 'saving code', developers practicing XP create extremely simple code which can be modified anytime later. For this business case, developers can modularize the code as per lab technology module and clinical information module, that is, code for generation of blood reports can be segregated from code behind administrative activities like registering a patient.

References:

https://hygger.io/blog/disadvantages-and-advantages-of-extreme-programming/

http://www.brighthubpm.com/methods-strategies/87839-advantages-of-extreme-programming/

https://dzone.com/articles/extreme-programming-tips-amp-advantages

Provide a sample answer choosing RUP

c. As we know that Dr. Batra's Pathology lab is going through tough times managing numerous patient reports, it is in dire need of a system that can safely manage information and provide correct test reports to patients who are battling grievous circumstances due to dengue and chikungunya. It needs a system that can correctly store patient's information along with the correct test results. To handle this primary purpose of the business case, RUP methodology would be best suited as it manages high-risk requirements and advocates verifying software quality.

Since RUP focuses on iteratively building a software, system needs to focus on critical user-requirements early in the iterations to avoid risks. With RUP, developers can start building a software that would allow patients to register themselves from a web-based platform and through a bar-code reading system test reports can be linked correctly and subsequently delivered at one's email address. Once this phase is rolled out, developers can again focus on other functionalities like adding a new test by doctors to the system or adding a new employee.

Since pathology forms the first step in diagnosis of any disease and critical patients are the end-users of the application, it is imperative to deliver a high-quality software. Quality assessment would be integrated in every step and would not be a separate activity during software development when the system architecture is too rigid to incorporate any further changes. Thus, all the processes would run in parallel and ensure a high quality software.

References:

http://geekgroove.net/rational-unified-process-and-its-advantages-and-disadvantages

https://www.ibm.com/developerworks/rational/library/content/03July/1000/1251/1251_bestpractices_TP026B.pdf

Provide a sample answer choosing scrum

d. There are primarily two reasons due to which the management at Dr. Batra's Path Lab has decided to move from a pen-and-paper based model to a laboratory management system. Firstly, patients' life is at risk and secondly, the laboratory's reputation is at stake. Since the situation-at- hand demands a quicker response in terms of providing a sound platform for patients to check reports and book a test, software development using SCRUM methodology would be best suited because it will allow the management to see quantifiable results and drastically reduce product-time to market.

Since the team meets on a daily-basis in SCRUM, it is easier to track progress of each individual and make sure everyone is a value-addition to the team. Thus, issues are spotted well in advance because of daily stand-ups and while it's fresh in a developer's memory, a cross-collaboration amongst team members helps to address risks earlier in the cycle. For this business case, it would be highly useful to address potential issues on a daily basis and constantly improve the quality of the software.

Moreover, in SCRUM, as we have a dedicated product owner that has a sound domain knowledge of the product, it significantly saves time to document requirements as it happens in waterfall methodology. This leads to an early development cycle, real-time clarification of issues, higher team motivation and increased customer satisfaction as the product reaches a market faster. Thus, a laboratory management software would reach in the hands of the patient earlier.

References:

http://www.dummies.com/careers/project-management/10-key-benefits-of-scrum/

http://www.belatrixsf.com/blog/benefits-pitfalls-of-using-scrum-software-development-methodology/