

Logic University Stationary Store

PROJECT REPORT



TEAM 4

Ayisha Fathima | Kyaw Thiha | Ling Teck Moh Benedict |
Shermaine Lim Si Hui | Ngo Vu Hanh Nguyen |
Saw Htet Kyaw | Yeo Jia Hui

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1.0 Introduction

This project report is a detailed description of the activities which define the various phases of the project. It also reflects our takeaways from this project and some discussion on what could have been done differently given the benefit of hindsight.

This project is about delivering a software solution aimed at improving LOGIC University Stationary Store's inventory and disbursement system. Its main objective is to eliminate the reliance on manual processes - mainly overcoming the need to store essential documents in the form of hardcopies and hence allowing greater efficiency by reducing the amount of manual work that would be involved in tracking and maintaining these documents.

Problems Faced by the Current System:

- Important information such as price, supplier details and stock movement are stored in hard copies in several places making information gathering cumbersome – as these documents can get easily lost and tracking become very difficult.
- Stocks deplete quickly despite efforts to implement re-order levels. Hence, resulting in complaints from departments and frustration in both departments and store clerks.
- Unable to update manual records promptly (in addition to point (a)).
- Fulfillment of a requisition takes a long time as the clerk must manually track and consolidate the stationary requested before he can gather them from the store for packing.
- Miscommunication between the store clerk and department regarding who the department representative, who will be collecting the stationary, is and where the collection point will be.
- No clear communication efforts to inform department representatives promptly when stationary is ready for collection and for verification/ acknowledgement upon delivery of stationary.

The solution delivered through this project will be a computerized system that can tackle the above problems. This will mainly be through the computerization of the requisition, disbursement, and inventory management processes. The system produced will also make use of the University's e-mail system as a means of communication between the store and other departments. At the end of the day, Logic University Stationary Store (LUSS) will be able to overcome operational inefficiencies and difficulties caused by their existing manual system and provide quality service to their customers.

1.1 Activities In Project

We followed an adaptive approach towards managing our project's Software Development Lifecycle (SDLC). Where we adapted from the Phase Model and Agile practices. We first started by building a minimum viable product and then built additional features and capabilities on top of that in the following iterations.

The phases of our software development lifecycle are specified in the table below.

Phase	Description
Business Modelling	<ul style="list-style-type: none"> Identifying business actors and entities Understanding processes that take place within the business The extent to which we can automate/ computerize these processes
Requirement Analysis	<ul style="list-style-type: none"> Requirements Gathering: <ul style="list-style-type: none"> Interviewed users to gather and clarify about requirements Identification of actors Requirements Specification: <ul style="list-style-type: none"> Drafting use cases Prototyped User Interface (UI) screen designs that captured business activities performed by users. Reviewed UI requirements with users.
Project Planning	<ul style="list-style-type: none"> Produce preliminary project work plan, project schedule and start progress reports.
High Level Design	<ul style="list-style-type: none"> Discussed important technical design specifications <ul style="list-style-type: none"> Architecture Database System Machine Learning Identifying the features required for a minimum viable product (ranked features derived from requirements gathering according to priority) Built a bare minimum viable product Basic Analysis Modelling <ul style="list-style-type: none"> Identify objects and attributes Refined further in Phase 1.
Phase 1: Web Phase	<ul style="list-style-type: none"> Detailed design, coding, testing and implementation of each web feature. (Group was split according to Dept functions and Store functions – after full completion of a feature, we merged our code together to see how the system works and then fixed bugs and added more capabilities where necessary)

	<ul style="list-style-type: none"> • Refined objects and their attributes and had enough information and details to produce class diagrams, sequence diagrams, state chart diagrams, etc.... • Could further refine relational database design and architecture and machine learning related documentation.
Phase 2: Android Phase	<ul style="list-style-type: none"> • Detailed design, coding, testing and implementation of each app feature. (Group was split according to Dept functions and Store functions – after full completion of a feature, we merged our code together to see how the system works and then fixed bugs and added more capabilities where necessary)
Integration Testing	<ul style="list-style-type: none"> • Perform functional and unit testing for each use case. • Integrate codes
User Acceptance Testing	<ul style="list-style-type: none"> • Develop UAT performance test plans • Conduct performance testing • Conduct User Acceptance Test • Review Test Results
Deployment	<ul style="list-style-type: none"> • Get sign off on user acceptance • Deploy and hand over

2.0 Product Deliverables

2.1 Requirement Specification (Functional Requirements)

2.1.1 Use Cases Diagram



2.1.2 Actors (Name and Definition)

Department	
Department Employee (Dept Emp)	<ul style="list-style-type: none"> • An employee of a specific department in the university. • Requests for stationary by filling up and saving requisition form. <p><i>At any one time, for each department, there is only one requisition form that all employees will be able to view and fill.</i></p>
Department Head (Dept Head)	<ul style="list-style-type: none"> • Head of a specific department • Can approve/ reject requisitions submitted by Dept Rep on behalf of employees. • Can delegate employees to authorise approval/ rejection of requisitions for a specific period.
Department Representative (Dept Rep)	<ul style="list-style-type: none"> • Representative of a specific department • Responsible for submitting requisition to dept head for authorisation • Collects requested stationary at collection point and verifies requisition fulfilment. • Updates collection point
Delegated Employee (Delegated Emp)	<ul style="list-style-type: none"> • An employee who will be able to approve/ reject requisitions for a period specified by the dept head. • Always has access to same functions as normal employee (including during period of delegation).
Store	
Store Clerk	<ul style="list-style-type: none"> • An employee of the stationary store. • Processes requisitions and disburses them (partially/ fully) based on stock available. • Delivers requested stationary at collection point and verifies if it has been delivered to the right party. • Responsible for restocking and purchase order (PO) related processes (including interactions with suppliers)

	<ul style="list-style-type: none"> • Responsible for raising adjustment vouchers in the event of discrepancies for each item.
Store Supervisor	<ul style="list-style-type: none"> • Authorizes adjustment vouchers with value <= \$250 for each item.
Store Manager	<ul style="list-style-type: none"> • Authorizes adjustment vouchers with value > \$250 for each item.

2.1.3 Use Cases (Name and Definition)

Use Cases	Definition
Login	Allows department and store employees to log into the system.
Department Employee	
Raise Requisition Form	Allow the department staffs to create requisition forms to request for stationary from the stationary store.
View Stationery Catalogue	Allows users to see the list of stationeries available for selection
View Existing Requisition Requests	Allows employees to see the list of requisition forms they have created so far. Will be able to see both submission status and approval status.
View Requisition Details	Allows employees to see the type of stationary and quantity requested in the specific requisition.
Update Existing Requisition Form	Allows the department staffs to modify the requisition form before the department representative submits the form to the department head for approval
Receive Notification of Approval/Rejection of Stationery Requisition Form	Allow the department staffs to receive an email notification about the status of their submitted requisition forms
Department Representative	
Submit Requisition Form	Allows the department representative to submit the form to the department head for approval/ rejection.
Update Collection Point	Allows the department representative to change the collection point based on his/her preference
Department Head	
Approve/Reject Stationery Requisition Form	Allows the department head to approve or reject the requisition form submitted by department staffs

Delegate Authority	Allows the department head to delegate his authority and assign one of the staff in his department as a temporary department head to take over his role for a specified period. The delegated staff would be able to approve or reject requisition requests on behalf of the department head during the period of delegation. The delegated staff is not allowed to further delegate his temporary authority to other staff in the department
Receive Email Notification of Delegation	The selected delegated employee would receive an official email notification to inform them that they have been selected by the department head to stand in as a temporary department head for a specified period.
Store Clerk	
View Requisition List	Submit Requisition Fulfillment
Submit Requisition Fulfillment	Allows the clerk to input the specific quantity of stock that will be drawn for each stationary in the specific requisition.
Raise Purchase Order	Allows the store clerk to create a purchase order request to order items from the designated supplier
View Purchase orders	Allows the store clerk to view the list of purchase orders made to different suppliers
View Purchase Order Details	Allows the store clerk to see the details of each purchase order such as the type of stationary, quantity, and supplier from which ordered.
Generate Disbursement List	Allows store clerk to create disbursement list
Submit Disbursement Date	Allows store clerk to input date for disbursement
Acknowledge Disbursement	Allows store to verify if the code given by the dept rep at the point of collection is correct.
View Stock Inventory	Allows store clerk to view the transaction details of the flow of stationeries and display the final quantity of stationery after the latest transaction
Raise Stock Adjustment Request	Updated when there is a discrepancy between the quantity of requested goods

	and quantity of goods accepted by department representative
Receive Items from Supplier	Allows the store clerk to update in the system when they received the items and how much they received. Will also help update stock levels.
Manage Department	Allows the store clerk to carry out various functions like creating new department record, deletion of existing department record, updating details of existing department record and viewing the details of existing department in the system
Create Department	Allows the store clerk to create a new department record in the system
Delete Department	Allows the store clerk to delete an existing department record in the system
Update Department	Allows the store clerk to update the details of an existing department record in the system
View Details of Department	Allows the store clerk to view the details of an existing department record in the system
Manage Supplier	Allows the store clerk to carry out various functions like creating new supplier record, deleting supplier record, and viewing details of existing suppliers in the system
View Details of Supplier	Allows the store clerk to view the details of all the suppliers for different stationeries
Create Supplier	Allows the store clerk to create a new supplier record in the list of suppliers
Delete Supplier	Allows the store clerk to delete the record for a specific supplier in the list of suppliers
View Trend Analysis	Allows the store clerk to view the trend of ordered stationeries and compare them across different months using different filters
Store Manager/ Store Supervisor	
Issue Stock Adjustment Voucher	Allow store manager / store supervisor to issue an adjustment voucher to correct the discrepancy that had occurred

2.2 Requirement Specification (Non-Functional)

Some things we noted and derived from POD:

- Total 500 department employees including dept heads (50*10)
- Total no of users = $500 + 3 + 1 + 1 = 505$ (Including relevant stationary store clerk)
- Average: 50 employees request for stationary every week (5 employees from each department per week)
- *Assumption:* 10 requisitions per week (1 per department), 2 requisitions per day – store clerks process 2 requisitions per day. Store clerks work together for each requisition fulfilment.
- 5 to 10 items per request per department per week.
- One disbursement list generated for per week per department
- Purchase Order (PO) is raised biweekly with an average of 10 items per supplier.
- Supplier tender process occurs annually – *Assumption:* Suppliers likely to change on an annual basis
- Store clerk conducts monthly inventory check

2.2.1 User Volume

User Group	Country/location/Count	Remarks
Department Head	S'pore / Clementi / 10	Department Head authorizes and processes the employees' requisitions daily and when they need to delegate their authorization function to another employee.
Department Representative	S'pore / Clementi / 10	Department Representative will: <ul style="list-style-type: none"> • Consolidate and submit that final requisition form to Department Head for processing • Manages the collection point • Needs the system to receive notification when stationeries are ready for collection, will receive the acknowledge code by email • Acknowledging the disbursement at point of collection
Department Employee	S'pore / Clementi / 500	Employee can access system daily to: <ul style="list-style-type: none"> • create requisition form • view details and status of requisitions that have been submitted to Dept head.
Store Manager	S'pore / Clementi / 1	Store Manager will access the system daily to authorize and issue adjustment vouchers submitted by

		the Store Clerk for each item with discrepancies of value more than \$250.
Store Supervisor	S'pore / Clementi / 1	Store Manager will use the daily to authorize and issue adjustment vouchers submitted by the Store Clerk for each item with discrepancies of value under \$250.
Store Clerk	S'pore / Clementi / 3	<p>Store Clerks will use the system daily basis to:</p> <ul style="list-style-type: none"> • Consolidate and Track Requisitions for Order Fulfilment • Partial or Complete Order Fulfilment for Disbursement • Trend Analysis for seeing trends of quantity of stationeries ordered by each department across various periods (demand planning) • Inventory Management: <ul style="list-style-type: none"> - To view Stock List to monitor inventory - To CRUD (create, read, update, delete) Purchase Orders to replenish stocks - To CRUD Suppliers - To CRUD Departments • Store Clerks can track collection points to be there to acknowledge Disbursement Code when Department Representatives are collecting the stationeries

2.2.2 Use Case Transaction Volume

Biz transaction [use case]	Business criticality [critical/ moderate / low]	No. of user	Transaction information	Concurrent important activities
Login	Critical	505	- 5 employees per department: each employee logs in once a week.	

			<ul style="list-style-type: none"> - 3 Store Clerks: Each clerk logs in everyday - Store Supervisor: 1 time per month - Store Manager: 1 time per month 	
View Stationery Catalogue	Critical	500	<ul style="list-style-type: none"> - 5 employees per department: each employee 1 to 2 (at most) times per week 	
Raise Purchase Order	Critical	3	<ul style="list-style-type: none"> - 3 PO (items needed from each supplier consolidated in one PO) once in two weeks 	
Receive Items from Supplier	Critical	3	<ul style="list-style-type: none"> - By each store clerk, three times in 2 weeks (at most) - if each supplier delivers at different dates/ times 	
View Stock Inventory	Critical	3	<ul style="list-style-type: none"> - Each store clerk: sees 2 to 3 times per day when fulfilling requisitions. 	
View Requisition List	Critical	3	<ul style="list-style-type: none"> - Each store clerk: sees 2 to 3 times per day when fulfilling requisitions. 	
Submit Requisition Fulfilment	Critical	3	<ul style="list-style-type: none"> - Each store clerk: sees 2 to 3 times per day when fulfilling requisitions. 	
Generate Disbursement List	Critical	3	<ul style="list-style-type: none"> - 2 generated (for each requisition) per day by one store clerk 	
Raise Stock Adjustment Request	Critical	3	<ul style="list-style-type: none"> - 1 time per month by 1 staff 	
View Trend Analysis	Moderate	3	<ul style="list-style-type: none"> - Each store clerk sees it at least once in two weeks to 	

			make informed decisions for PO.	
Approve/Reject Stationery Requisition Form	Critical	10	- 1 time per week by each department head	
Delegate Authority	Moderate	10	- 1 time each by each department head per month	
Update Collection Point	Moderate	10	- 1 time by each department rep per month	
Receive Email Notification of Delegation	Moderate	10	- Received 1 time by each delegated employee from each department once a month.	
Raise Requisition Form	Critical	490	- 1 per week per department	
Submit Requisition Form	Critical	10	- 1 per week by each department head	
Receive Notification of Approval/Rejection of Stationery Requisition	Moderate	490	- 1 time per week by 1 employee	
Update Existing Requisition Form	Critical	490	5 times per week per department	
Issue Stock Adjustment Voucher	Critical	2	- Store Supervisor, 1 time per month - Store Manager, 1 time per month	
View Purchase orders	Critical	3	- 1 time for each PO, once every 2 weeks by each store clerk	
Manage Supplier	Moderate	3	- 1 time, for each supplier, once every 2 weeks by one store clerk	
View Details of Supplier	Critical	3	- 1 time, for each supplier, once every 2 weeks by each store clerk	
Create Supplier	Moderate	3	- 1 time per year by one store clerk	
Delete Supplier	Moderate	3	- 1 time per year by one store clerk	

Manage Department	Moderate	3	- 1 time per year by one store clerk	
Create Department	Moderate	3	- 1 time per year by one store clerk	
Delete Department	Moderate	3	- 1 time per year by one store clerk	
Update Department	Moderate	3	- 1 time per year by one store clerk	
View Details of Department	Critical	1	- 2 to 3 times per day by each store clerk	

2.2.3. Entity Volume

Business entity class	Source document	Retention period	Target volume
Department	Department Record	Forever	$10 \leq x < 15$ (In the event of creation of new dept in the future)
Collection Point	Department Record	Forever	6
Employee	Employee Record	Forever	505
DelegatedEmployee	Delegated Employee Record	1 year	$1*12*10 = 120$
DelegatedEmployeeDetail	Delegate Employee Details Record	1 year	$1*12*10 = 120$
Stationery & Stock	Stationery Record & Stock Record	2 years	At most: $90*2=180$ (for each)
Purchase Order (PO)	Purchase Order Record	3 years	$(52/2)*3= 78$ (52 weeks in a year, 3 purchase orders every 2 weeks)
PODetail	Purchase Order Details List	3 years	$(52/2)*3=78$ (52 weeks in a year, 3 purchase orders every 2 week)
Supplier & Supplier Details	Supplier Records & Supplier Details List	2 years	At most $10*2=20$ (for each)
DeptRequisition	Requisition Records	3 years	$1*52*10*3=1560$
RequisitionDetail	Requisition List	3 years	$1*52*10*7*3=10920$ (assuming avg 7 stationary per requisition)

Disbursement	Disbursement List	3 years	At most (accounting for one requisition having multiple disbursement): $1*52*3*10*2=3120$
DisbursementDetail	Disbursement Detail List	3 years	$1*52*3*10*2=3120$
Adjustment Voucher	Adjustment Voucher Records	3 years	$1*52*3 = 156$

2.2.4. Security Requirement and Access Matrix

Data [entity class]\user role[actor]	Department Head	Delegated Employee(With respect to when assigned)	Department Representative	Department Employee	Store Manager	Store Supervisor	Store Clerk
Adjustment Vouchers	x	x	x	x	ru	ru	cr
Adjustment Details	x	x	x	x	r	r	r
Delegated Employee	crud	x	x	x	x	x	x
Delegated Employee Details	rud	x	x	x	x	x	x
Departments	x	x	x	x	x	x	crud
Department Requisitions	ru	ru	cru	cru	x	x	r
Department Requisition Details \ Dep Head	ru	ru	ru	ru	x	x	r
Disbursements \ Store Clerk	x	x	x	x	x	x	cru
Disbursement Details \ Store Clerk	x	x	x	x	x	x	cru
Employees	ru	x	x	x	x	x	x
Purchase Orders (POs)	x	x	x	x	x	x	crud
Stationaries	x	x	r	r	x	x	r
Stocks	x	x	x	x	x	x	r
Suppliers	x	x	x	x	x	x	crud
Supplier Details	x	x	x	x	x	x	crud

2.2.5 Cloud Reliability Requirements

Cloud system was configured instead of Local Area Network (LAN) for flexibility and safety issues especially during the Covid-19 situation. This means staff can work and access the system from home, and they are not restricted to the LAN system at Logic University office.

LAN and Cloud

A Local Area Network is a collection of devices connected in a physical location (e.g. building, office or home etc). A LAN can be small or large, for small, it can a home network, while, for large, it can be an enterprise network to handle thousands of users and devices in an office or institution (Services, 2020).

According to Probrand (2020), “A Cloud Server, on the other hand, is a virtual server running in a cloud computing environment. It is built , hosted, and delivered with a cloud computing platform via the internet, and can be accessed remotely. Cloud servers are efficient as they have all the software required to run and can function as independent units.” .

Operation Time

The physical work environment may operate at certain timings during the week. By implementing with Cloud for the online system, both department and store side have the flexibility and convenience to order, process and do any tasks anytime and anywhere.

With a secure cloud system, this allows staffs to be able to work from home or anywhere, not just at Logic University premises because of LAN. This is applicable for the on-going Covid-19 situation for the safety of staffs as they work from home, minimizing the chance of coronavirus transmission and clusters by avoiding physical interaction in the office.

Efficiency of Cloud Scalability, Disaster Recovery, Hardware Failure Elimination

Cloud servers can scale and adjust operations to handle sudden big increase in transactions, traffic, and concurrent users. Cloud Servers also have their own disaster recovery meaning there will be no server failure or downtime because they have mirror servers.

Mirror servers will instantly backup and fulfil the role of the primary server if the primary server fail and crash. In the case of LAN dedicated servers, hardware failure can occur and if there is no mirror server as backup, the system will be down, hindering and delaying work and requires additional time

2.3 UI Screen Prototype

2.3.1 Login (Web)

Web Interface
LOGIN (GENERAL PAGE)

1. Account user is required to enter both corporate username and password as assigned by your respective department
2. Click on the “Login” button to enter main page

Username:
Password:

Login

Account user cannot leave username and password fields empty

Click on “Login” button after all fields have been filled in

2.3.2 Department Employee Screens (Web)

2.3.2.1 View Existing Requisition Requests (Employee)

NORMAL EMPLOYEE
➤ Normal Employee will view the following screen below once logged in

Requisition Id	Submission Status	Approval Status	Action
1	Submitted	Pending	Details

Requisition List Requisition Form Mrs Pamela Kow Logout

Normal employee can click on the “Requisition List” tab to view the list of requisitions created so far.

Normal Employee can click on the “Requisition Form” tab to create new requisition requests

Name of Employee

Submission Status: Draft/ Submitted based on whether Dept Rep has submitted req.

Approval Status: Pending/ Approved/ Rejected based on whether Dept Head has processed.

Click to see details (name of stationary and qty requested and reason for rejection.)

2.3.2.2 View Requisition Details (Employee)

The screenshot shows a web browser window titled "Requisition Details". At the top, there are tabs for "Requisition List" and "Requisition Form". On the right, it shows the user "Mrs Pamela Kow" and a "Logout" link. The main content is a table with two columns: "Item Name" and "Qty". The table contains the following data:

Item Name	Qty
Pen Whiteboard Marker Black	20
Thumb Tacks Large	10

Annotations with arrows point to various elements:

- An arrow points from the "Logout" link to a callout box stating: "Employee can proceed to sign out of his account by clicking on the “Logout” tab".
- An arrow points from the "Qty" column header to another callout box stating: "Reason for rejection provided by dept head will be updated here once dept head has processed requisition".
- An arrow points from the "Reason:" label to a callout box stating: "Employee can click on Requisition Form to go back to form and modify requisition. Can only do this while requisition submission status is draft".
- An arrow points from the "Item Name" column header to a callout box stating: "The details of the requisition requests that would be displayed".

2.3.2.3 Employee Requisition Form

Raise Requisition Form | View Stationary Catalogue | Update Existing Requisition Form

The screenshot shows a web browser window titled "Requisition Form". At the top, there are tabs for "Requisition List" and "Requisition Form". On the right, it shows the user "Mrs Pamela Kow" and a "Logout" link. The main content is a table with two columns: "Item Name" and "Quantity". The table contains the following data:

Item Name	Quantity
Transparency Blue	0
Thumb Tacks Large	10
Trays In/Out	0
Shorthand Book (100 pg)	0
Clips Paper Large	0
Envelope Brown (3"x6")	0
Eraser (hard)	0
Exercise Book (100 pg)	0
File Separator	0
File-Blue Plain	0
Highlighter Blue	0
Hole Puncher 2 holes	0
Pad Postit Memo 1"x2"	0
Paper Photostat A3	0

Annotations with arrows point to specific areas:

- An arrow points from the "Requisition Form" tab to a callout box stating: "Normal Employee will arrive at this page when they click on the “Requisition Form” tab".
- An arrow points from the "Quantity" column header to a callout box stating: "Step 2: Select the required quantity for any stationery items through manual input like typing in the quantity or click on the up and down button to select the quantity accordingly".

192.168.0.107:8080/Dept/NewEmployeeRequisitionForm

Exercise Book (100 pg)	0
File Separator	0
File-Blue Plain	0
Highlighter Blue	0
Hole Puncher 2 holes	0
Pad Postit Memo 1"x2"	0
Paper Photostat A3	0
Pen Ballpoint Black	0
Pen Transparency Permanent	0
Pen Whiteboard Marker Black	20
Pencil 2B	0
Ruler 12"	0
Scissors	0
Scotch Tape	0
Sharpener	0
Stapler No. 28	0
Clips Double 1	0

Click the “save” button below so that a requisition request draft would be created

Save

2.3.3 Department Representative Screens (Web)

2.3.3.1 Department Representative Requisition List

DEPARTMENT REPRESENTATIVE

➤ Department representative will view the following screen below once logged in

192.168.0.107:8080/Dept/EmployeeRequisitionList

Requisition List Requisition Form Submit Requisition Manage Collection Point Jenny Wong Mei Lin Logout

Name of Department Representative

Employee Requisition List

Requisition Id	Submission Status	Approval Status	Action
1	Draft	Pending	Details

Requisition forms pending submission will be displayed here.

Click on the Details hyperlink to view the details of the requisition

2.3.3.2 Department Representative Requisition Details

The screenshot shows a web browser window titled "Requisition Details". At the top, there is a navigation bar with links: "Requisition List", "Requisition Form", "Submit Requisition", "Manage Collection Point", and a user profile "Jenny Wong Mei Lin Logout". Below the navigation bar is a title "Requisition Details". A table displays two items: "Pen Whiteboard Marker Black" with a quantity of 20 and "Thumb Tacks Large" with a quantity of 10. To the left of the table, the text "Reason:" is followed by a box containing: "Since requisition form is still in draft status, Dept rep can click on Requisition Form tab to access form and modify requisition." Below the table, another box contains: "This requisition request is the one created previously by normal employee Mrs Pamela". A third box to the right contains: "Upon clicking the 'Details' hyperlink present in the previous screen, the details of the requisition would be displayed".

2.3.3.3 Submit Requisition Form (Department Representative)

The screenshot shows a web browser window titled "Requisition Drafts". At the top, there is a navigation bar with links: "Requisition List", "Requisition Form", "Submit Requisition", "Manage Collection Point", and a user profile "Jenny Wong Mei Lin Logout". Below the navigation bar is a title "Requisition Drafts". A table displays one row with "Requisition Id" 1, "Submission Status" Draft, and two actions: "Submit" and "View". To the left of the table, a box contains: "Click on the 'Submit Requisition' tab to view the pending requisition drafts for submission to the dept head for approval". Below the table, another box contains: "Click on the 'Submit' hyperlink above to submit the specific requisition draft over to the dept head to obtain his approval". A third box to the right contains: "Click on the 'View' hyperlink to check the details of the requisition again before submitting".

2.3.3.4 Update Collection Point (Department Representative)

Requisition List Requisition Form Submit Requisition Manage Collection Point Jenny Wong Mei Lin Logout

Manage Collection Point

Department: English Dept
Current Collection Point: EngineeringSchool

Select New Collection Point:

- StationeryStore
- ManagementSchool
- MedicalSchool
- EngineeringSchool
- ScienceSchool
- UniversityHospital

Save

Current collection point displayed.
Will be updated when new collection point is chosen and saved.

Select the new collection point which you would like to change to

Click on the "Manage Collection Point" tab to view the current screen of managing collection point

2.3.4 Department Head Screens (Web)

2.3.4.1 Approve/Reject Stationary Requisition Form (Department Head)

DEPARTMENT HEAD

➤ Department Head will see the following screen once logged in

Requisition Approval List Delegated Employee List Prof Ezra Pound Logout

Requisition List

Requisition Id	Requestor	Approval Status
1	Jenny Wong Mei Lin	Pending

Name of Department Head

Clicking on the "Requisition Approval List" tab would also display the same view as this screen as the main priority of a department head is to approve/reject requisition requests.
All requisition with pending approval status listed here.

Department Head can click on the "Requisition Id" hyperlink to view more details about the requisition

Requisition Approval List Delegated Employee List Prof Ezra Pound Logout

Requisition

Item Name	Quantity
Pen Whiteboard Marker Black	20
Thumb Tacks Large	10

Reason

If the Department Head decide to reject the requisition request, she can indicate her reason in the box below. Filling in the reason box is not compulsory.

RequisitionApprovalStatus Approved ▾

-
- Pending
- Approved
- Rejected

If the department head wants to approve a requisition, she can click on the dropdown list and choose the approved status to indicate her approval

Lastly, click on the "Save" button to approve the requisition and this requisition request will be sent to the store

2.3.4.2 Delegate Authority (Department Head)

localhost:56352/Delegate/Deleg... + Prof Ezra Pound Logout

Delegated Employee List

Create

No	Employee Name	Start Date	End Date	Status	Action
----	---------------	------------	----------	--------	--------

Click on the "Create" hyperlink to create a new employee delegation

Click on the Delegated Employee List tab to view this current page

192.168.0.107:8080/Delegate/CreateNewDelegatedEmployee

Requisition Approval List Delegated Employee List Prof Ezra Pound Logout

Create New Employee Delegation

Employee Name : Mrs Margaret

Start Date : 28/08/2020

End Date : 31/08/2020

Submit

Once all required fields have been selected, proceed to click on the "Submit" button to save the new delegation

192.168.0.107:8080/Delegate/DelegatedEmployeeList

Requisition Approval List Delegated Employee List Prof Ezra Pound Logout

Delegated Employee List

[Create](#)

Department Head is given the option to cancel a delegation. When the "Cancel" hyperlink is clicked on, the status of the delegation will be updated

No	Employee Name	Start Date	End Date	Status	Action
1	Mrs Margaret	28-August-2020	31-August-2020	Selected	Cancel Extend

When a new delegation has been successfully created, the details of the delegation will be displayed with the status indicating "selected" to show that the particular employee has been selected as a delegate

Department Head is given the option to extend a delegation to a later date. When the extend hyperlink is clicked on, the status of the delegation will be updated

Screen for “Extend” function:

The screenshot shows a web-based application window titled "Extend Delegation". At the top, there are links for "Requisition Approval List" and "Delegated Employee List". On the right, it says "Prof Ezra Pound Logout". The main form has fields for "Delegated Employee Name" (containing "Mrs Margaret") and "EndDate" (set to "02/09/2020"). Below these is a "Submit" button. To the right of the date field is a calendar icon. A callout box points to the name field with the text "Name of delegated employee will be displayed in the box below". Another callout box points to the calendar icon with the text "Department Head can click on the calendar symbol to select a later date to extend a specific delegation". A third callout box points to the "Submit" button with the text "When the department head is done choosing the new end date, she can click on the “Submit” button to save the updated delegation request".

2.3.5 Screens for Delegated Employee (Web)

The screenshot shows a web-based application window titled "DELEGATED EMPLOYEE". It displays a "Requisition List" table with three columns: "Requisition Id", "Requestor", and "Approval Status". The table has one row with values: "2", "Jenny Wong Mei Lin", and "Pending". Above the table, the name "Mrs Margaret" is listed along with a "Logout" link. A callout box points to the "Requisition Id" column with the text "Delegated Employee can click on the “Requisition Id” hyperlink to view more details about the requisition". Another callout box points to the "Name of Delegated Employee" with the text "Name of Delegated Employee". A third callout box points to the bottom of the page with the text "In normal circumstances, normal employees would not be able to access the requisition approval list. However, due to the delegation request made by the Department Head in the previous screen. The employee received a temporary authority to approve/reject requisition for a limited time".

If the Delegated Employee decide to reject the requisition request, she can indicate her reason in the box below

Item Name	Quantity
Transparency Blue	16
Trays In/Out	18
Thumb Tacks Large	17

Reason

RequisitionApprovalStatus Pending

Save

After clicking the “Requisition Id” hyperlink in the previous screen, this current screen will be displayed where Delegated Employee can view more details about the requisition

If the department head wants to approve a requisition, she can click on the dropdown list and choose the approved status to indicate her approval

Lastly, click on the “Save” button to approve the requisition and this requisition request will be sent to the store

Requisition Approval List Requisition List Requisition Form Mrs Margaret Logout

Requisition Id Requestor Approval Status

Delegated employee can also access normal employee functions

Delegated Employee can click on the “Logout” tab after all tasks have been completed

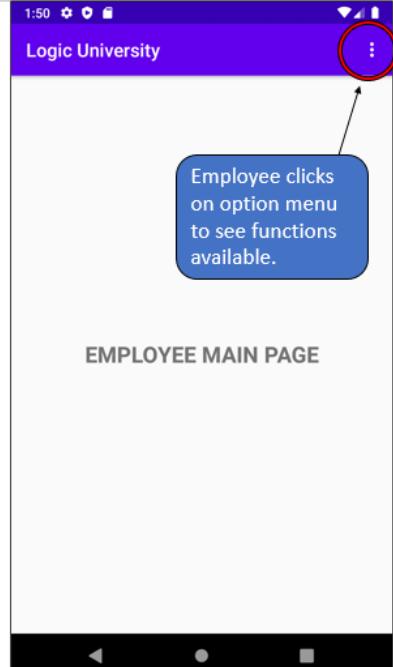
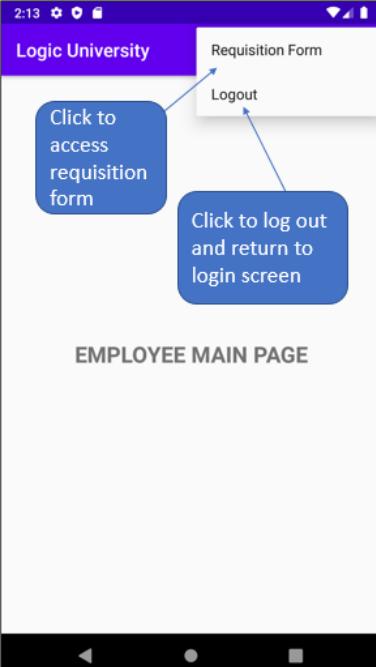
After approval have been given by the Delegated Employee, the requisition request will be sent to the store and pending approval requisition list will be empty

2.3.6 Login (Android)

<p>Android Interface</p> <p>LOGIN (GENERAL PAGE)</p> <ol style="list-style-type: none">1. Account user is required to enter both corporate username and password as assigned by your respective department2. Click on the "Login" button to enter main page		
--	---	--

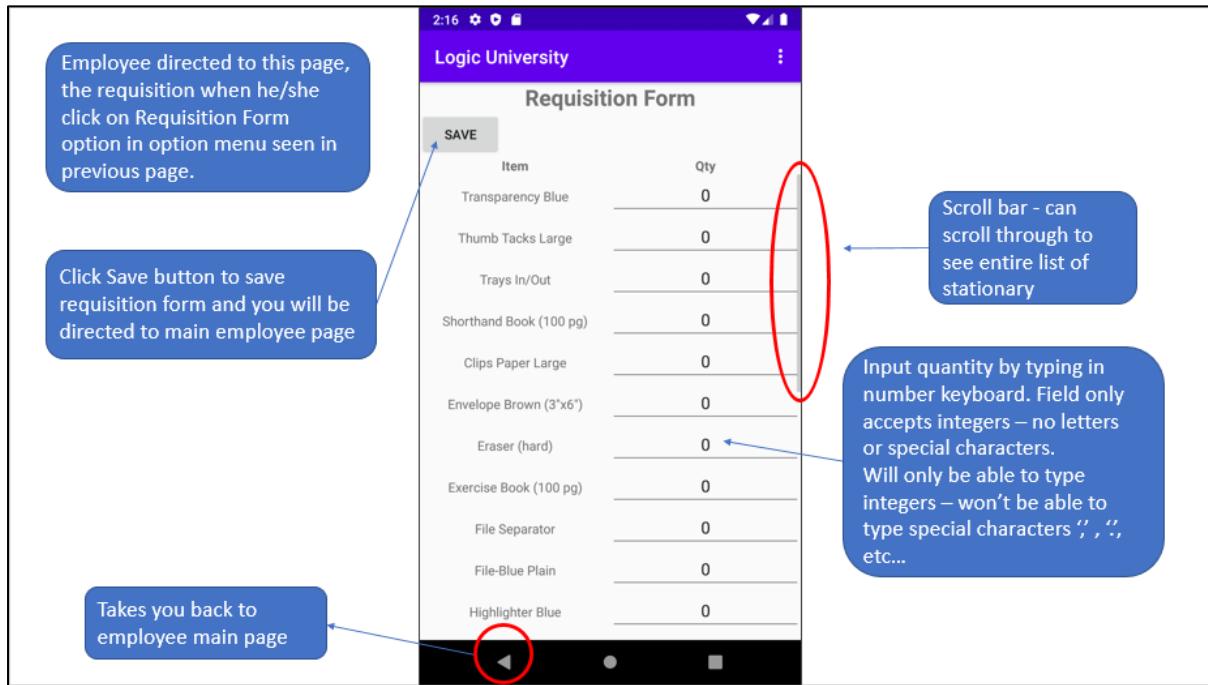
2.3.7 Department Employee Screens (Android)

2.3.7.1 Employee Main Page

	
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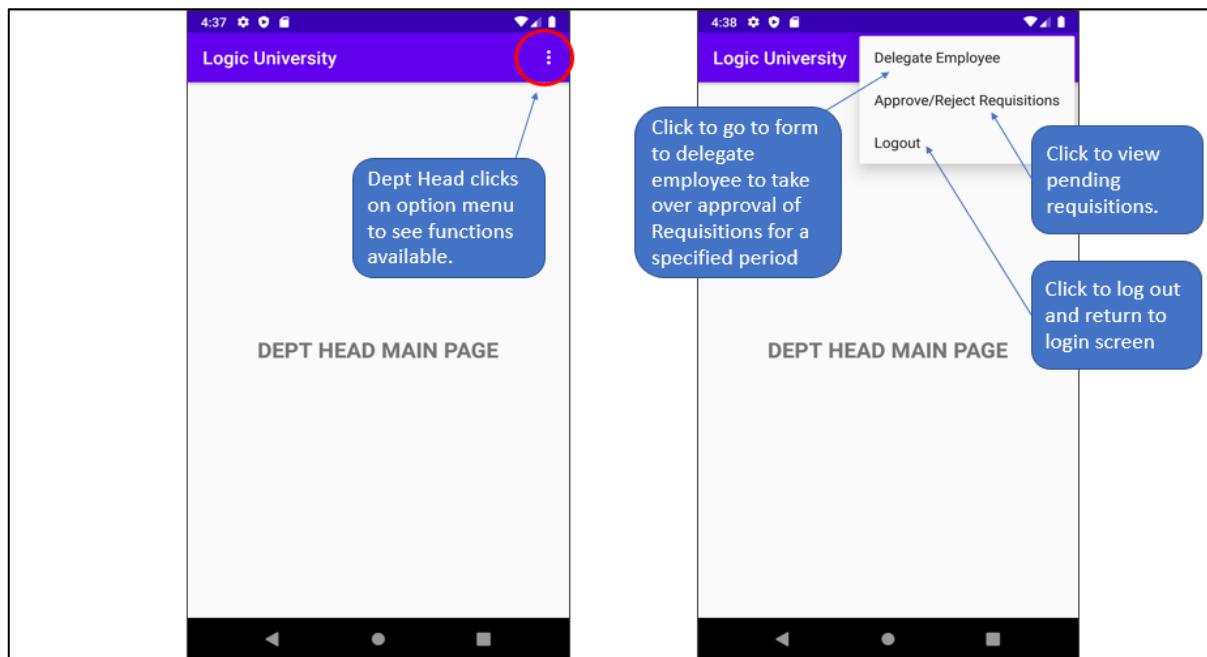
2.3.7.2 Employee Requisition Form

Raise Requisition | View Stationary Catalogue | Update Existing Requisition Form

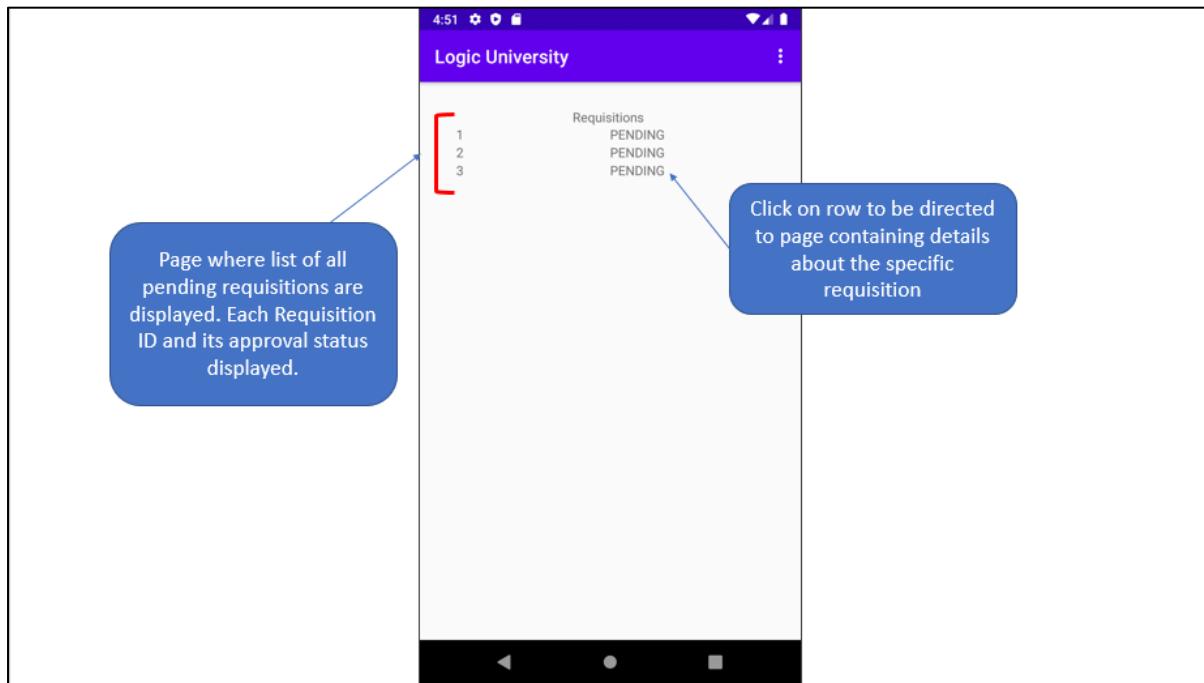


2.3.8 Department Head Screens (Android)

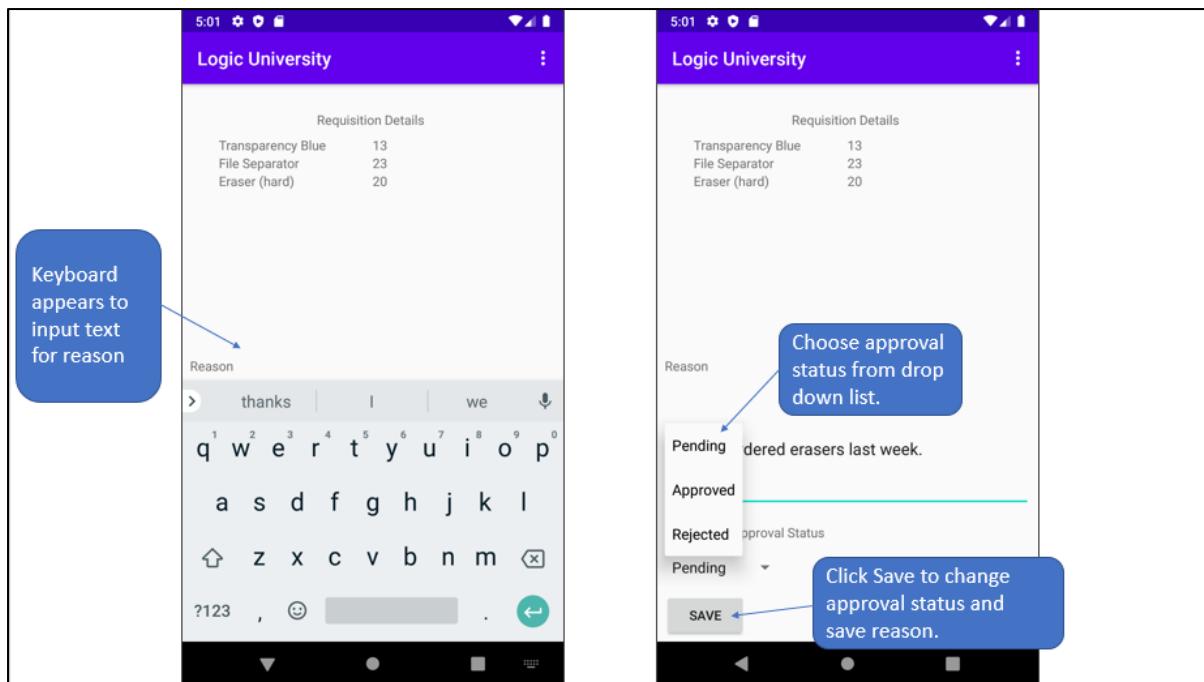
2.3.8.1 Department Head Main Page



2.3.8.2 View List of Requisitions Pending Approval



2.3.8.3 Approve/ Reject Stationary Requisition



2.3.9 Store Clerk Screens (Web)

2.3.9.1 View Trend Analysis

Trend Analysis Table/Bar

Stationery select

Item: Select

assign

Start Date mm/dd/yyyy

End Date mm/dd/yyyy

Columns Choose a value...
 × Registrar Dept
 × Commerce Dept
 × Store Dept

Show 15 entries

Search: _____

Stationery	Qty	A_Date	Department Name	Month	Year
Pen Transparency Permanent	230	5/25/2020 12:00:00 AM	Commerce Dept	5	2020
Pen Transparency Permanent	157	5/25/2020 12:00:00 AM	Registrar Dept	5	2020
Pen Transparency Permanent	300	4/25/2020 12:00:00 AM	Commerce Dept	4	2020
Pen Transparency Permanent	88	4/25/2020 12:00:00 AM	Registrar Dept	4	2020
Pen Transparency Permanent	300	3/25/2020 12:00:00 AM	Commerce Dept	3	2020
Pen Transparency Permanent	175	3/25/2020 12:00:00 AM	Registrar Dept	3	2020
Pen Transparency Permanent	150	2/25/2020 12:00:00 AM	Commerce Dept	2	2020
Pen Transparency Permanent	160	2/25/2020 12:00:00 AM	Registrar Dept	2	2020
Pen Transparency Permanent	200	1/25/2020 12:00:00 AM	Commerce Dept	1	2020

Qty

User can filter Item , Department and Date period, and results will render for both Table and Bar

2.3.9.2 View Requisition List

Store Clerk Requisition List

Show 10 entries

Search: _____

Requisition Id	Dept	Fulfillment Status
1	English Dept	ToBeProcessed

Showing 1 to 1 of 1 entries

Previous 1 Next

- Requisition List will display the all the requisition forms that are approved by respective department heads .
- Click "Requisition Id" to view the Requisition Details

2.3.9.3 Submit Requisition Fulfilment

Store Clerk Requisition Fulfillment

Item Name	Requested Qty	Stock Qty	Collected Qty	To Withdraw Qty	Withdrawn
Transparency Blue	4	96	4	0	0
Scotch Tape	7	96	4	3	2
Highlighter Blue	5	95	5	0	0
Exercise Book (100 pg)	8	92	8	0	0
Envelope Brown (3"x6")	10	90	10	0	0
Trays In/Out	9	91	9	0	0

Save

- Then , Requisition Fulfillment Details will be displayed, Store Clerk can input the Quantity she want to fulfill
- Once clicking "Save", Requisition Fulfillment will change to Status "Partial" or "Fulfilled"

Store Clerk Requisition List

Requisition Id	Dept	Fulfillment Status
1	English Dept	Partial

Show 10 entries Search:

Showing 1 to 1 of 1 entries

Previous 1 Next

- Click "Requisition Id" to continue fulfill the Requisition
- After fulfilling completely the Requisition, it will be change to status "fulfilled" and disappears from Requisition List.

2.3.9.4 Generate Disbursement List

Store Clerk Disbursement List

Disbursement Id	Status	Collection Date	Action
15	PendingPacking	N/A	Edit
16	PendingPacking	N/A	Edit
17	PendingPacking	N/A	Edit

Show 10 entries Search:

Showing 1 to 3 of 3 entries Previous 1 Next

- Click "Edit" to see details and further actions.
- There are 3 status for Disbursement : Pending Packing, Pending Disbursement and Acknowledleg

2.3.9.5 Submit Disbursement Date (Disbursement List Details)

Store Clerk Disbursement Detail

Item Code	Item Name	Qty
E001	Envelope Brown (3"x6")	0
E030	Exercise Book (100 pg)	0
H011	Highlighter Blue	0
S040	Scotch Tape	2
T020	Transparency Blue	0
T100	Trays In/Out	0

Show 10 entries Search:

Showing 1 to 6 of 6 entries Previous 1 Next

- Input Date for Disbursement
- Then, click "Submit" to issue the Disbursement

2.3.9.6 Acknowledge Disbursement

Store Clerk Disbursement List

Disbursement Id	Status	Collection Date	Action
16	PendingDisbursement	09/27/2020	Acknowledge
17	PendingPacking	N/A	Edit

Show 10 entries Search:

Showing 1 to 2 of 2 entries Previous Next

After "Submit" the Disbursement Details, the Status is changed to "Acknowledge"

Store Clerk Disbursement Acknowledgement

DISBURSEMENT ID:	16
DEPARTMENT:	English Dept
DEPARTMENT REPRESENTATIVE:	Jenny Wong Mei Lin
COLLECTION POINT:	EngineeringSchool
ACKNOWLEDGEMENT CODE:	c0f04f51-a095-4661-af41-853f3a0be95e

Show 10 entries Search:

Item Name	Quantity
Envelope Brown (3"x6")	0
Exercise Book (100 pg)	0
Highlighter Blue	0
Scotch Tape	2
Transparency Blue	0
Trays In/Out	0

Showing 1 to 6 of 6 entries Previous Next

User input the Acknowledge Code and click "Acknowledge" button in order to issue Disbursement Acknowledgement

2.3.9.7 View Stock Inventory

Store Stock List Page

Item Number	Category	Description	Unit of Measure	In Stock
C001	Clip	Clips Double 1	Dozen	1000
C004	Clip	Clips Paper Large	Box	100
E001	Envelope	Envelope Brown (3"x6")	Each	90
E020	Eraser	Eraser (hard)	Each	100
E030	Exercise	Exercise Book (100 pg)	Each	92
F020	File	File Separator	Set	100
F021	File	File-Blue Plain	Each	100
H011	Pen	Highlighter Blue	Box	95
H031	Puncher	Hole Puncher 2 holes	Each	100
P010	Pad	Pad Postit Memo 1"x2"	Packet	100

Showing 1 to 10 of 24 entries

Previous 1 2 3 Next
 Activate Windows

Quantity of Stock will be automatically updated :

- After receiving items from Supplier, Quantity of stock will be auto- added.
- Upon fulfilling requisition, Quantity of stock will be auto deducted

2.3.9.8 Raise Stock Adjustment Request

Store Clerk Adjustment Voucher List

Voucher#	Date issued	Authorised by	Status
AV1	N/A	N/A	Draft
AV2	N/A	N/A	Draft

Showing 1 to 2 of 2 entries

Previous 1 Next

- Click "Voucher #" to see the details
- Click "Create" to create a new Adjustment Voucher
- The Status is Draft because Store Clerk does not submit .

- Quantity is auto-filled but Store Clerk can modify it
- User can fill a reason of discrepancies.
- Upon clicking "Save", the voucher will be passed to Supervisor/ Manager

Store Clerk Adjustment Voucher Detail

Voucher#: AV2

Date issued:

By: N/A

Authorised By:N/A

Show 10 entries

Search:

Item Code	Quantity adjusted	Reason
C004	-2	
S010	-1	
T100	-1	

Showing 1 to 3 of 3 entries

Previous Next

- After Store Clerk submitted the voucher, the status will be changed to "Pending Issue"

Store Clerk Adjustment Voucher List

Create

Show 10 entries

Search:

Voucher#	Date issued	Authorised by	Status
AV1	N/A	StoreManager	PendingIssue
AV2	N/A	StoreSupervisor	PendingIssue

Showing 1 to 2 of 2 entries

Previous Next

2.3.9.10 View Purchase Orders

Purchase Order List

Click "Delete" button, there is a new layout to confirm delete action

Delete
Are you sure you want to delete this?
PO

PO Id	Order Date	Supplier Name	Status	Action
1	10/10/2020 12:00:00 AM	FairPrice	Processing	Delivery Details Delete
2	8/20/2020 12:00:00 AM	ColdStorage	Processing	Delivery Details Delete

Show 10 entries

Search:

Showing 1 to 2 of 2 entries

Previous 1 Next

Upon receiving items from Supplier, click "Delivery", input Received Date and Save, PO status will be changed to "Completed" => stock quantity is auto-updated

2.3.9.11 View Purchase Order Details

Details

PO

Id	1
Order Date	10/10/2020 12:00:00 AM
Received Date	
POStatus	Processing
Supplier Name	FairPrice

PO Status is " Processing" when the PO was created but the items are not received from the supplier

Item Number	Item Name	Qty	Unit Price	Amount
C001	Clips Double 1	10	10	100
C004	Clips Paper Large	20	10	200

Total Price
300

Click the link to go back to the PO List

Back to List

Activate Wir

2.3.9.12 Raise Purchase Order

Create Purchase Order

Create Supplier

Item Name	Unit Price	Predicted Quantity	Quantity
File-Blue Plain	15	302	0
File Separator	10	200	0

Submit

Predicted Quantity from Machine Learning Demand Forecasting Algorithm

User input Qty

Create
PO

OrderDate
8/27/2020 3:41 AM

Supplier
Citimart

Back to List **Next**

Click "Next", UI will show all items, unit price of the Supplier

2.3.9.13 Receive Items from Supplier

Purchase Items Delivery

OrderDate
8/20/2020 12:00 AM

ReceiveDate
mm/dd/yyyy --:-- --
The ReceiveDate field is required.

Item Name	Unit Price
Envelope Brown (3"x6")	10
Eraser (hard)	30

Save

Back to List

- After receiving item from Supplier, user click "Delivery" button, input Received Date
- => PO status will be auto changed to "Completed" and Stock quantity is auto-updated

2.3.9.14 Manage Supplier

Supplier List

Suppliers

[Create](#)

Click "Create" to create a new Supplier

No	Supplier Name	Address	Phone Number	Action
1	Citimart	Jurong East	86664 4668	Details Delete
2	Giant	Bukit Batok	8334 4338	Details Delete
3	Metro	Marina Bay	8112 2118	Details Delete
4	ColdStorage	Kovan	8224 4228	Details Delete
5	FairPrice	Ang Mo Kio	8668 8668	Details Delete

Show 10 entries

Search:

Showing 1 to 5 of 5 entries

Previous 1 Next

User can delete and view details of Suppliers

2.3.9.15 Delete Supplier

Trend Analysis Requisition  Mrs Jane Koh Logout

Suppliers

[Create](#)

Are you sure you wish to delete this nomination?

Cancel Delete

No	Supplier Name	Address	Phone Number	Action
1	Citimart	Jurong East	86664 4668	Details Delete
2	Giant	Bukit Batok	8334 4338	Details Delete
3	Metro	Marina Bay	8112 2118	Details Delete
4	ColdStorage	Kovan	8224 4228	Details Delete
5	FairPrice	Ang Mo Kio	8668 8668	Details Delete

Show 10 entries

Search:

Showing 1 to 5 of 5 entries

Previous 1 Next

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2.3.9.16 View Details of Supplier

Supplier Detail

Supplier Name	Citimart
Address	Jurong East
Telephone No	86664 4668

Show <input type="button" value="10"/> entries	Search: <input type="text"/>	
No	Item Name	Unit Price
1	Highlighter Blue	10
2	Hole Puncher 2 holes	20

No	Item Name	Unit Price
----	-----------	------------

Showing 1 to 2 of 2 entries
Previous

Next

Upon click "Detail" button in Supplier List, User can see the Supplier Details

2.3.9.16 Create Supplier

2.3.9.16 View Departments

Department List

Department List

[Create New](#)

Show **10** entries

Search:

DeptCode	DeptName	TelephoneNo	FaxNo	CollectionPoint	
COMM	Commerce Dept	874 1284	892 1256	MedicalSchool	Edit Details Delete
CPSC	Computer Science	890 1235	892 1457	ManagementSchool	Edit Details Delete
ENGL	English Dept	874 2234	892 1456	EngineeringSchool	Edit Details Delete
REGR	Registrar Dept	890 1266	892 1465	ScienceSchool	Edit Details Delete
STORE	Store Dept	890 1266	892 1465	StationeryStore	Edit Details Delete

Showing 1 to 5 of 5 entries

Previous **1** Next

2.3.9.17 Manage Departments

Details

Department

DeptCode	COMM
DeptName	Commerce Dept
TelephoneNo	874 1284
FaxNo	892 1256
CollectionPoint	MedicalSchool
Department Head	Mrs Lin

[Edit](#) | [Back to List](#)

User can view Details of Departments

Edit

Department

DeptCode	<input type="text" value="COMM"/>
DeptName	<input type="text" value="Commerce Dept"/>
TelephoneNo	<input type="text" value="874 1284"/>
FaxNo	<input type="text" value="892 1256"/>
CollectionPoint	<input type="text" value="MedicalSchool"/>

Save

2.3.9.18 Issue Stock Adjustment Voucher

Authorize Adjustment Voucher List

Adjustment Voucher Id	Voucher#	Date issued	Authorised by	Status
2	AV2	N/A	StoreSupervisor	PendingIssue

Show 10 entries Search:

Showing 1 to 1 of 1 entries Previous Next

Click Voucher Id to view Details and issue the voucher

The store supervisor will issue a stock adjustment voucher for anything under \$250 per item adjustment. Otherwise, Manager will issue the voucher.

Supervisor/Manager Adjustment Voucher Detail

Item Code	Quantity adjusted	Reason
C004	-2	damaged goods
S010	-1	
T100	-1	

Show 10 entries Search:

Showing 1 to 3 of 3 entries Previous Next

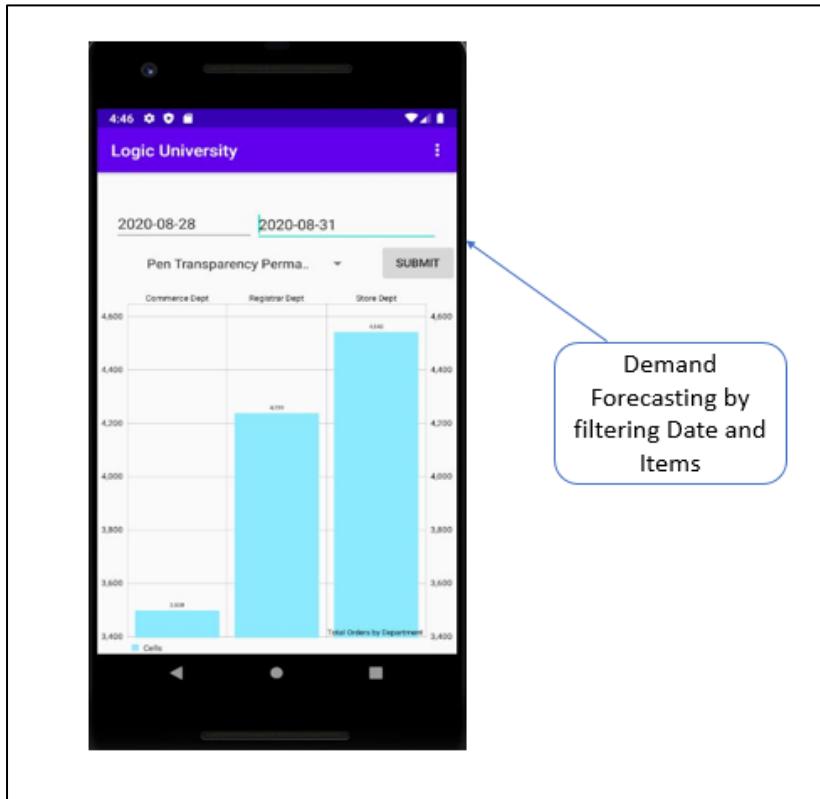
Click "Issue" button to approve Adjustment Voucher.

2.3.10 Store Screens (Android)

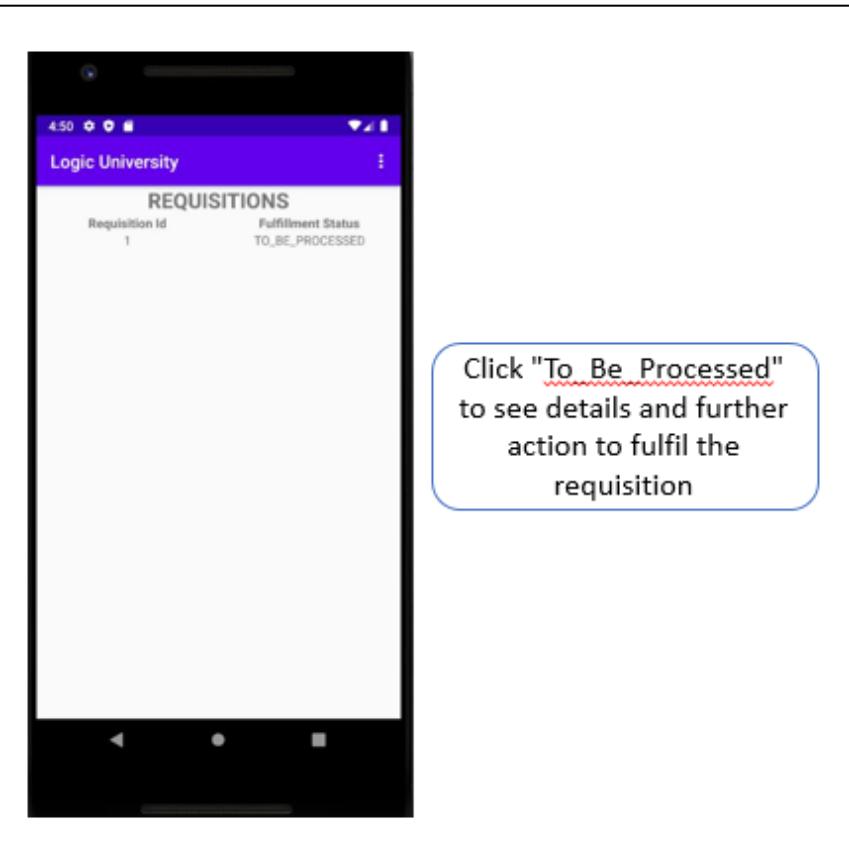
2.3.10.1 Store Clerk Main Page



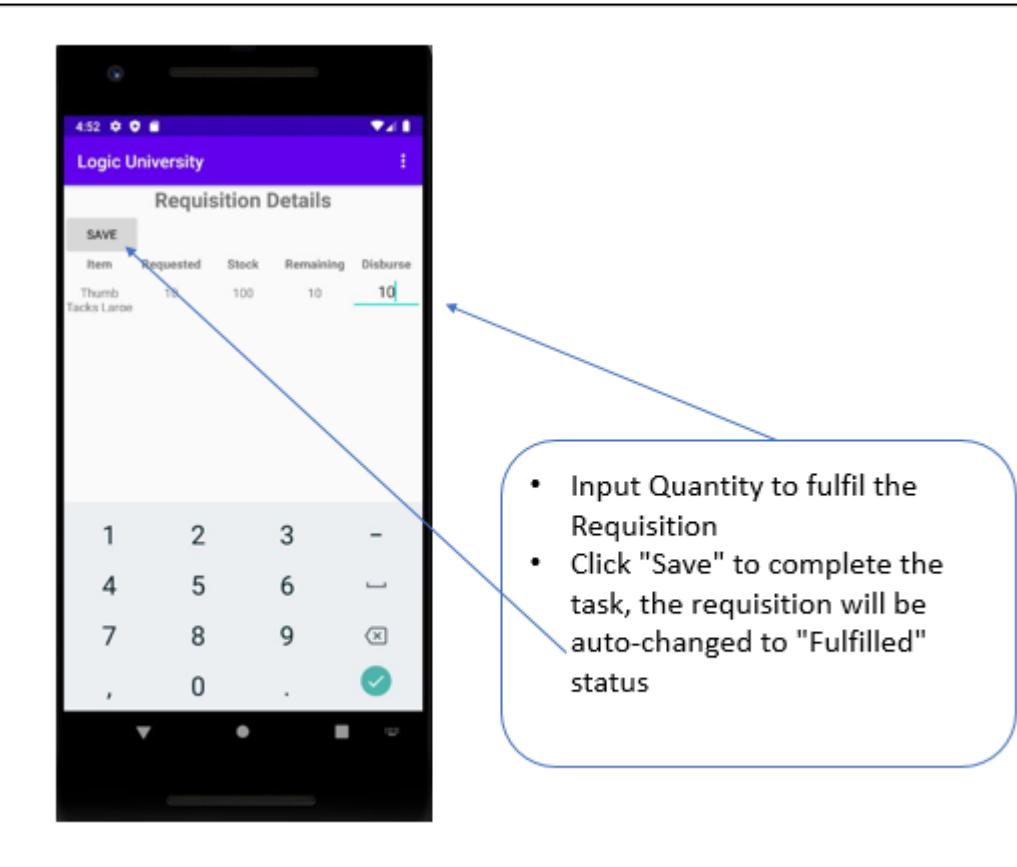
2.3.10.2 View Trend Analysis



2.3.10.3 View Requisition List



2.3.10.4 Submit Requisition Fulfilment



2.3.10.5 Generate Disbursement List

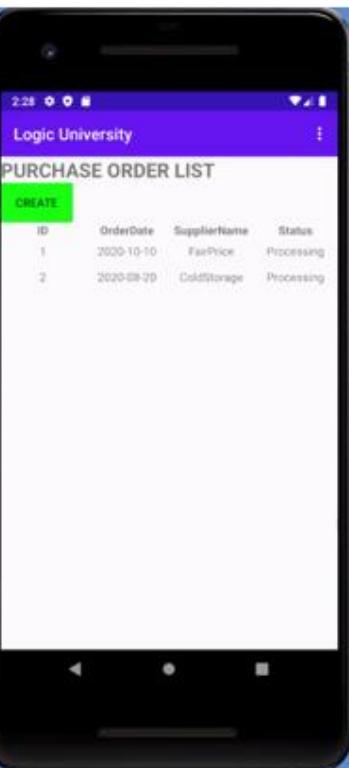


2.3.10.6 Submit Disbursement Date

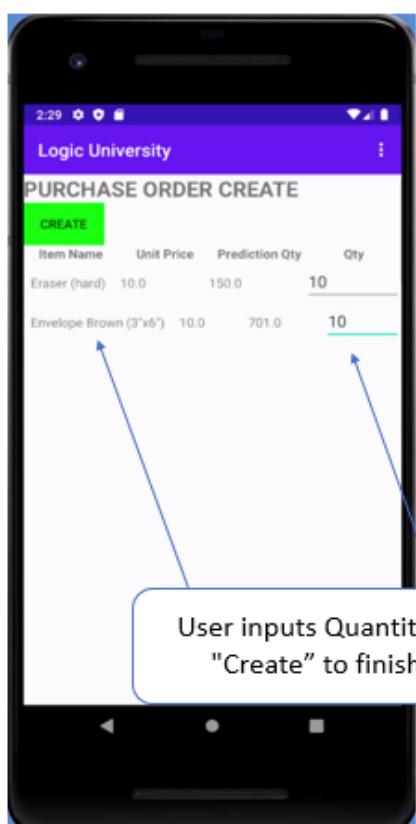


- User can select Collection Date
- Click "Submit" to finish the task, the Status will be auto changed.

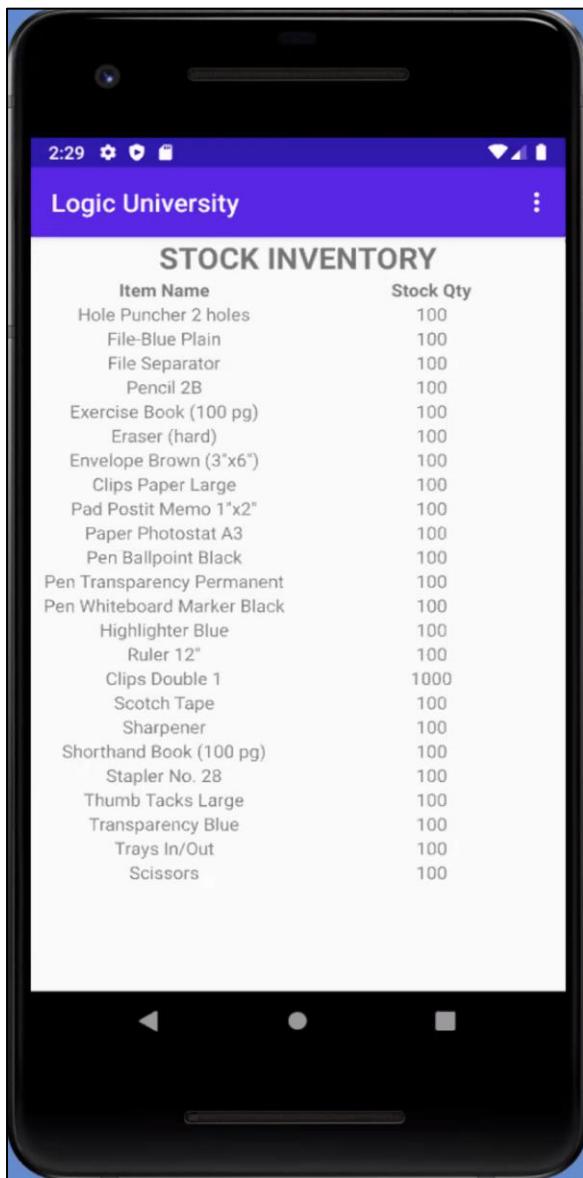
2.3.10.7 Raise Purchase Orders



Click " Create"
to create a
new PO



2.3.10.8 View Stock Inventory



2.4 System Architectural Platform Flow and Documentation

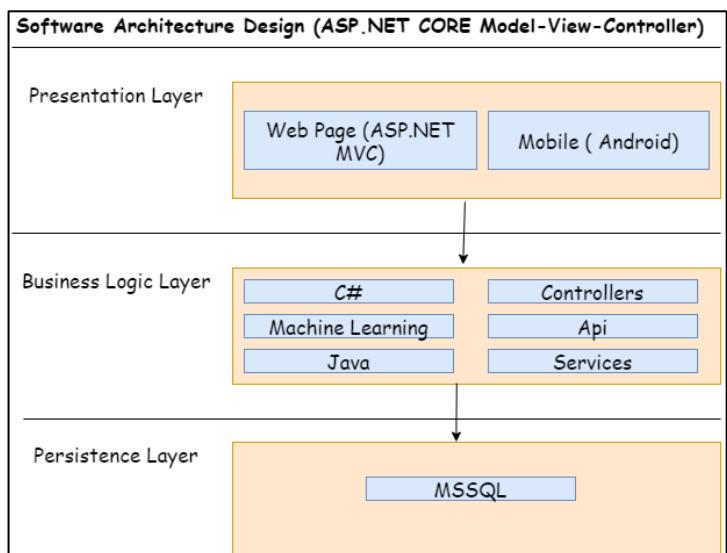


Figure 1

Technology and Supporting Tools

Implementation Technology specified:

- ASP.NET CORE Entity Framework
- Azure Machine Learning
- HTML, CSS, JavaScript, Bootstrap, Jquery
- Cloud VPS with HTTPS and SSL
- Java to code for Android, Gradle to build Android APK
- Persistence layer: MS SQL Server

Tools:

- Development tools: MS Visual Studio, Android Studio, Git
- Diagrams and Modelling tool: WhitestarUML, Draw.io

Figure 2

3-Tier System Architecture Diagram

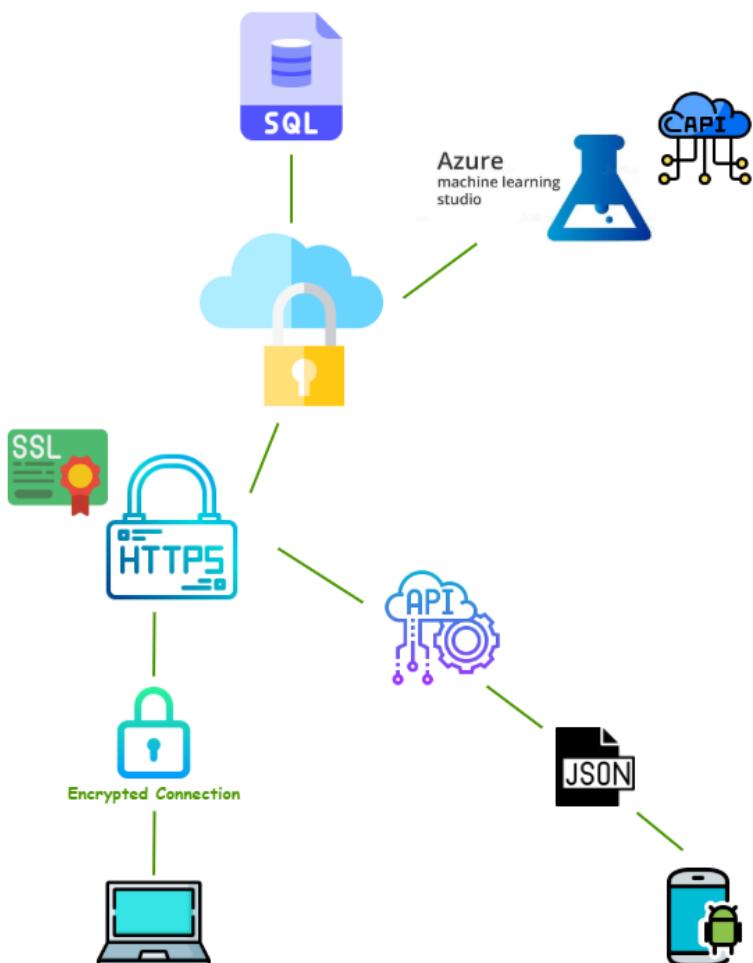


Figure 3

System Architecture Flow (Figure 3)

Security Layer and HTTPS Encryption

The C# ASP.NET CORE MVC is published and deployed to Cloud Virtual Private Server. HTTPS and SSL Certification with domain name is configured to secure and encrypt connections from various endpoints.

Web

For accessing web applications, it will display in HTTPS with the domain name, masking IP address and prevent denial-of-service (DDoS) attacks that can temporarily or indefinitely disrupt services of a host to the internet.

In our 3-Tier system architecture, the database will only be called by limited services to protect the data. Users visiting the site, filling in forms and doing tasks like demand forecasting through Azure Machine Learning API, will be calling directly through the web server as the entry point and users cannot directly access and hack into the database. This forms a security layer as database access is not granted to anyone but the web server.

Mobile

For mobile applications, through Android Studio, the final APK is built and used on physical Android Devices. The APIs and DTOs are created in the C# ASP.NET CORE MVC and passed as JSON for Android application. The JSON is calling from the HTTPS, and transformed into usable and viewable UIs in Android Studio with the libraries such as Jackson library, Charts using MPAndroidChart, RecyclerView, Adapters etc. Again, the APIs are also secured with HTTPS and SSL certification.

Performance Scaling and Database Load Reduction

The 3-tier system architecture is also more maintainable and scalable as we can always do performance balancing and tuning on the web server instead of the database. This is crucial especially when there are tons of users, because if users were to call directly to the database(2-tier architecture), the database will become extremely laggy. With 3-tier architecture, it is easier to scale performance because the web server does not contain data and even if there are a lot of web servers, it is a stateless server. There is also database load reduction as the presentation layer/ web server can cache the data retrieved from the database, saving space.

Cloud Scalability, Disaster Recovery and Cost-Efficiency

Cloud servers have quick scalability to adjust to operations that may have sudden steep spike of traffic involving concurrent users. Cloud servers also have their own disaster recovery. There is no server failure or downtime since cloud servers will always have mirror servers.

This means that there are always many other servers that serve as instant backup to fulfil the role of the primary server if it fails or crash. This is better than having on-premise dedicated server(can be your own local laptop), as it is expensive to invest in multiple servers and can experience hardware failure, taking time to purchase the hardware components to fix or scale performance.

Cloud Servers are very cost-efficient, they only charge based on the usage, which is cheaper than investing one big sum to buy a hardware server and still pay fixed maintenance fees regardless of the usage.

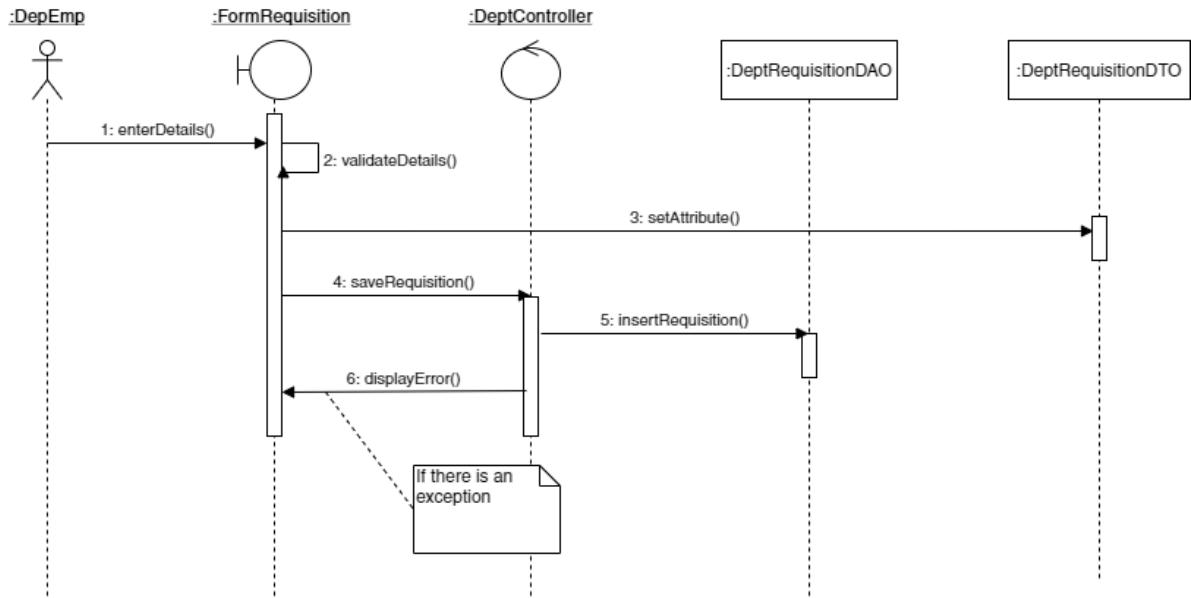
Therefore, the web and mobile applications and endpoints are secured with the addition of HTTPS, SSL Certification,

reliability through immediate disaster recovery, performance, scalability optimized with Cloud.

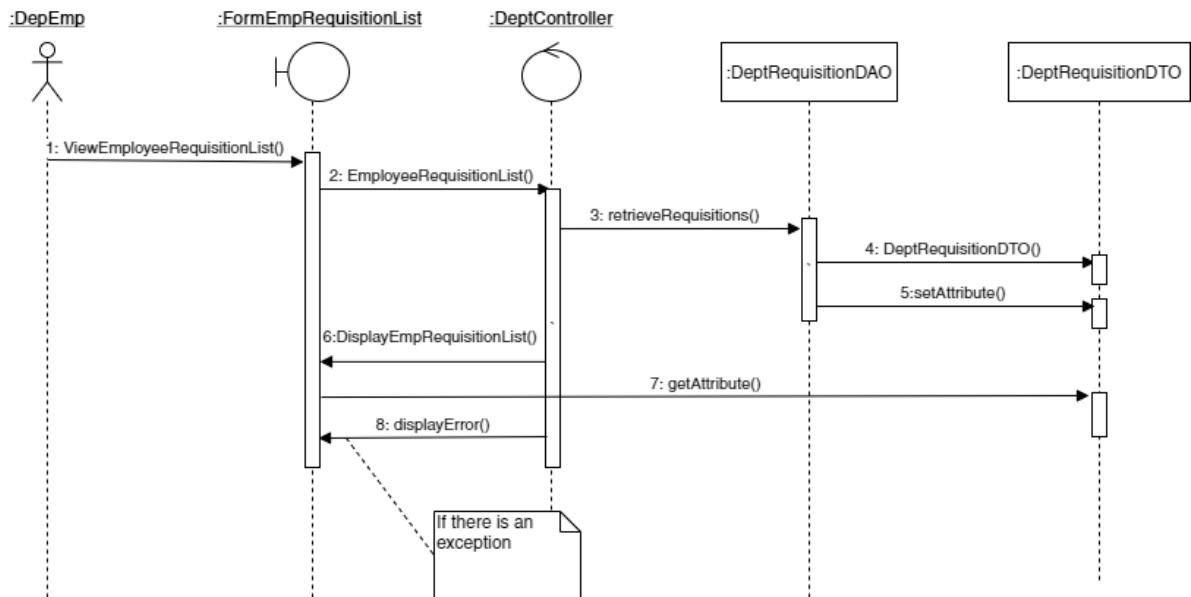
2.5 Final Sequence Diagram

2.5.1 Department:

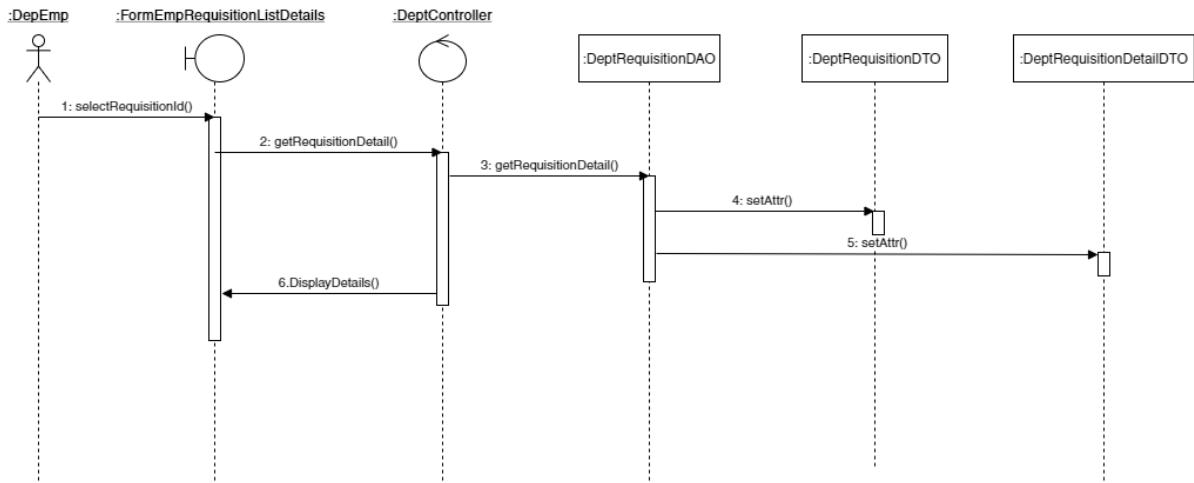
2.5.1.1 Raise Requisition Form



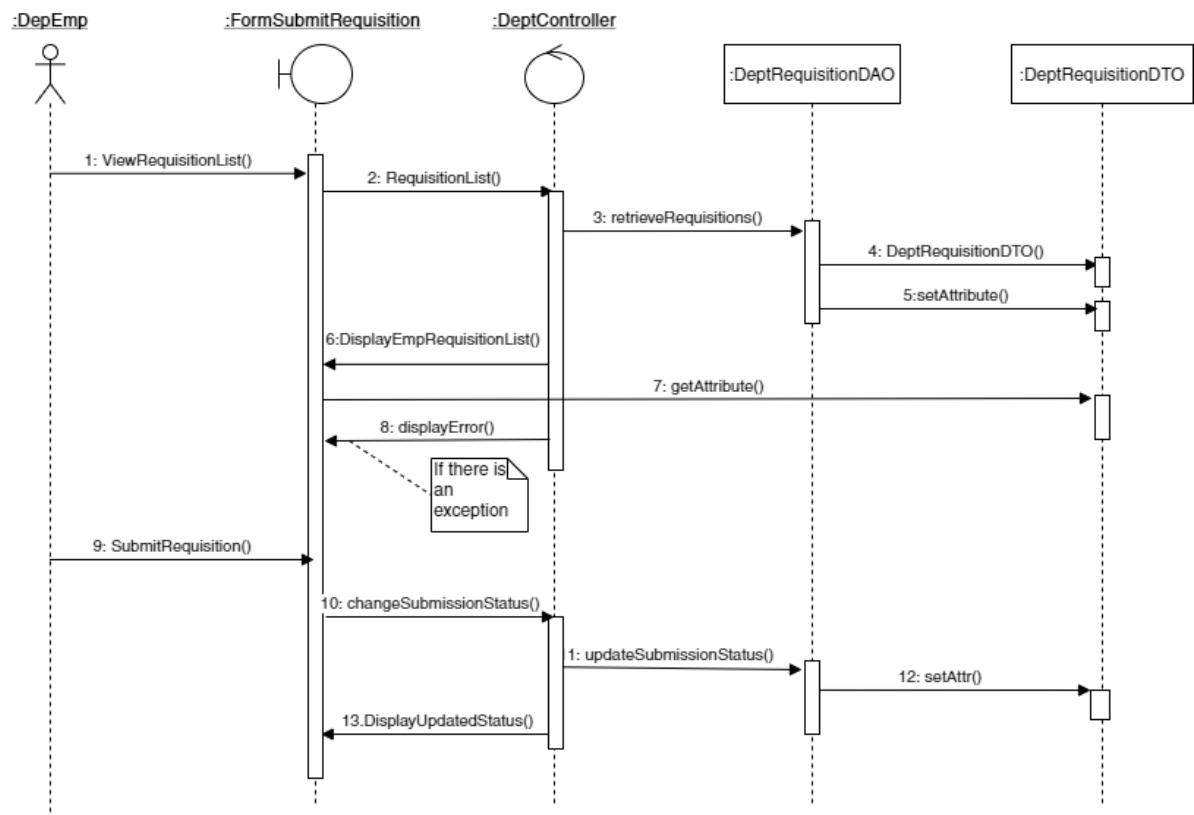
2.5.1.2 View Existing Requisition Requests



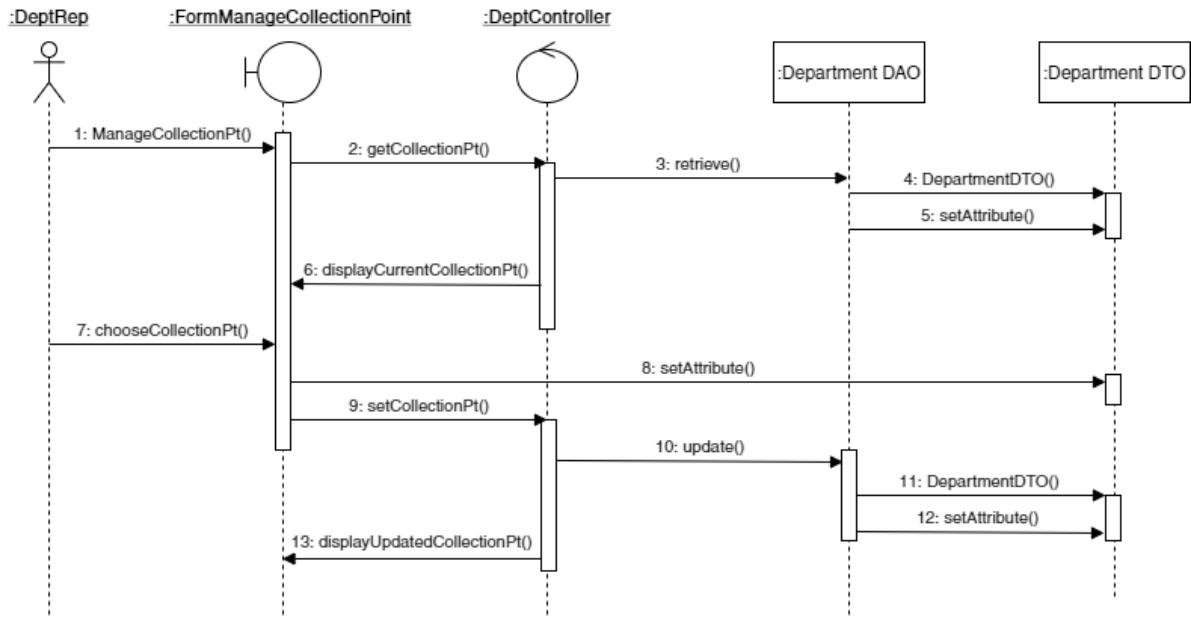
2.5.1.3 View Requisition Details



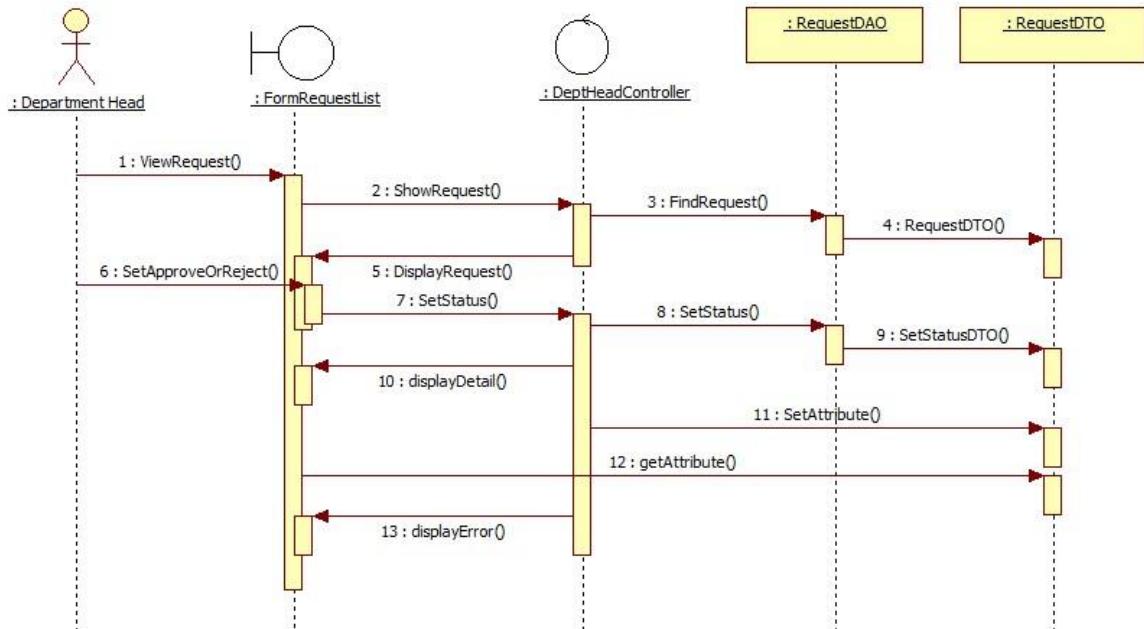
2.5.1.4 Submit Requisition Form



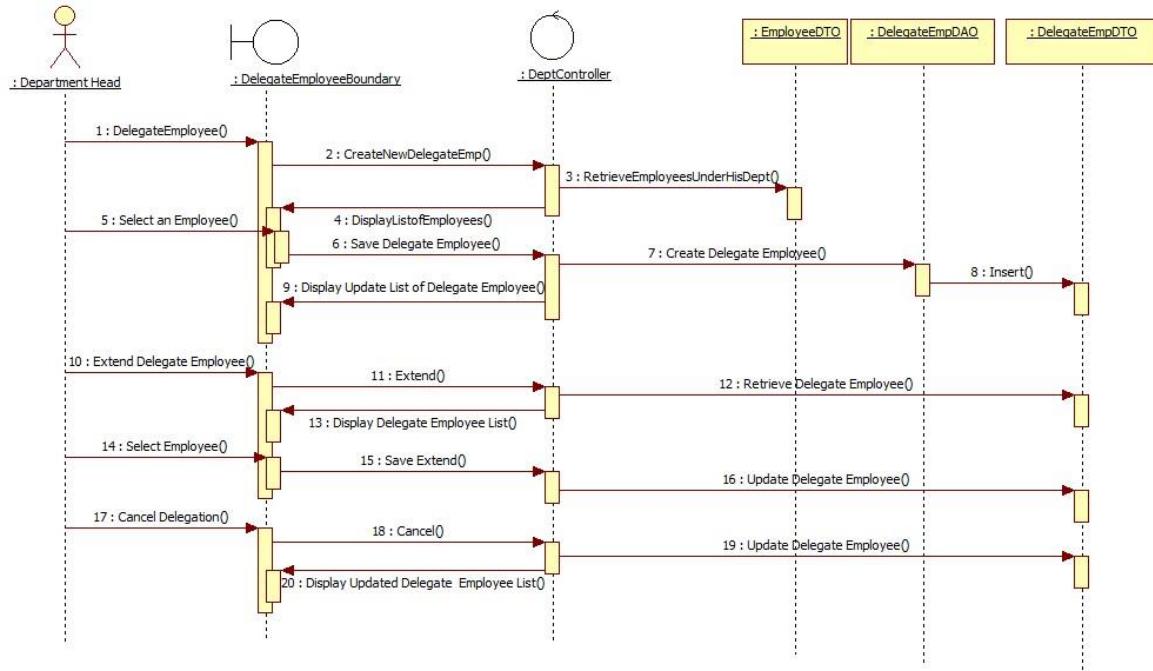
2.5.1.6.5 Update Collection Point



2.5.1.6 Dept Head Approve/Reject Req

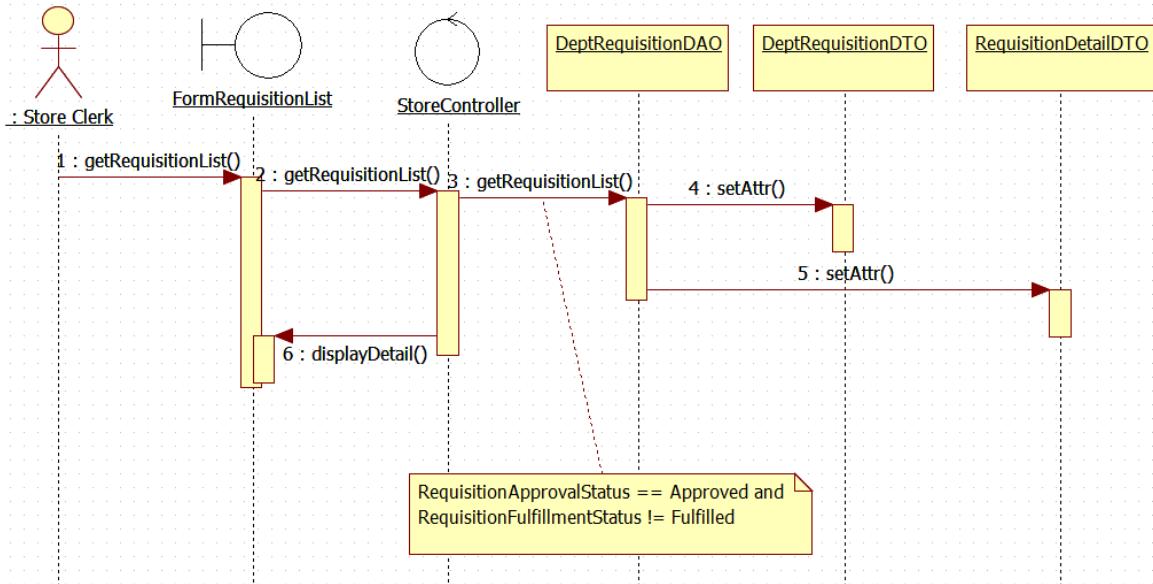


2.5.1.7 Dept Head Delegate Employee

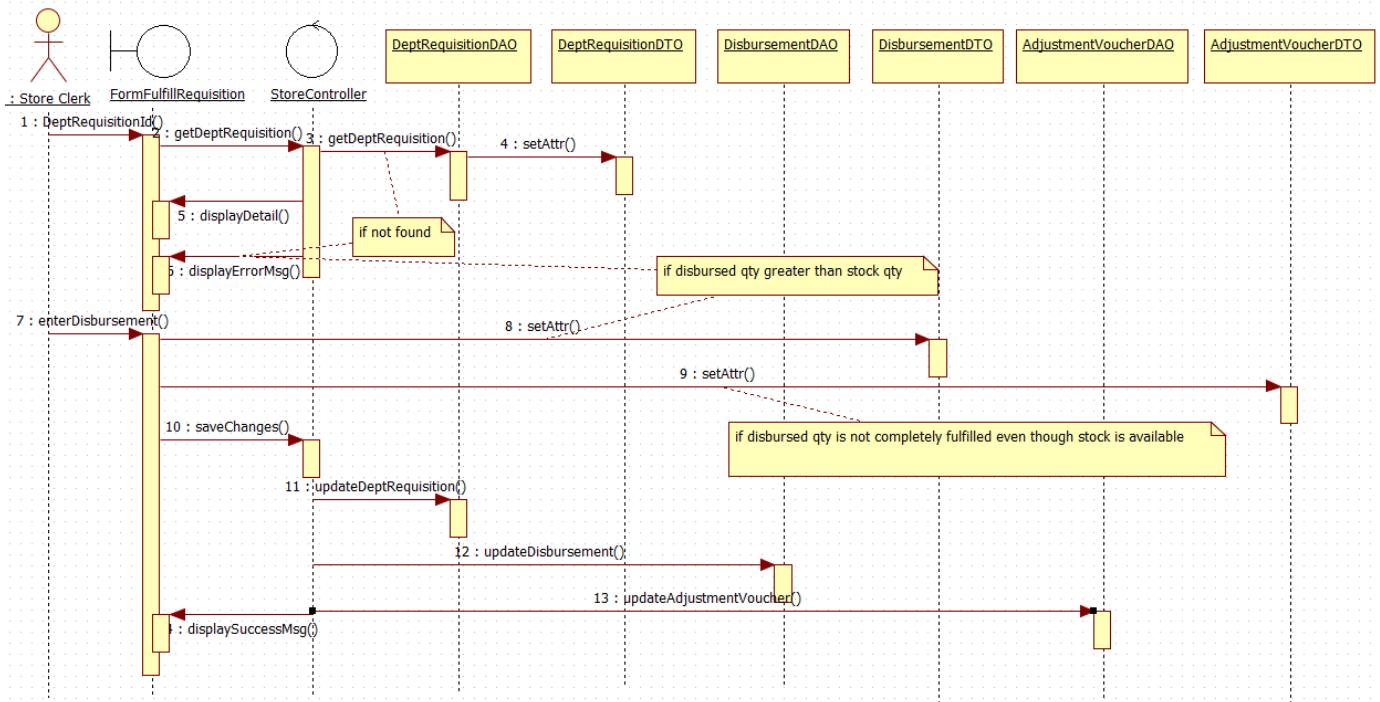


2.5.2 Store:

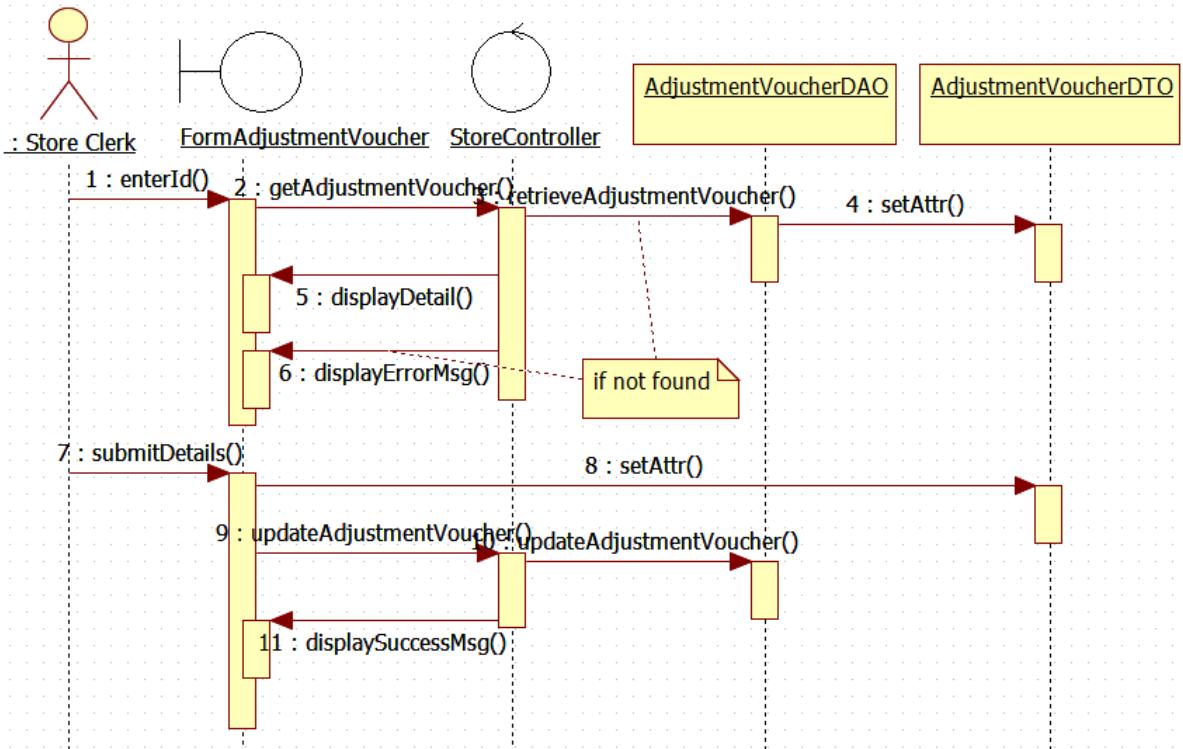
2.5.2.1 View Requisition List



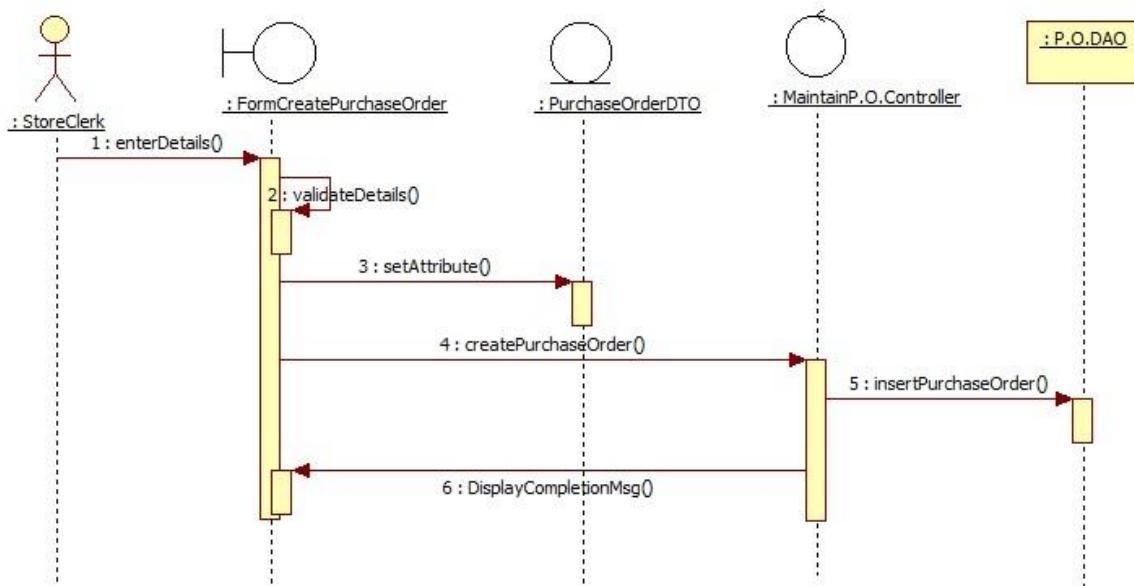
2.5.2.2 Submit Requisition Fulfilment



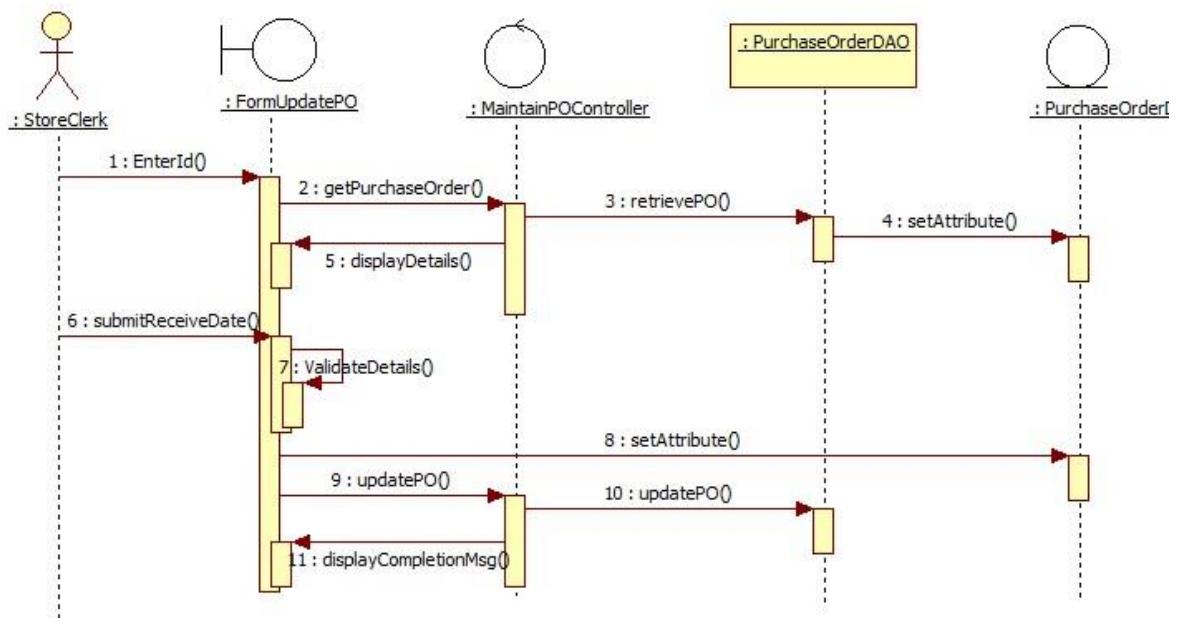
2.5.2.3 Raise Stock Adjustment Request



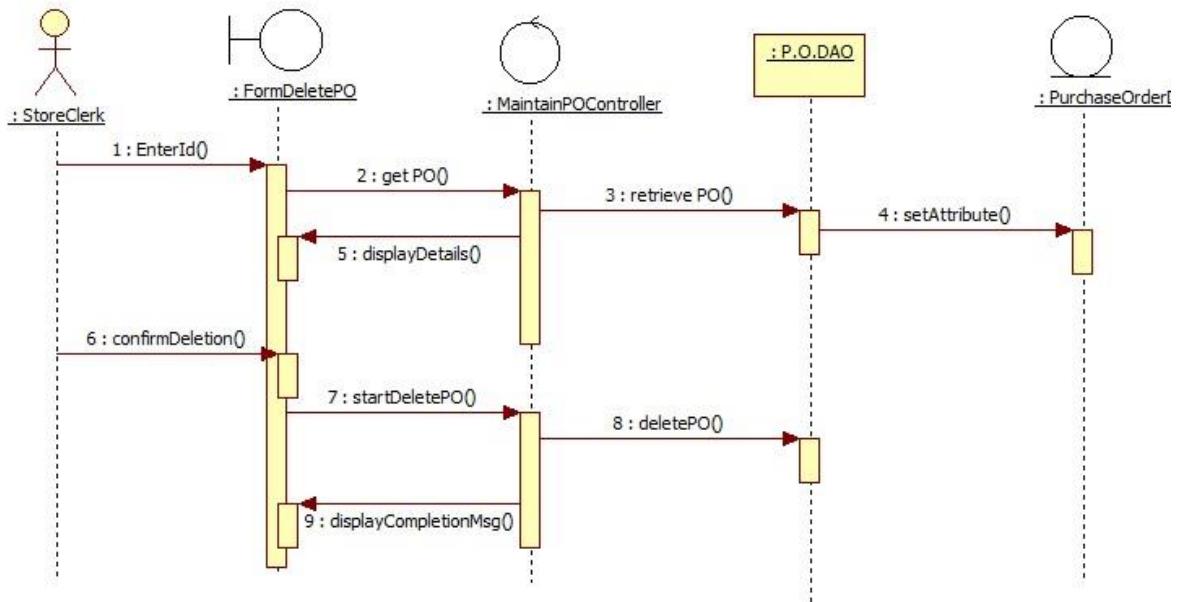
2.5.2.4 Raise Purchase Order



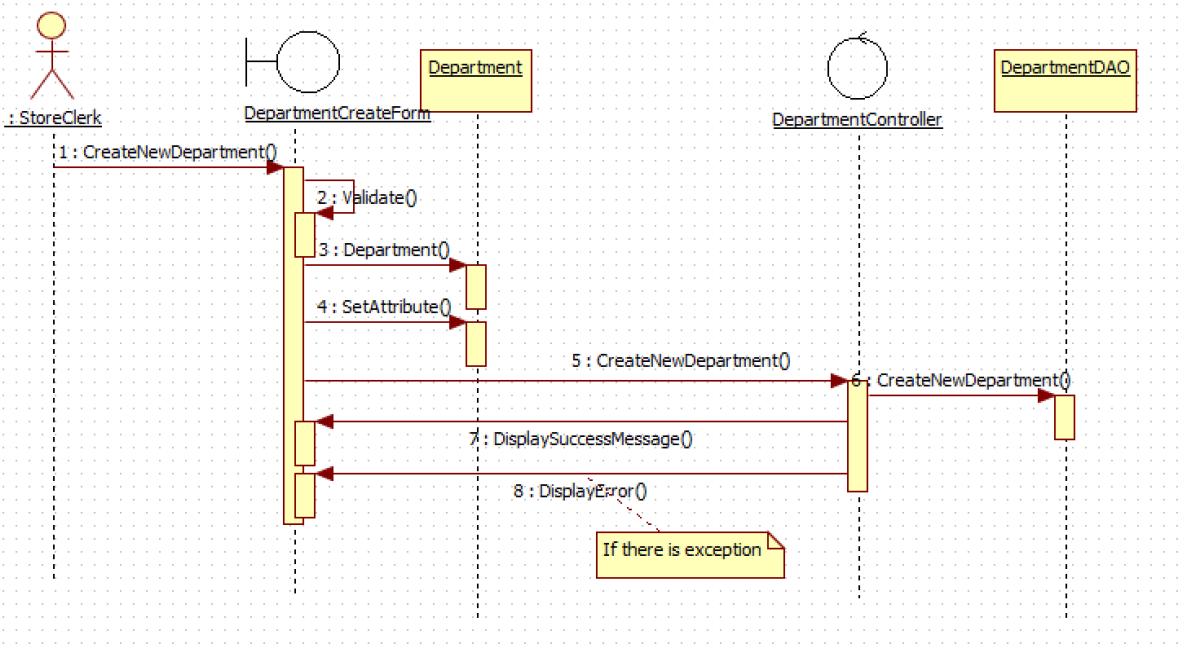
2.5.2.5 Update Purchase Order



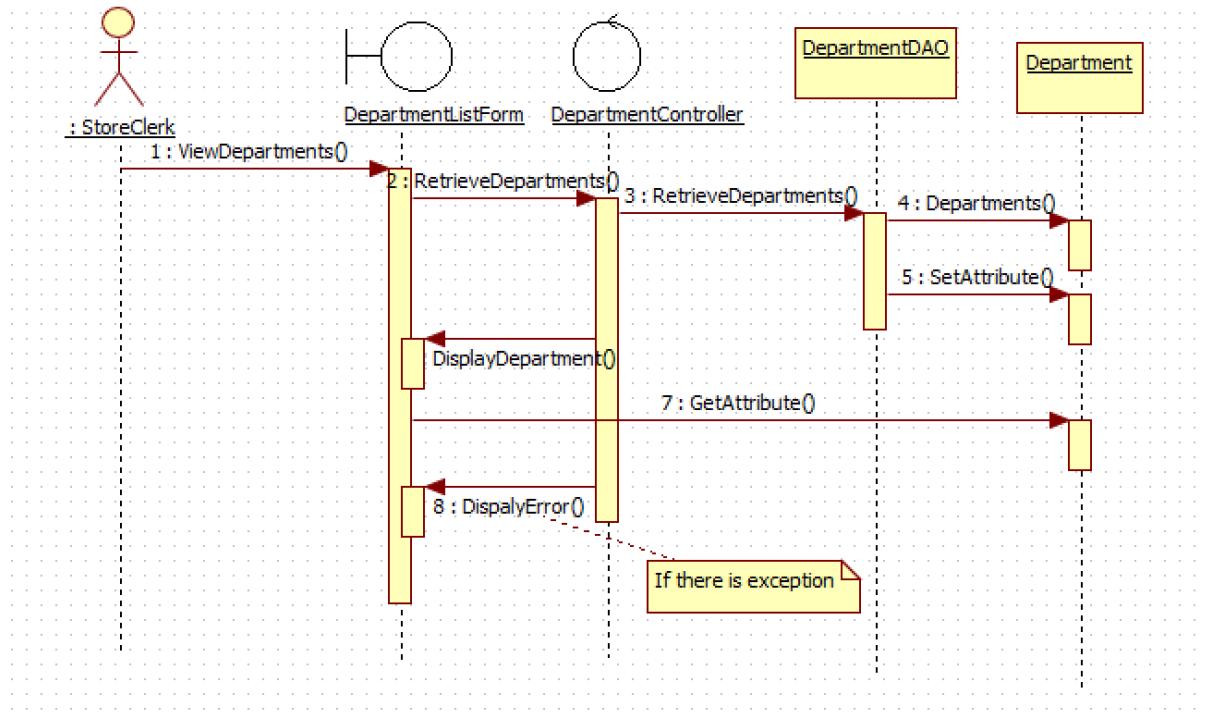
2.5.2.6 Delete Purchase Order



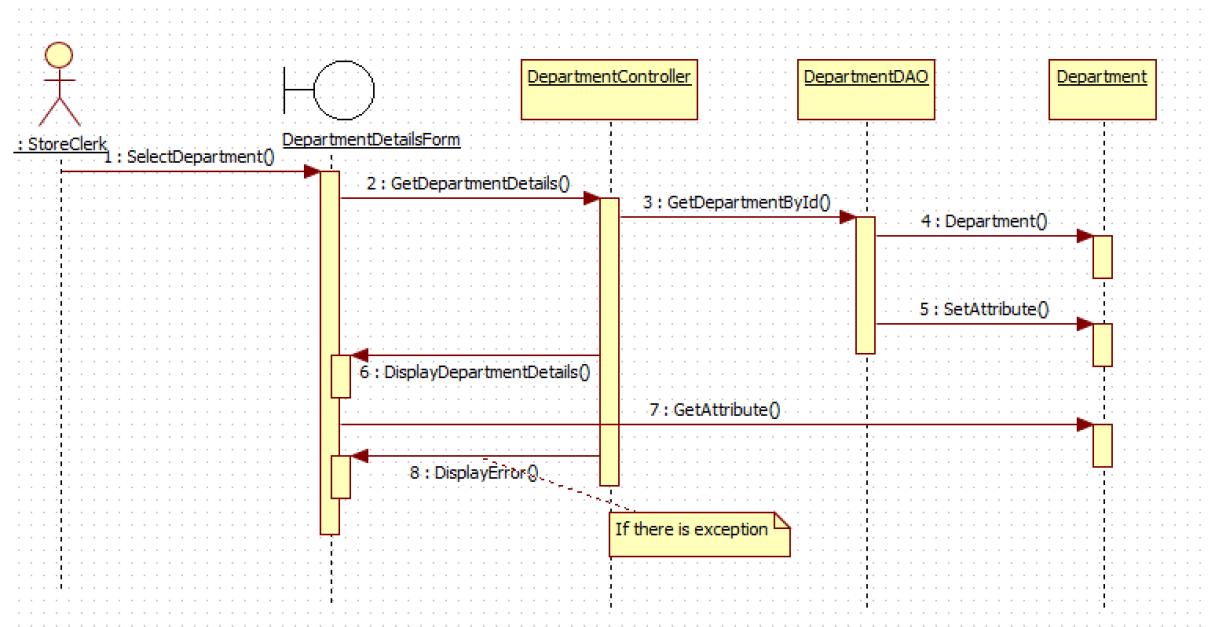
2.5.2.7 Create New Department



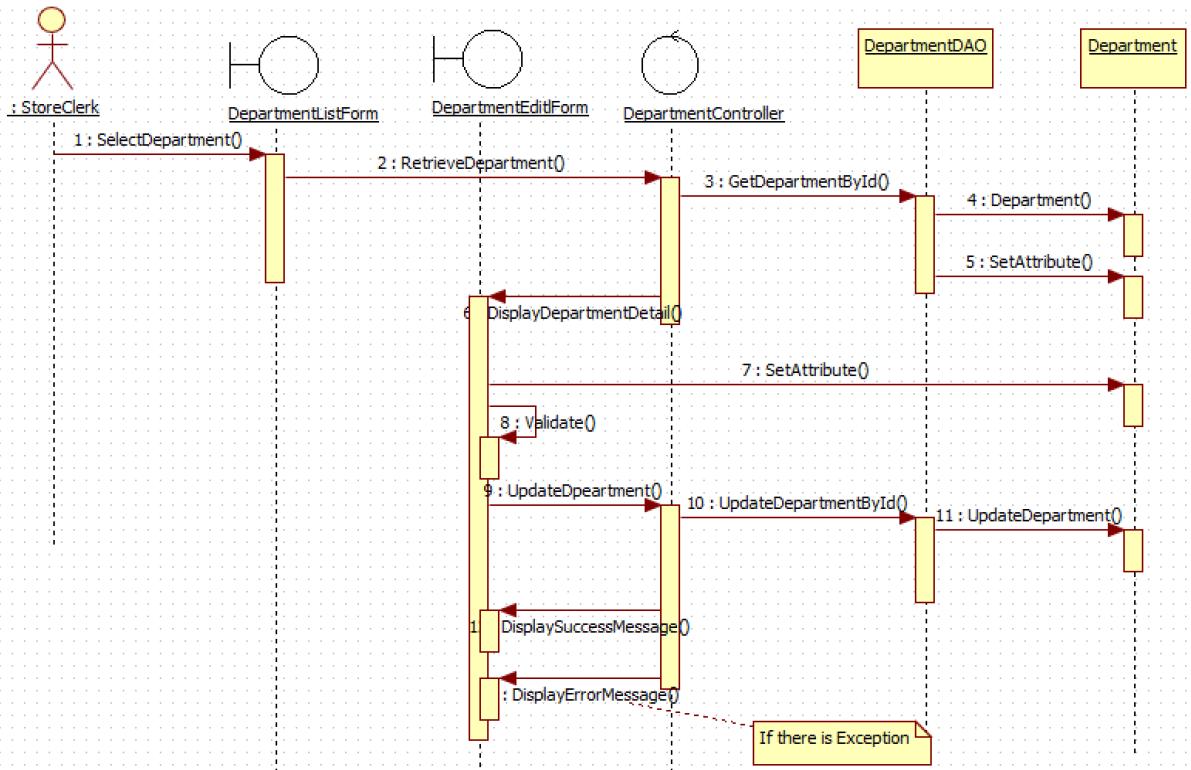
2.5.2.8 Department List



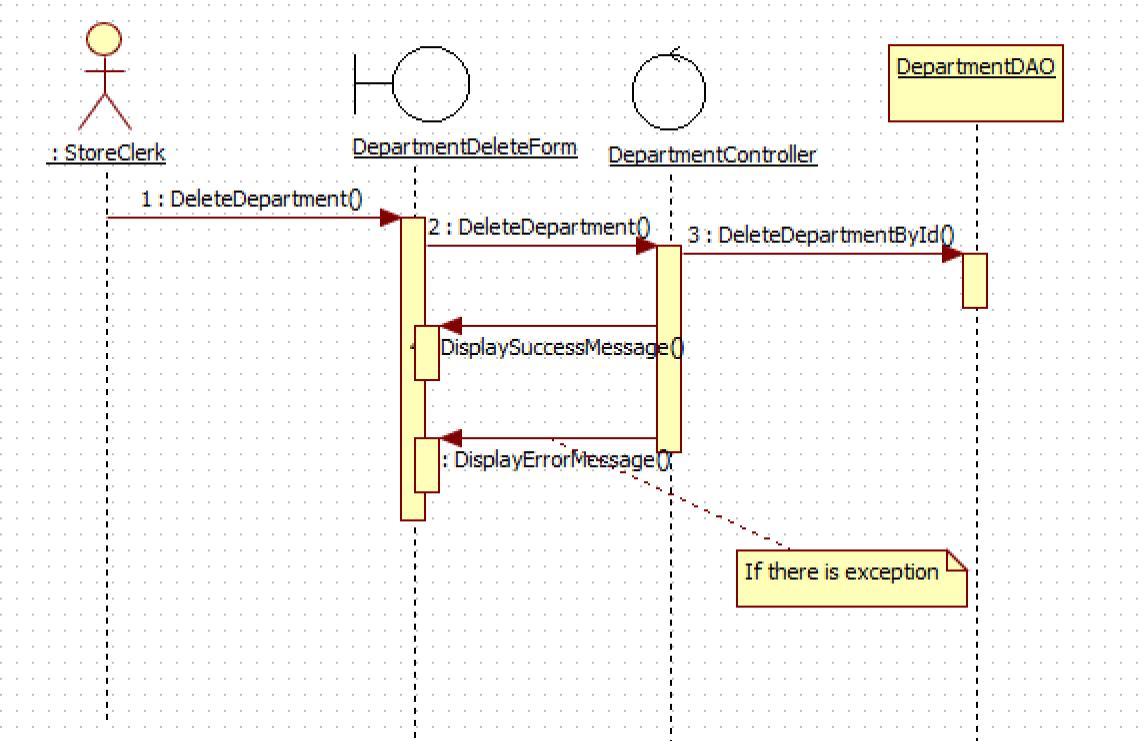
2.5.2.9 View Details of Department



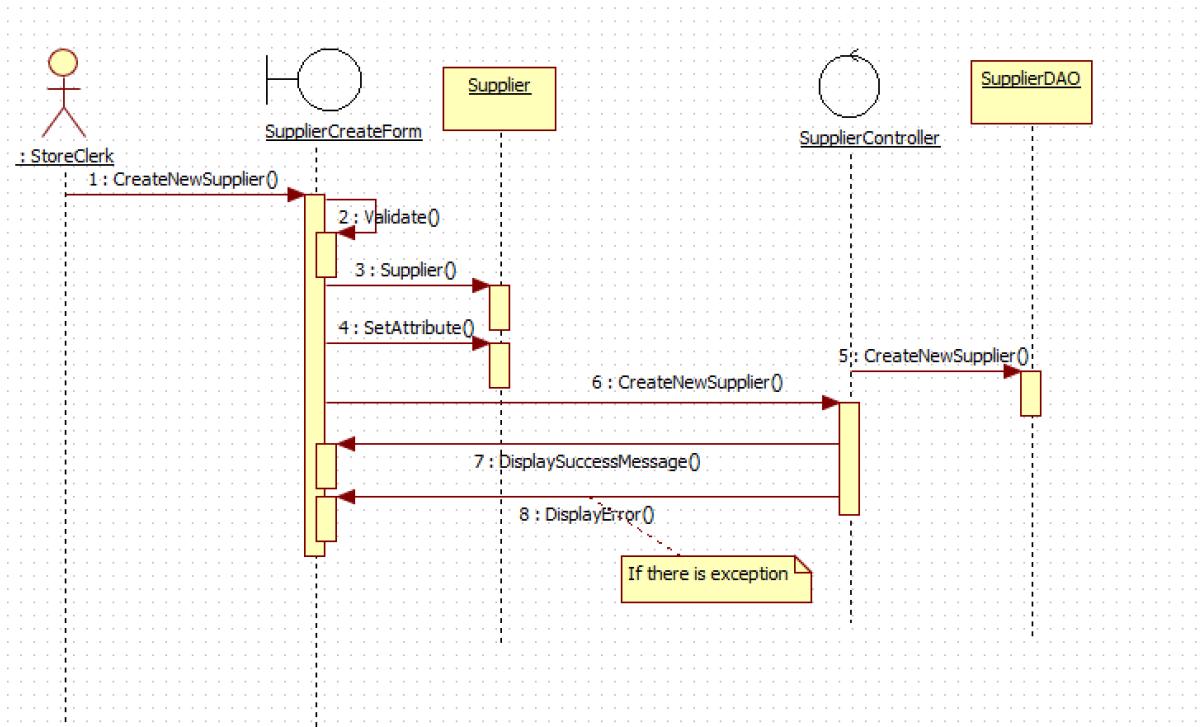
2.5.2.10 Update Department



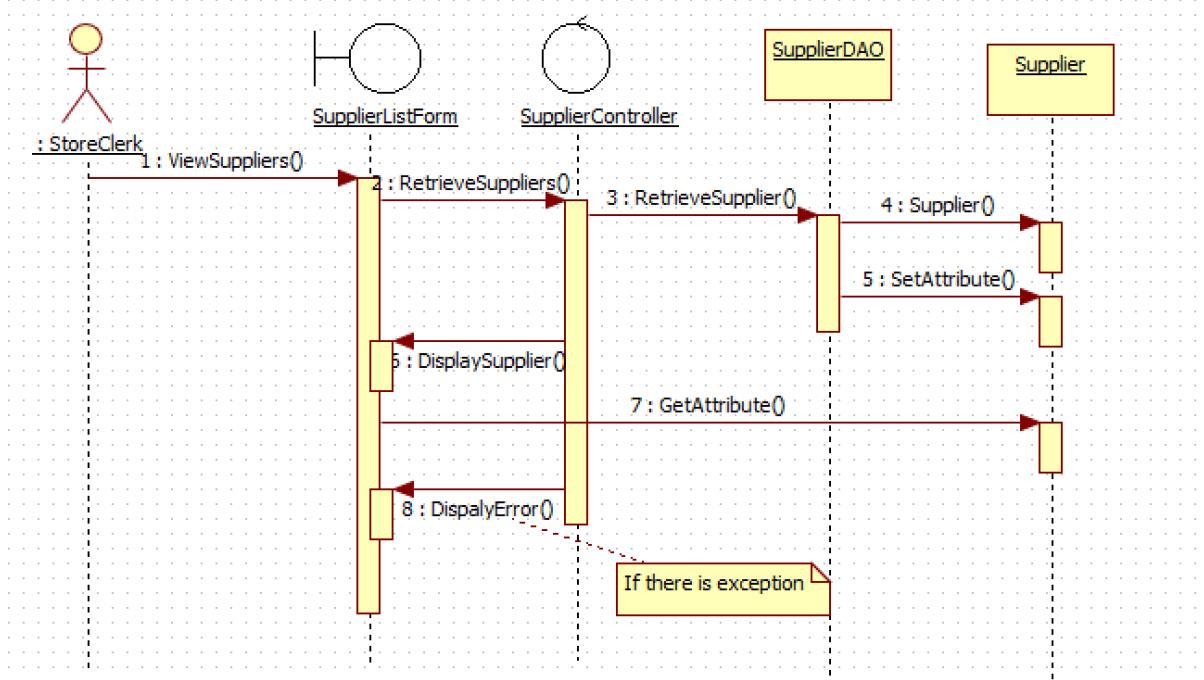
2.5.2.11 Delete Department



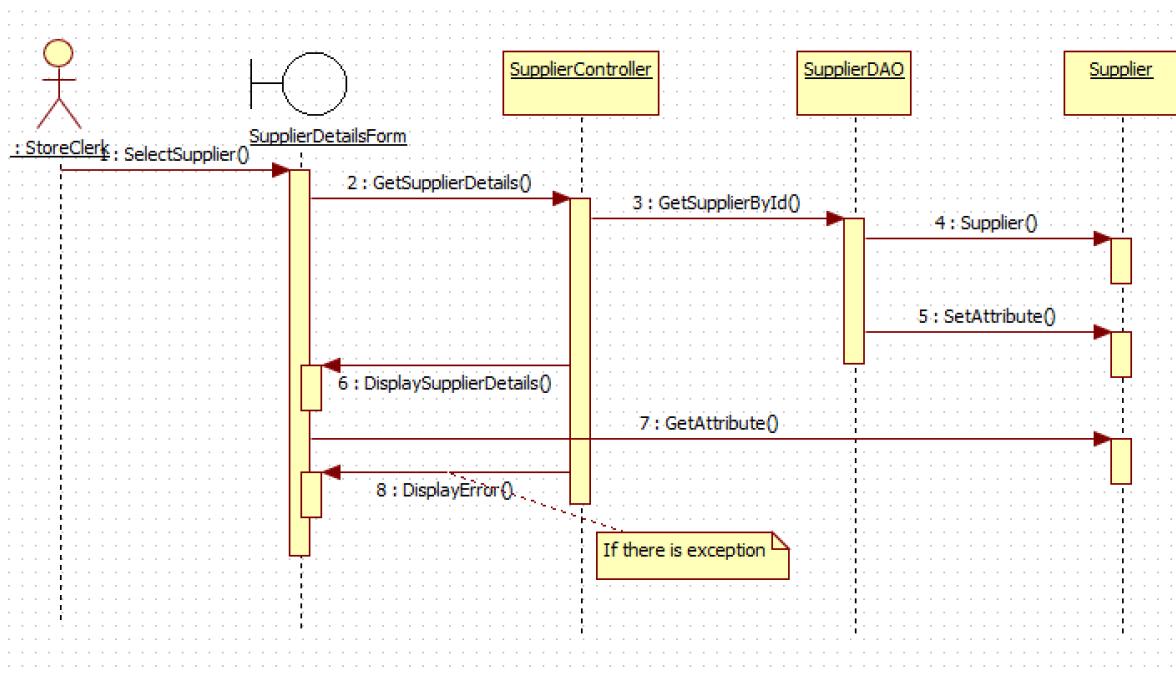
2.5.2.12 Create Supplier



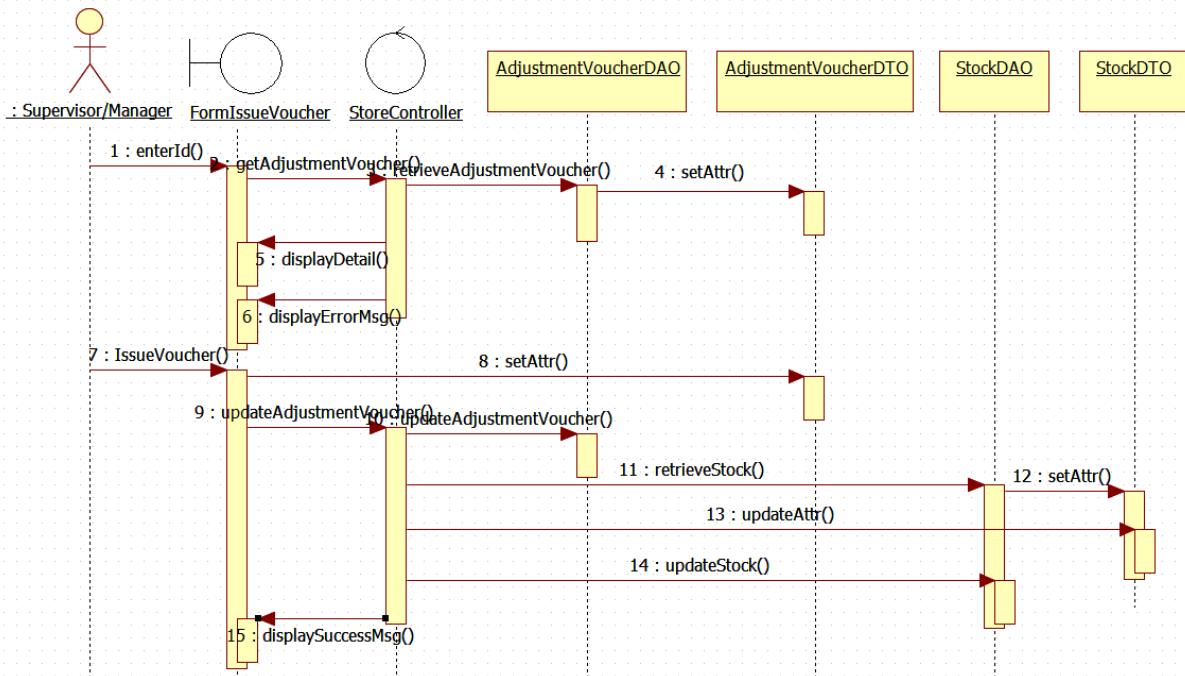
2.5.2.13 Manage Supplier (View Supplier List)



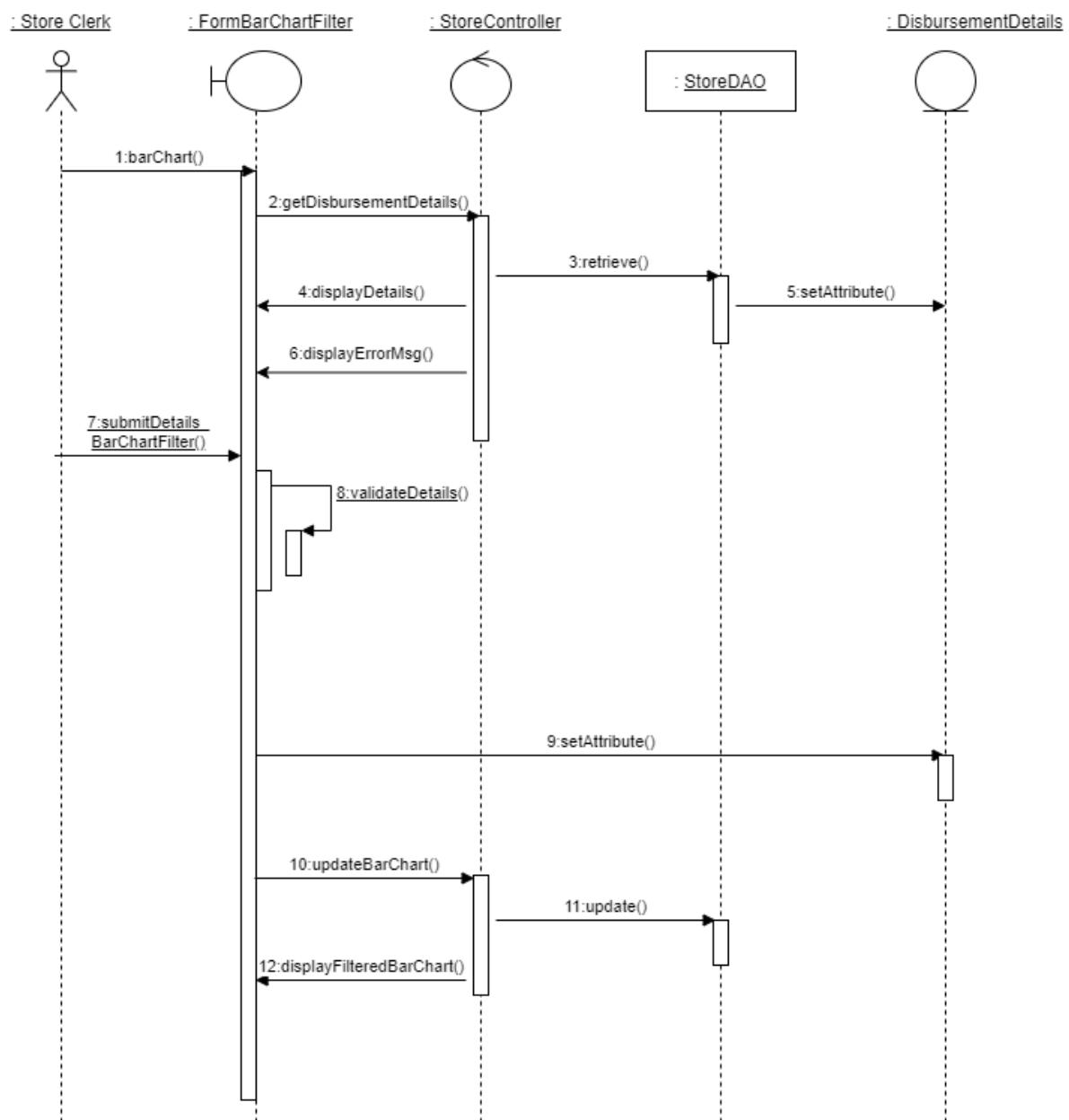
2.5.2.14 View Details of Supplier



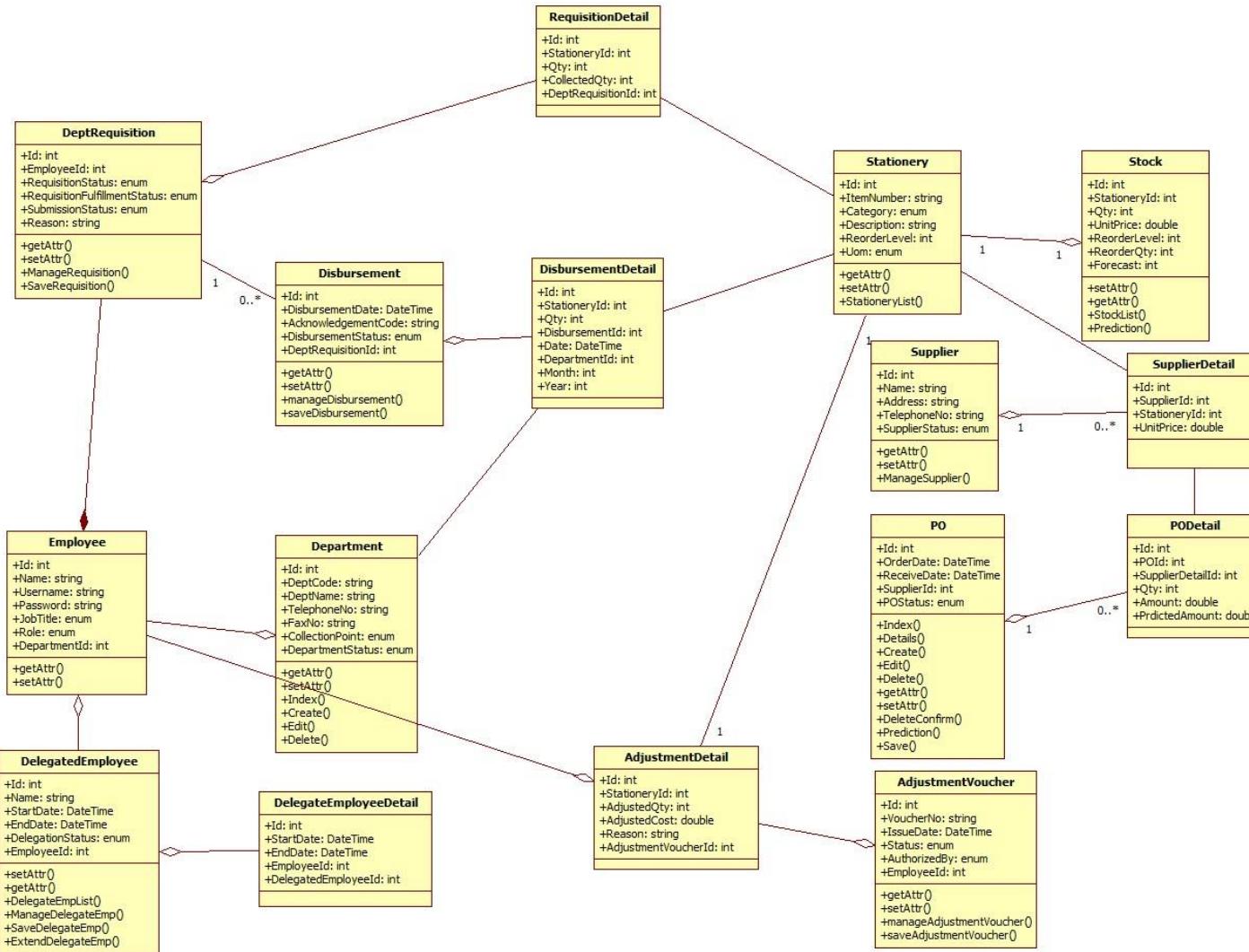
2.5.2.15 Issue Stock Adjustment Voucher



2.5.2.16 View Trend Analysis

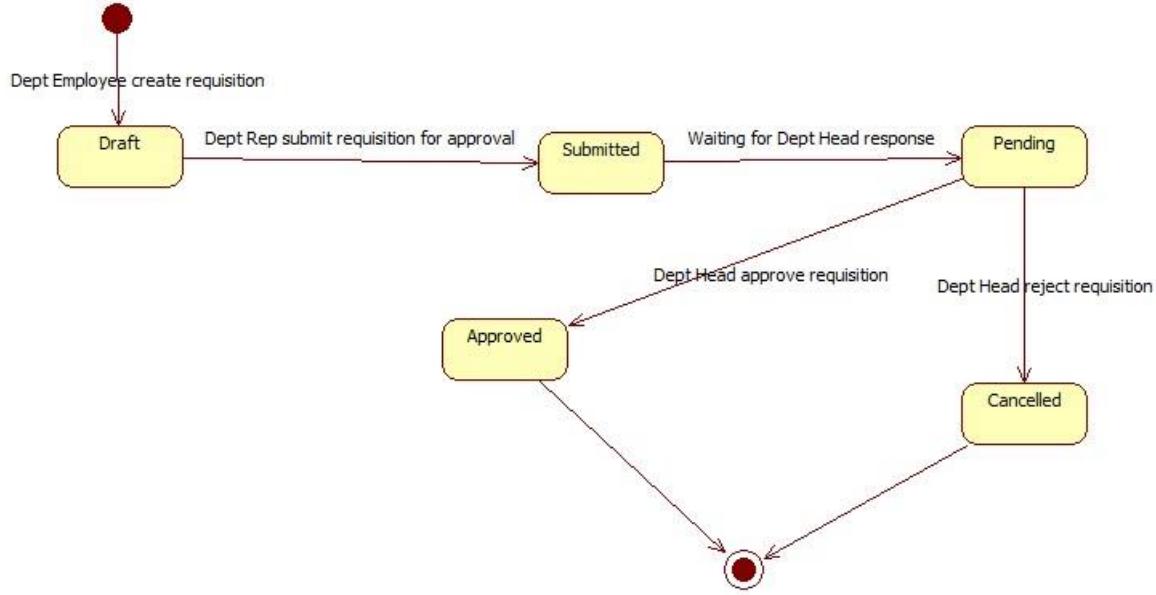


2.6 Consolidated Class Diagram

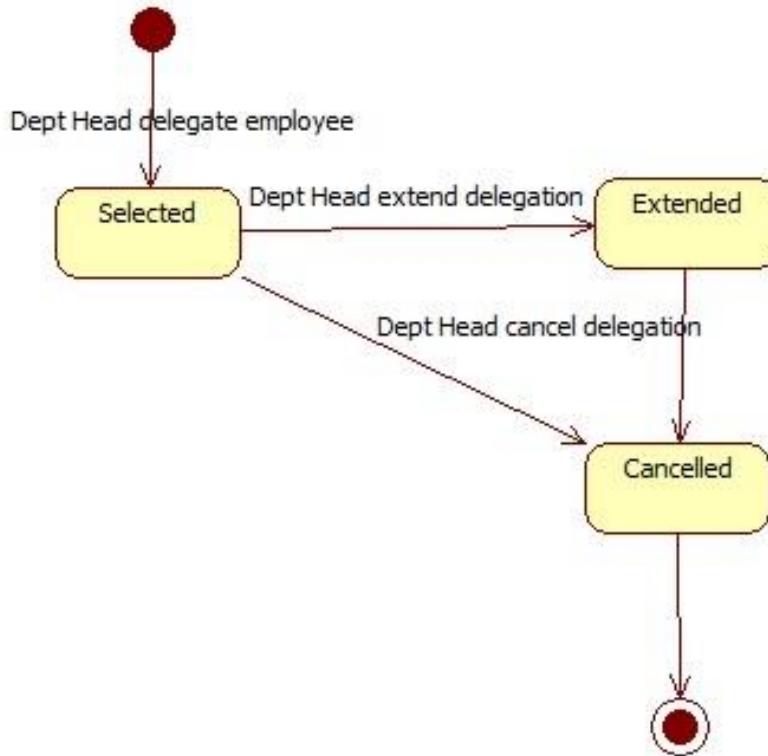


2.7 State Chart Diagram

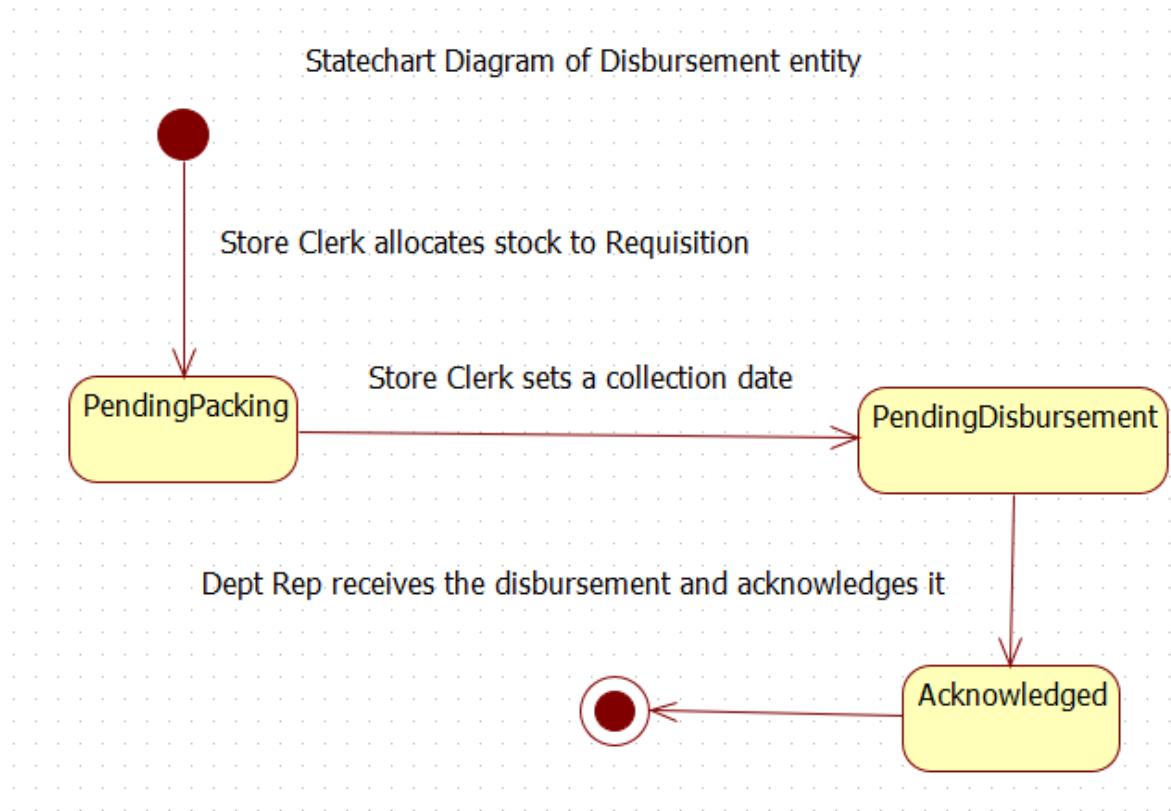
2.7.1 Department Requisition State Diagram



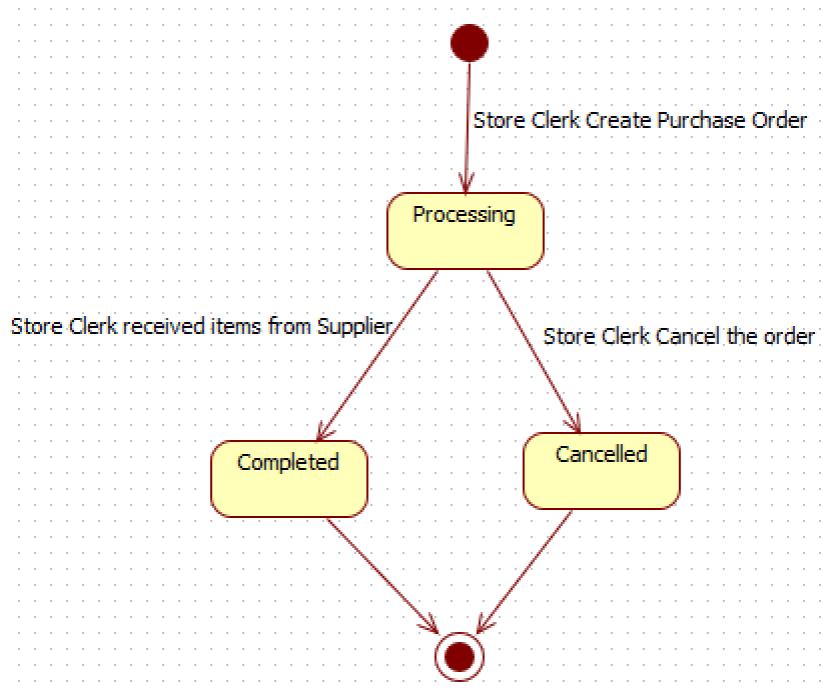
2.7.2 Delegated Employee State Diagram



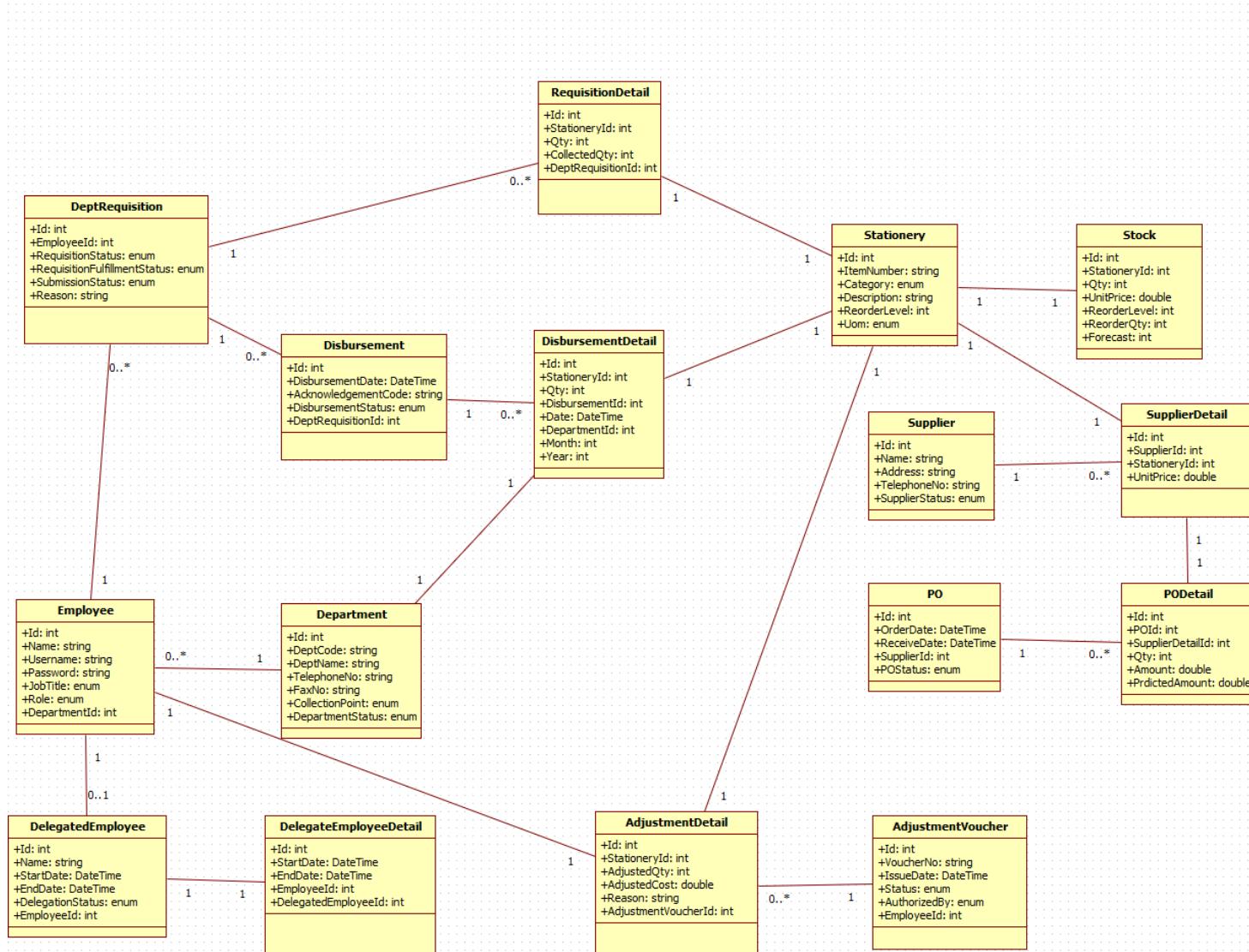
2.7.3 Disbursement State Diagram



2.7.4 Purchase Order State Diagram



2.8 Relational Database Diagram



2.9 Functional Testing For Use Cases

Test Plan 1			
Test Type: Integration			
TestID: 01	Prepare by/date: Ayisha Fathima/ 08-2020	31-	Tested by/Date : Ayisha Fathima / 31-08-2020
Test Description Testing “Raise Requisition Form” as a Department Employee.		Program tested Boundary Class: Login, View Requisition Form Control Class: DeptController Entity Class: DeptRequisition	

Test Data

(1) DeptRequisition table is empty before creation of requisition

Results Messages					
Id	EmployeeId	RequisitionApprovalStatus	RequisitionFulfillmentStatus	SubmissionStatus	Reason
Query executed successfully.					

(2) Employee Requisition List (UI) before creation of requisition

Requisition List Requisition Form		Mrs Pamela Kow Logout	
Employee Requisition List			
Requisition Id	Submission Status	Approval Status	Action

(3) Filling Requisition Form

Requisition Form	
Item Name	Quantity
Transparency Blue	15
Thumb Tacks Large	16
Trays In/Out	17
Shorthand Book (100 pg)	0
Clips Paper Large	0
Envelope Brown (3"x6")	0
Eraser (hard)	0

(4) New record created in DeptRequisition table upon saving of form

Results Messages						
Id	EmployeeId	RequisitionApprovalStatus	RequisitionFulfillmentStatus	SubmissionStatus	Reason	
1	1	0	0	0	NULL	

Query executed successfully. | ASUS (15.0 RTM) | ASUS\NTU Student (55) | BenProject | 00:00:00 | 1 rows

(5) Correct requestor employee info captured (See Id: 3)

Results Messages						
Id	Name	Username	Password	JobTitle	Role	DeptId
1	Mr Timothy	1emp3	nVhtwKSKLjBIOeCml1CJNDjo03ni+kXpToLFs6uwD=	0	0	1
2	Jenny Wong Mei Lin	1deptrep1	/+isROqkkK3u+9WKuUOnz3rZ0vth2BhHg8gaUyNt0=	3	3	1
3	Mrs Pamela Kow	1emp1	nVhtwKSKLjBIOeCml1CJNDjo03ni+kXpToLFs6uwD=	0	0	1

(6) One requisition record now displayed in Employee Requisition List UI

The screenshot shows a web-based application interface for managing employee requisitions. At the top, there is a navigation bar with icons for Requisition List and Requisition Form, and user information (Mrs Pamela Kow, Logout). Below the navigation, the title "Employee Requisition List" is centered. A table below the title displays a single row of requisition data:

Requisition Id	Submission Status	Approval Status	Action
1	Draft	Pending	Details

(7) Correct stationary and correct quantity displayed in UI

The screenshot shows a "Requisition Details" page. At the top, there is a navigation bar with icons for Requisition List and Requisition Form, and user information (Mrs Pamela Kow, Logout). Below the navigation, the title "Requisition Details" is centered. A table below the title lists items with their quantities:

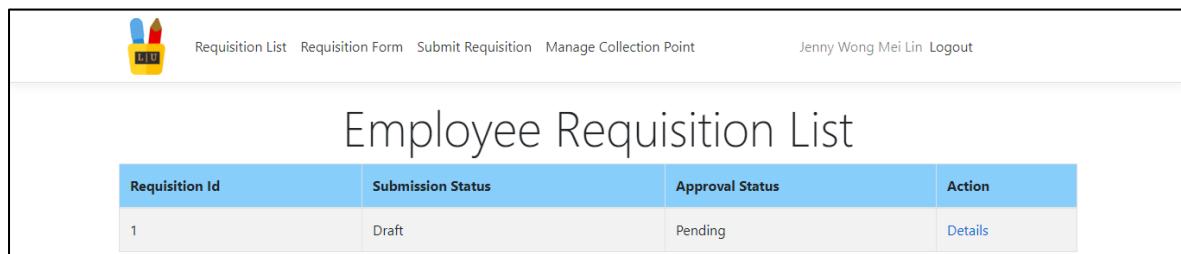
Item Name	Qty
Transparency Blue	15
Trays In/Out	17
Thumb Tacks Large	16

Below the table, there is a field labeled "Reason:".

(8) The above info must also be stored correctly in DeptRequisitionDetails table.

Results Messages						
Id	StationeryId	Qty	CollectedQty	DeptRequisitionId		
1	1	15	0	1		
2	2	22	0	1		
3	3	21	0	1		
20	20	4	0	0	1	
21	21	3	17	0	1	
22	22	2	16	0	1	

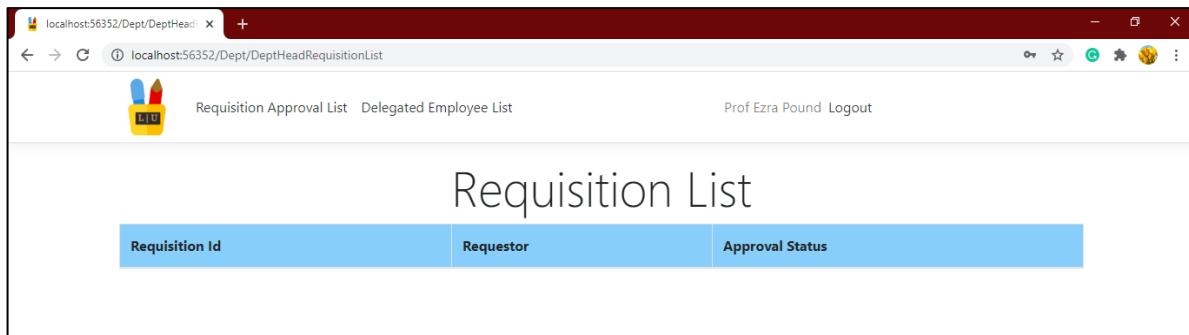
(9) Requisition form is now available for submission and viewing on Department Representative dashboard.



The screenshot shows a web application titled "Employee Requisition List". At the top, there is a navigation bar with links: Requisition List, Requisition Form, Submit Requisition, Manage Collection Point, and a user profile for "Jenny Wong Mei Lin" with a "Logout" link. Below the navigation bar is the main content area with the title "Employee Requisition List". A table displays one record:

Requisition Id	Submission Status	Approval Status	Action
1	Draft	Pending	Details

(10) Requisition should not be visible because department representative has not yet submitted the requisition.



The screenshot shows a web application titled "Requisition List". At the top, there is a navigation bar with links: Requisition Approval List, Delegated Employee List, and a user profile for "Prof Ezra Pound" with a "Logout" link. Below the navigation bar is the main content area with the title "Requisition List". A table is displayed, but it is currently empty:

Requisition Id	Requestor	Approval Status

s/n	Test Step	Expected Result	Actual Result
1	Login as a department employee by entering “1emp1” as username and “emp” as password, then click on “Login” button.	Successfully login as a department employee	As per expected result.
2	Land on Employee Requisition List page – page which displays list of requisitions created by employee	The list should be currently empty.	As per expected result.
3	Click on “Requisition Form” tab to open a requisition form	<ul style="list-style-type: none"> - New requisition form created with all stationary quantity at 0 (since there are no other existing requisitions in draft status) - No new record created in DeptRequisition table in database as form has not been saved yet. 	As per expected result.
4	Fill in required quantity for stationary of preference.	Should not be able to input any quantity below zero.	As per expected result.
5	Click on “Save” to save requisition	<ul style="list-style-type: none"> - Brought to Employee Requisition List Page 	As per expected result.

		- New record created in DeptRequisition table.	
6	Employee Requisition List now shows one requisition record. Click on “Details” to display stationary and quantity selected in previously in the form.	- Submission Status and Approval Status of record should be Draft and Pending respectively.	As per expected result.
7	Stationary and quantity chosen in the form is displayed	- The correct stationary and the correct quantity must be displayed. - The above info must also be stored correct in DeptRequisitionDetails table.	As per expected result.
8	Login as Department Representative.	- Successful login - Requisition submitted by employee must be visible.	As per expected result.
9	Login as Department Head	- Successful login - Requisition should not be visible because department representative has not yet submitted the requisition.	As per expected result.

Test Plan 2																																																																																																																																																																																																												
Test Type: Integration																																																																																																																																																																																																												
TestId: 02	Prepare by/Date: Ngo Vu Hanh Nguyen/30-08-2020		Tested by/Date: Ngo Vu Hanh Nguyen/30-08-2020																																																																																																																																																																																																									
Test Description Testing "Raise new Purchase Order form" as a store clerk.		Program tested Boundary Class: Log_in, View Purchase Order Form Control Class: POController Entity Class: PO																																																																																																																																																																																																										
Test Data <table border="1"> <thead> <tr> <th colspan="7">(1) Employee</th> </tr> <tr> <th>Id</th><th>Name</th><th>Username</th><th>Password</th><th>JobTitle</th><th>Role</th><th>Deptid</th></tr> </thead> <tbody> <tr><td>6</td><td>Mrs Marilyn</td><td>2depthead2</td><td>YJV/BDXwn8SlhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPT=</td><td>1</td><td>1</td><td>2</td></tr> <tr><td>7</td><td>Mrs Lynch</td><td>2deptrep2</td><td>/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=</td><td>3</td><td>3</td><td>2</td></tr> <tr><td>8</td><td>Mr Henry</td><td>2emp1</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>2</td></tr> <tr><td>9</td><td>Mrs Linda</td><td>2emp2</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>2</td></tr> <tr><td>10</td><td>Mrs Lin</td><td>3depthead3</td><td>YJV/BDXwn8SlhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPT=</td><td>1</td><td>1</td><td>3</td></tr> <tr><td>11</td><td>Mr Ong</td><td>3deptrep3</td><td>/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=</td><td>3</td><td>3</td><td>3</td></tr> <tr><td>12</td><td>Mr Ken</td><td>3emp1</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>3</td></tr> <tr><td>13</td><td>Mr Nick</td><td>3emp2</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>3</td></tr> <tr><td>14</td><td>Mr Peter</td><td>4depthead4</td><td>3Qc5D6VDg1vyPobnTgv/fFNAJ7JD7vSNIAscDy8k0zw=</td><td>1</td><td>1</td><td>4</td></tr> <tr><td>15</td><td>Ms Jane</td><td>4emp1</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>4</td></tr> <tr><td>16</td><td>Mr Fury</td><td>3emp3</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>3</td></tr> <tr><td>17</td><td>Ms Kate</td><td>4emp2</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>4</td></tr> <tr><td>18</td><td>Ms Priscilla</td><td>4emp3</td><td>nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=</td><td>0</td><td>0</td><td>4</td></tr> <tr><td>19</td><td>Ms. Kelly</td><td>deptrep4</td><td>/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=</td><td>3</td><td>3</td><td>4</td></tr> <tr><td>20</td><td>Mrs Jane Koh</td><td>storeclerk</td><td>TqnYnML+2MIzrG1MHV6FCDvRZRF8a98OJELL+p8...</td><td>4</td><td>4</td><td>5</td></tr> <tr><td>21</td><td>Mr Gary Lim</td><td>supervisor</td><td>CDTC1gclrFkCJXs7eN0WGTJtHAKQ2/HkfMFk3VuMg...</td><td>5</td><td>5</td><td>5</td></tr> <tr><td>22</td><td>Mrs Marilyn Monroe</td><td>manager</td><td>buSkac1OkQU4R/XT/LYdvMkejw7xC+d0jaTEobo4LR...</td><td>6</td><td>6</td><td>5</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="5">(2) Purchase Order</th> </tr> <tr> <th>Id</th><th>OrderDate</th><th>SupplierId</th><th>POStatus</th><th>ReceiveDate</th></tr> </thead> <tbody> <tr><td>1</td><td>2020-10-10 00:00:00.0000000</td><td>5</td><td>2</td><td>0001-01-01 00:00:00.0000000</td></tr> <tr><td>2</td><td>2020-08-20 00:00:00.0000000</td><td>4</td><td>2</td><td>0001-01-01 00:00:00.0000000</td></tr> <tr><td>3</td><td>2020-08-30 06:58:00.0000000</td><td>1</td><td>2</td><td>0001-01-01 00:00:00.0000000</td></tr> </tbody> </table> <table border="1"> <thead> <tr> <th colspan="5">(3) Purchase Order Details</th> </tr> <tr> <th>Id</th><th>POLd</th><th>SupplierDetailId</th><th>Qty</th><th>prdictedAmount</th></tr> </thead> <tbody> <tr><td>1</td><td>1</td><td>7</td><td>10</td><td>0</td></tr> <tr><td>2</td><td>1</td><td>4</td><td>20</td><td>0</td></tr> <tr><td>3</td><td>2</td><td>6</td><td>10</td><td>0</td></tr> <tr><td>4</td><td>2</td><td>5</td><td>30</td><td>0</td></tr> <tr><td>5</td><td>3</td><td>1</td><td>100</td><td>0</td></tr> <tr><td>6</td><td>3</td><td>9</td><td>100</td><td>0</td></tr> </tbody> </table>	(1) Employee							Id	Name	Username	Password	JobTitle	Role	Deptid	6	Mrs Marilyn	2depthead2	YJV/BDXwn8SlhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPT=	1	1	2	7	Mrs Lynch	2deptrep2	/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=	3	3	2	8	Mr Henry	2emp1	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2	9	Mrs Linda	2emp2	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2	10	Mrs Lin	3depthead3	YJV/BDXwn8SlhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPT=	1	1	3	11	Mr Ong	3deptrep3	/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=	3	3	3	12	Mr Ken	3emp1	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3	13	Mr Nick	3emp2	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3	14	Mr Peter	4depthead4	3Qc5D6VDg1vyPobnTgv/fFNAJ7JD7vSNIAscDy8k0zw=	1	1	4	15	Ms Jane	4emp1	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	4	16	Mr Fury	3emp3	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3	17	Ms Kate	4emp2	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	4	18	Ms Priscilla	4emp3	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	4	19	Ms. Kelly	deptrep4	/+isROqkkK8u+9jWKuUOnz3rZOvth2BhHg8gaUyNlto=	3	3	4	20	Mrs Jane Koh	storeclerk	TqnYnML+2MIzrG1MHV6FCDvRZRF8a98OJELL+p8...	4	4	5	21	Mr Gary Lim	supervisor	CDTC1gclrFkCJXs7eN0WGTJtHAKQ2/HkfMFk3VuMg...	5	5	5	22	Mrs Marilyn Monroe	manager	buSkac1OkQU4R/XT/LYdvMkejw7xC+d0jaTEobo4LR...	6	6	5	(2) Purchase Order					Id	OrderDate	SupplierId	POStatus	ReceiveDate	1	2020-10-10 00:00:00.0000000	5	2	0001-01-01 00:00:00.0000000	2	2020-08-20 00:00:00.0000000	4	2	0001-01-01 00:00:00.0000000	3	2020-08-30 06:58:00.0000000	1	2	0001-01-01 00:00:00.0000000	(3) Purchase Order Details					Id	POLd	SupplierDetailId	Qty	prdictedAmount	1	1	7	10	0	2	1	4	20	0	3	2	6	10	0	4	2	5	30	0	5	3	1	100	0	6	3	9	100	0						
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9	Mrs Linda	2emp2	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2																																																																																																																																																																																																						
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16	Mr Fury	3emp3	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3																																																																																																																																																																																																						
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18	Ms Priscilla	4emp3	nVhtwKSktBIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	4																																																																																																																																																																																																						
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21	Mr Gary Lim	supervisor	CDTC1gclrFkCJXs7eN0WGTJtHAKQ2/HkfMFk3VuMg...	5	5	5																																																																																																																																																																																																						
22	Mrs Marilyn Monroe	manager	buSkac1OkQU4R/XT/LYdvMkejw7xC+d0jaTEobo4LR...	6	6	5																																																																																																																																																																																																						
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s/n	Test Step	Expected Result	Actual Result
1	Login as a store clerk by entering “Username” and “Password”, then click on “Login” button.	Successfully login as a store clerk.	As per expected result.
2	Raise a new Purchase Order by filling out Order Date, Supplier Name, then user can click “Next” to continue create the PO details or click “Back to list” to go back the Purchase Order List	Order Date, Supplier Name are not null (validation).Upon click “Next”, a PO details will be displayed. Or, click “Back to List”, go back to the Purchase Order List	As per expected result.
3	In Purchase Order Details form, all the chosen supplier's items, unit price will be showed. In addition, there is a “predicted Qty” column will be displayed (demand forecast). User inputs Quantity, then click “Submit” to finish creating a Purchase Order.	A new purchase order is created according to Order Date, Supplier, Item Name, Unit Price, Quantity with status “Processing”	As per expected result.
4	In Purchase order List, store clerk can see the POs with status “processing” and “completed”. By clicking “Detail” button, he/she can see the details of the PO.	User can see the raised PO with all details of the PO.	As per expected result.
5	In Purchase Order List UI,a store clerk can delete a PO by clicking “Delete” button, then a confirmation deletion will be displayed , then click “Delete” again, the PO will be deleted.	User can delete a PO with Id and there is also confirmation deletion message.	As per expected result.
6	In Purchase Order List UI, after receiving items from a supplier, store clerk click “Delivery” button, the Received Date will auto update to the current date, then click “Save”, the PO status will be auto changed to “Completed” and Item Quantity will be auto added in Stock Quantity.	User can change PO status to “Completed” by clicking “Delivery” button, the receive date will auto updated to current Date, after click “Save”, Item Quantity will be auto added in Stock Quantity	As per expected result.
7	Logout by clicking logout button on right side bar of the page.	Account logged out, and back to login page.	As per expected result.

Test Plan 3						
Test Type: Integration						
TestID: 03	Prepare by/date: Yeo Jia Hui /30-08-2020				Tested by/Date: Yeo Jia Hui / 30-08-2020	
Test Description Testing “Delegate Employee” as a department head.				Program tested Boundary Class: View Delegate Employee Control Class: Department Controller Entity Class: department Head		

Test Data

(1) Employee Table (Database) – Mrs Pamela Kow Role Id is “0” before delegation

Results		Messages					
	ID	Name	Username	Password	JobTitle	Role	Deptid
1	1	Mr Timothy	1emp3	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1
2	2	Jenny Wong Mei Lin	1deptrep1	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlto=	3	3	1
3	3	Mrs Pamela Kow	1emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1
4	4	Prof Ezra Pound	1depthead1	YJV/BDXwn8SlhkQ4y3F1dm0CUqxfXZQ2yAj6frXPPTE=	1	1	1
5	5	Mrs Margaret	1emp2	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1
6	6	Mrs Marilyn	2depthead2	YJV/BDXwn8SlhkQ4y3F1dm0CUqxfXZQ2yAj6frXPPTE=	1	1	2
7	7	Mrs Lynn	2deptrep2	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlto=	3	3	2
8	8	Mr Henry	2emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2
9	9	Mrs Linda	2emp2	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2
10	10	Mrs Lin	3depthead3	YJV/BDXwn8SlhkQ4y3F1dm0CUqxfXZQ2yAj6frXPPTE=	1	1	3
11	11	Mr Ong	3deptrep3	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlto=	3	3	3
12	12	Mr Ken	3emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3

Query executed successfully. LAPTOP-LCAVGVIK (15.0 RT)

(2) Department Employee UI – before delegation

 Requisition List Requisition Form
Mrs Pamela Kow Logout

Employee Requisition List

Requisition Id	Submission Status	Approval Status	Action

(3) Department Head UI – delegate an employee

 Requisition Approval List Delegated Employee List
Prof Ezra Pound Logout

Delegated Employee List

Create

No	Employee Name	Start Date	End Date	Status	Action
1	Mrs Pamela Kow	30-August-2020	31-August-2020	Selected	Cancel Extend

(4) After delegation, Mrs Pamela Kow Role Id is now “7” after delegation

Results			Messages				
	ID	Name	Username	Password	JobTitle	Role	Deptid
1	1	Mr Timothy	1temp3	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	0	1
2	2	Jenny Wong Mei Lin	1deptrep1	/+isROqkkK8u+9jWKuUOnz3rZovth2BhHg8gaUyNlto=	3	3	1
3	3	Mrs Pamela Kow	1temp1	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	7	1
4	4	Prof Ezra Pound	1depthead1	YJV/BDXwn8SlhkQ4y3FIdm0CUqxfxZQ2yAj6frXPPTE=	1	1	1
5	5	Mrs Margaret	1temp2	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	0	1
6	6	Mrs Marilyn	2depthead2	YJV/BDXwn8SlhkQ4y3FIdm0CUqxfxZQ2yAj6frXPPTE=	1	1	2
7	7	Mrs Lynn	2deptrep2	/+isROqkkK8u+9jWKuUOnz3rZovth2BhHg8gaUyNlto=	3	3	2
8	8	Mr Henry	2emp1	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	0	2
9	9	Mrs Linda	2emp2	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	0	2
10	10	Mrs Lin	3depthead3	YJV/BDXwn8SlhkQ4y3FIdm0CUqxfxZQ2yAj6frXPPTE=	1	1	3
11	11	Mr Ong	3deptrep3	/+isROqkkK8u+9jWKuUOnz3rZovth2BhHg8gaUyNlto=	3	3	3
12	12	Mr Ken	3emp1	nVhtwKSKLBIOeCml1CJNDjo03ni+kXpToLfs6uwDao=	0	0	3

Query executed successfully. I LAPTOP-ICAVGVIK (15.0 RTM)

(5) Department Employee UI – Change in dashboard after delegation

The screenshot shows a dashboard titled "Requisition List". At the top, there are navigation links: "Requisition Approval List", "Requisition List", and "Requisition Form". On the right, there are user details: "Mrs Pamela Kow" and "Logout". Below the title, there is a table header with columns: "Requisition Id", "Requestor", and "Approval Status". The main area is currently empty, indicating no data.

(6) Department Head UI – Extend/Cancel delegation

The screenshot shows a page titled "Delegated Employee List". At the top, there are navigation links: "Requisition Approval List" and "Delegated Employee List". On the right, there are user details: "Prof Ezra Pound" and "Logout". Below the title, there is a table header with columns: "No", "Employee Name", "Start Date", "End Date", "Status", and "Action". A single row is present: "1" for No, "Mrs Pamela Kow" for Employee Name, "30-August-2020" for Start Date, "29-September-2020" for End Date, "Extended" for Status, and "Cancel | Extend" for Action.

The screenshot shows a page titled "Delegated Employee List". At the top, there are navigation links: "Requisition Approval List" and "Delegated Employee List". On the right, there are user details: "Prof Ezra Pound" and "Logout". Below the title, there is a table header with columns: "No", "Employee Name", "Start Date", "End Date", "Status", and "Action". The row from the previous screenshot has been updated: "Cancelled" for Status and "Cancel | Extend" for Action.

(7) After cancellation of delegation, Mrs Pamela Kow Role Id is back to “0”

Results								
	Messages							
	Id	Name	Username	Password	JobTitle	Role	Deptid	
1	1	Mr Timothy	1emp3	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1	
2	2	Jenny Wong Mei Lin	1deptrep1	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlt0=	3	3	1	
3	3	Mrs Pamela Kow	1emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1	
4	4	Prof Ezra Pound	1depthead1	YJV/BDXwn8SIhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPTE=	1	1	1	
5	5	Mrs Margaret	1emp2	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	1	
6	6	Mrs Marilyn	2depthead2	YJV/BDXwn8SIhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPTE=	1	1	2	
7	7	Mrs Lynh	2deptrep2	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlt0=	3	3	2	
8	8	Mr Henry	2emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2	
9	9	Mrs Linda	2emp2	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	2	
10	10	Mrs Lin	3depthead3	YJV/BDXwn8SIhkQ4y3Fldm0CUqxfXZQ2yAj6frXPPTE=	1	1	3	
11	11	Mr Ong	3deptrep3	/+isROqkkK8u+9jWKuUOnz3rZ0vth2BhHg8gaUyNlt0=	3	3	3	
12	12	Mr Ken	3emp1	nVhtwKSKLtbIOeCml1CJNDjo03ni+kXpToLFs6uwDao=	0	0	3	

Query executed successfully.

LAPTOP-LCAVGVIK (15.0 RTM)

s/n	Test Step	Expected Result	Actual Result
1	Login as a department head by entering “Username” and “Password”, then click on “Login” button.	Successfully login as a department head.	As per expected result.
2	Click on “Delegated Employee List” tab to view the list of delegated employees and click on the “create” button to create a new employee delegation. The department head will be able to select a specific employee to delegate authority as well as the start date and end date of delegation. By clicking on the submit button, the delegation will be created.	Successfully created an employee delegation by clicking “Submit” button and an email notification will be sent to the department staff who have been selected for the delegation.	As per expected result.
3	The department head can also choose to click on the “extend” button to extend an existing delegation. The delegated employee list will show the name of the delegated employee, start date and updated end date of the delegation and the status of the delegation will change to indicate “extended”.	Successfully extended the end date of the delegation for the current delegated employee by clicking the “Extend” button. In this scenario, an email notification will be sent to the delegated employee to inform him/her about the extension of the delegation	As per expected result
4	The department head can also choose to click on the “cancel” button to cancel an existing delegation. The delegated employee list will be updated to show that the status of the delegation has been changed to indicate “cancelled”	Successfully cancelled the existing delegation for a current delegated employee by clicking the “Cancel” button. In this scenario, an email notification will be sent to the delegated employee to inform him/her about the cancellation of the delegation	As per expected result

5	Logout by clicking the “logout” button on the top right-hand corner of the page.	Account logged out and routed back to login page.	As per expected result.
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3. Recommendations

The current optimization and future improvements/recommendations:

3.1 Current Optimization

The current system has been optimized with:

- Cloud, HTTPS Encryption and Optimization Performance
- Algorithmic Efficiency
- Readability and Minimize Repetition of Codes
- Optimization of Performance and Memory Consumption with WOW64

Cloud Optimization

For this project, HTTPS encryption was configured with domain as Google will penalize sites that don't have HTTPS and this also prevents MITM(Man-in-the-middle) attacks (Chapendama,2018).

Cloud was also preferred and used rather than using Local Area Network(LAN) for the safety of the staffs and flexibility to work from home during the Covid-19 situation. Access our cloud deployed web app here:

<https://alogicuniversity.nusteamfour.online/>

Algorithmic Efficiency

For this project, algorithmic code optimization was implemented as commented in source code for Store Controller for several functions like BarChartFilter() and StoreClerkDisbursementDetailsListApi(). Source codes were mostly O(n) and foreach/ for loops were preferred over recursion as loop iteration uses same time complexity like recursion but with less space. Recursion uses more space.

For maximum efficiency, resource usage was minimized with time and space complexity where algorithms are compared to see the efficiency based on how long the algorithm takes to complete and space where how much working memory of RAM is needed by the algorithm.

Algorithmic efficiency is a property of an algorithm which is related to the amount of computational resources used by the algorithm. An algorithm is analysed to determined resource usage and the algorithm efficiency measured with the different resource usage (Algorithm Efficiency | MIT Teaching and Learning Laboratory., 2020).

Readability and Minimize Repetition of Codes

For this project, under the source code, for example, the ASP.NET MVC project has the Services folder which contains .cs codes for email and qtyprediction to be used for other functions in the controllers to minimize code repetition and enhance readability of codes.

Optimization of Performance and Memory Consumption with WOW64

For this project, 32-bit was used to enable applications to run faster on Cloud Windows VPS system. 32-bit application usually use less memory than the equivalent 64-bit application as the 64-bit versions use 64-bit values and use twice of the space.

Windows uses WOW64(Win32 or Win64) subsystem, effectively works as a 32-bit Windows mini-emulator on x64 systems is a full emulator on Itanium(IA64) systems. The additional size affects application start-up, shutdown times and other activities that will access disk drives. Therefore, 32-bit applications generally will run faster. 32-bit may use more memory but can be faster than 64-bit application (Performance and Memory Consumption Under WOW64 - Win32 apps.,2018).

3.2 Future Improvements

- CI/CD with JIRA
- Hotlink Protection

[CI/CD with JIRA](#)

In the future, for DevOps, CI/DI will be implemented with JIRA into this project for efficient issue tracking and project management.

In DevOps and Agile(methodology), a continuous and automated delivery is the backbone to ensure fast and reliable delivery possible. Requires proper continuous integration and delivery(CI/CD) tools (*Best 14 CI/CD Tools You Must Know / Updated for 2019.*, 2019).

Jira software can foster collaboration across DevOps teams and Jira bug issue and tracking tool allows DevOps to fix issues and deliver value timely, overall, facilitating efficient project management (*Jira / Issue & Project Tracking Software / Atlassian.*, 2020).

[Hotlink Protection](#)

Hotlink protection will restrict HTTP referrers to prevent others from embedding assets on other sites. Hotlink protection also saves bandwidth by prohibiting other sites from displaying the company's(*Logic University*) images (*What Is Hotlinking? - KeyCDN Support.*, 2020).

4. Lessons Learned

- Need to improve user requirement gathering. That is, we need to make the most out of each interview and session with the user to get a clear picture of what the user wants and how it will benefit them. This includes asking them more details about how they carry out certain tasks and what their pain points regarding those tasks. We should also very clearly reiterate to them our understanding of their needs (during the interview itself not just in charter) so that both parties are on the same page.
- Pair/ Trio programming proved to be very helpful during development stages as team members could program more efficiently and it was a great opportunity for everyone to learn new things from each other.
- Clearly defining each other's task every day during the stand-up meeting proved to be very helpful in preventing duplication of work (which could lead to waste in time and effort)
- Learnt how to be more resourceful in searching for articles online (E.g. using the right keywords and constantly identifying which sites are more informative and reliable)

5. Problems and Solutions

- Conflicts during merge which could corrupt or override other members' codes
 - Version control and tracking of history in git, using options such as branching in the event one is not sure of changes made and occasionally saving working drafts locally as well. Generally, we also need to work on how proficient we are in using GitHub.
- Issues were encountered on many instances when we were working with datatype ENUM. Enum made some controller methods and code for view in HTML pages more complicated.
 - Familiarised ourselves with the methods that could manipulate ENUM into other data types so that we could find easier ways to transfer ENUM data.
- Implementing API endpoints in ASP.NET Core
 - Our teammate Ben spent weeknights and weekends researching extensively on forums such as StackOverflow and developer blogs and then shared his knowledge with us
- Implementing logic in Android to consume JSON data from API endpoint
 - Again, our teammate Ben had done extensive research on this
- Time Management
 - Flexible and proactive working – if there is backlog and someone is free to help, they assist in the task as each scrum member is cross functional. No one strictly does only the tasks they are assigned to. Pair programming was also implemented to improve productivity.

6. Looking back

Looking back, this project was a very enriching experience for all us. Some of the decisions we made put us on the right track while some others may have created obstacles for us. Regardless, we greatly value the experience and lessons learnt.

Making the most out of user interviews to gather user requirements better and better time management (so that there is more time to discover bugs or change functionalities if we had misinterpreted certain requirements) are some of the things we would have done differently.

Other than that, we worked well as a team and was always eager to gain any new knowledge that could help our project. We certainly embarked on this project with the right attitude and hope to continue doing so in our future projects.

7.0 Azure Machine Learning Documentation

Introduction

Logic University faces several issues pertaining to stocks that requires inventory supply planning and control. With Machine Learning to automate the demand forecasting, predicting demands to fulfil orders is simplified, able to process larger datasets , and predicts with higher accuracy to prevent over/under-stocking compared to the traditional and tedious way to plan and control supply and demand orders.

Issues

- Although there is a pre-defined re-order stock level, items are often under-stocked and unable to fulfil demands from departments.
- The existing stocks in inventory deplete too fast before the reordered stocks arrive, and, as a result, many departments are unsatisfied and complain. This means the inventory is not sufficiently stocked and planned to bolster for current or future demands.
- The store clerk also takes too long to consolidate stationery requests, information and documents are stored in several places, making it difficult to retrieve and track information quickly.

Solution

- Machine Learning Demand Forecasting Automation to reduce forecasting errors by 70-90%
- Machine Learning Demand Forecasting Automation to reduce time taken to do demand forecasting and stock planning by 95-97% compared to traditional and manual methods of calculations which are also heavily influenced by human decision/bias.
- Technology Enhanced Supply Chain Management will lead to an improved accuracy that aims to predict and fulfil the demands of customers and ensure inventory is not over/under-stocked to facilitate efficient warehouse space management
- The computerisation of the stationery store inventory functions, consolidation of Orders from Departments and Purchase Orders to Suppliers
- Storing documents and information as e-copy on MSSQL and Cloud so it is easy and fast to retrieve and track

Demand Forecasting and Supply Chain Management

Demand forecasting is a basic component of inventory, demand and supply planning and control, impacting competitiveness and profitability, providing important information for purchasing decisions, stock levels, logistics, finance and warehouse inventory space and cost management.

Traditional Predictions

Biases and systematic errors in demand forecasting are frequent in supply chain decision-making process when human factors and personal judgement are involved (Arvan et al.,2018). In addition, human decisions may become difficult when complex forecasting models are used because they may need many variables to produce greater accuracy, calling for the need for support from automated tools (Puchalsky et al., 2018).

Levelling up Demand Forecasting with Machine Learning and Automated Technology

Demand forecasting is a field of predictive analytics that predicts the demands of customers through analysing statistical data and identifying patterns and correlations. Machine Learning takes the practice to a higher level, improving the accuracy and reducing forecasting errors by 70-90% in supply chain management compared to traditional predictions (Tarallo, E. et al, 2019).

Business Challenges and Demand Forecasting Importance (Logic University)

A context always exists around customer behaviour. It can be an upcoming event, holiday, or trend etc. As real product demand varies, businesses may face challenges in:

- 1) Income and profit loss when products are out of stock or a service is unavailable
- 2) Cash tied up in stock or reduced margins that come with getting it out of the warehouse

For Logic University, since real product demand varies, they face challenges in income, profit loss and customer unsatisfaction/complaints as products are frequently out of stock. They also have poor demand and supply planning which means products are always under-stocked or some products may be over-stocked, a consequence of poor inventory management.

Therefore, products that are always under-stocked, will become out of stock which incur profit losses , customer unsatisfaction because they are unable to fulfil customer demands, while over-stocked products unnecessarily increase warehouse space and costs.

Demand forecasting is statistics-heavy and data-rich, which is applicable for machine learning algorithms. The automation of data flows will help to manage logistics and optimize an organization's supply chain, inventory management and performance (Budek, 2018).

Benefits of Demand Forecasting with Machine Learning for Logic University

According Taranenko (2020), Machine learning techniques allow predicting the amount/quantity of products to be purchased during a defined future period. The system will learn from the data for improved analysis and prediction. Compared to traditional demand forecasting methods, machine learning forecasting can:

- Accelerate and handle large data processing quickly
- Provide higher accuracy of forecast
- Adapt and update forecasts based on more recent data
- Improve Supplier Relation Management, by having the prediction of customer demands and quantity of orders, it improves decision making to plan with suppliers to facilitate Customer Relationship Management, ensuring customer demands are met and satisfied on time
- Improves Customer Relationship Management, because customers planning to order something may want the product to be available immediately. Demand forecasting allows predicting which products most likely need to be purchased in the next period, by creating optimal stock and safety stock in inventory for these products, there is immediate and sufficient stock availability for customers, increasing customer satisfaction

Azure Machine Learning Studio

Azure Machine Learning can build advanced analytical solutions and has great documentation to build, deploy and manage which is time and maintenance efficient with the scalability to manage and utilize big data (Azure Machine Learning documentation, 2020).

Azure Machine Learning Studio is a user interface layer with tools for authoring experiments with a palette of available modules, uploading and saving models, datasets user assets, sharing experiments and converting experiments to publish web services and consume at back-end development (Azure Machine Learning documentation, 2020).

For Logic University, **Figure 1** shows the experimental graph and the module palette experiment consisting of a directed acyclic graph connecting several modules. Modules encapsulate the data, machine learning

algorithms, data transformation routines, saved models and user-defined code. Modules are divided into various categories like machine learning and data manipulation etc. Such modules can be referenced from multiple experiments and web services. **Figure 2** shows the predictive experiment graph with added Web Service input and Web Service output to make predictions with Elastic APIs.

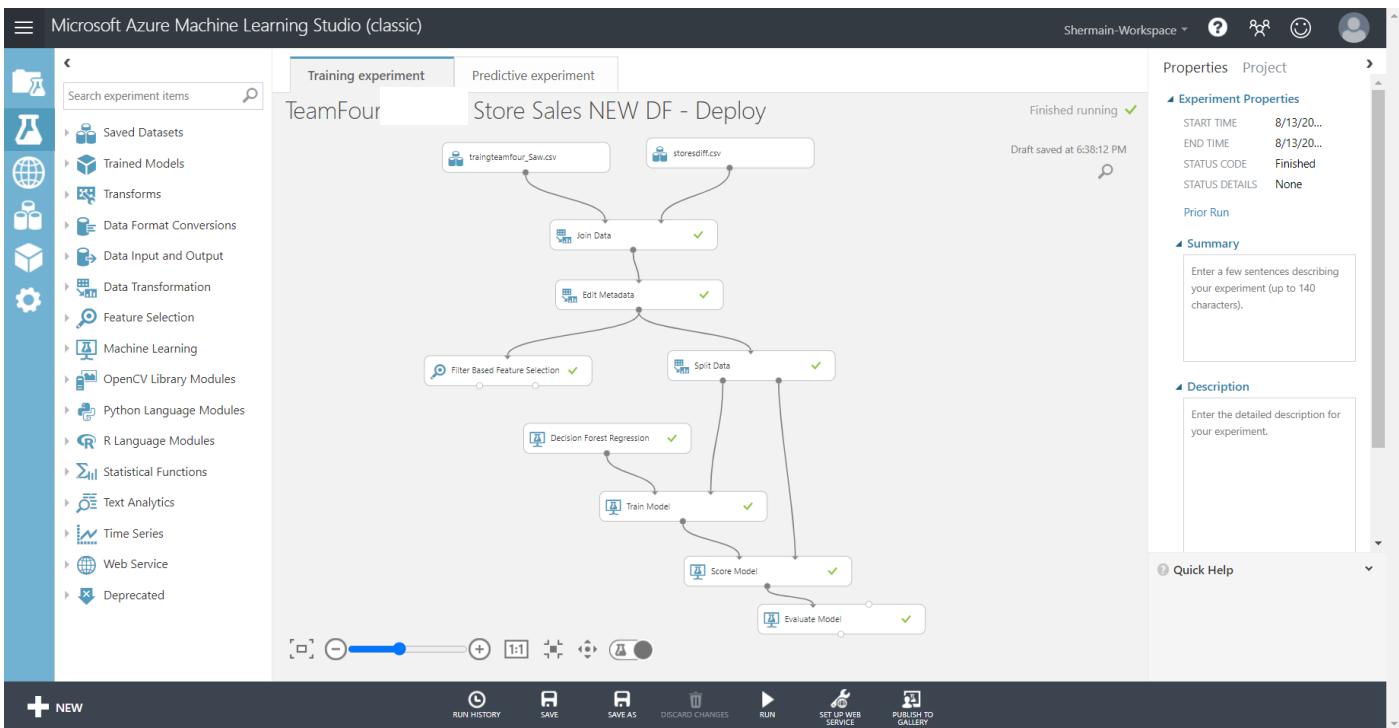


Figure 1: Azure Machine Learning Studio with the Training experimental graph for Demand Forecasting of Logic University

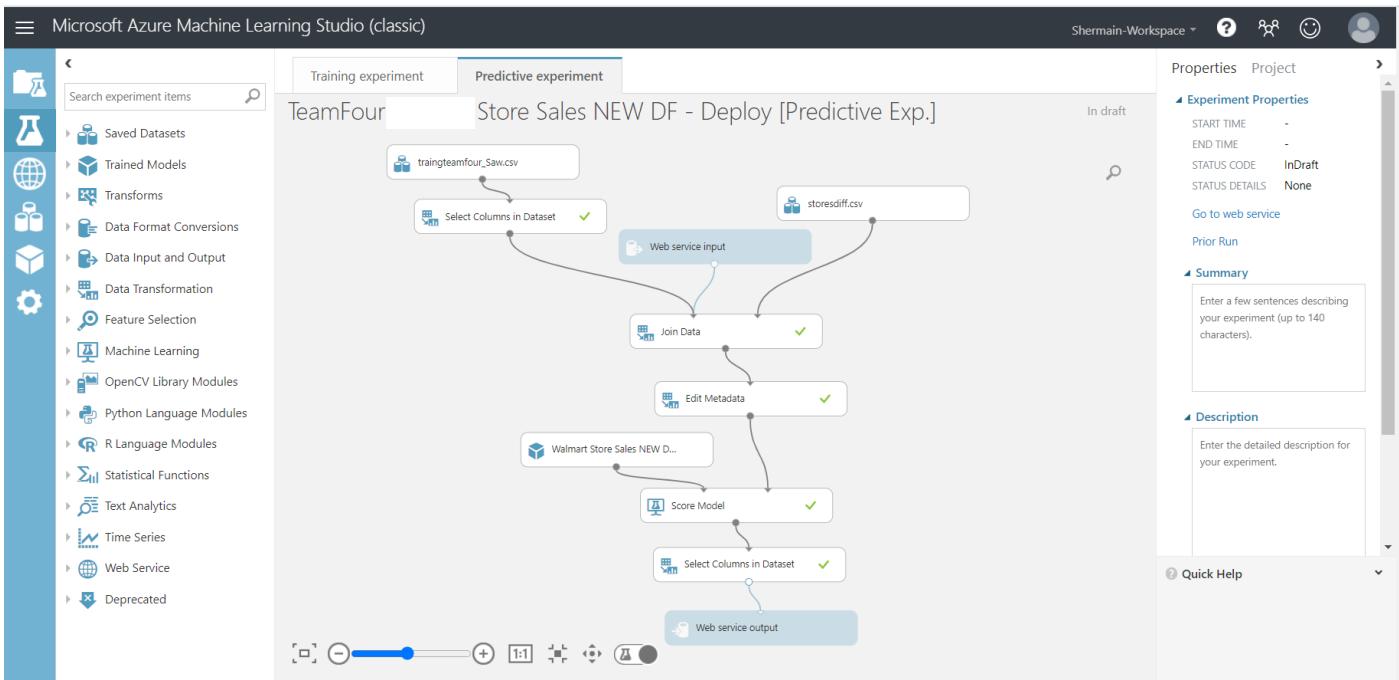


Figure 2: Azure Machine Learning Studio with the Predictive experimental graph for Web Service of Logic University

Process of Building Training Model and Predictive Web Service

Findings and Observations

The lack of data to train test model will affect the accuracy. Accuracy is improved through Data prep processes such as selecting only relevant columns and using Filter Based Feature Selection. Experimenting with different regression algorithms and using Decision forest regression algorithm achieved the best accuracy for the model.

Experimented Regression Algorithms:

- Bayesian Linear Regression
- Boosted Decision Tree Regression
- Linear Regression
- Decision Forest Regression (final)
- Random Forest Regression
- Neural Network Regression

An experiment comprises of datasets that provide data to analytical modules, which are connected to construct the predictive analysis model. One can use data from one or more sources, transform and analyse data through various data manipulation and statistical functions to generate result sets. The process is iterative. As one modifies the various functions and parameters, the results converge until a trained and effective model has been built. Then the training experiment can be converted to a predictive experiment which is then published as a web service so the model and Elastic APIs can be accessed (*ML Studio (classic): Deploy a web service - Azure , 2017*).

Diagram 1 displays a Capabilities Overview of Azure Machine Learning Studio.

Figures 3 and 4 show the flow of the experiments with the modules performing different functions, deploy web service and make predictions with Elastic APIs.

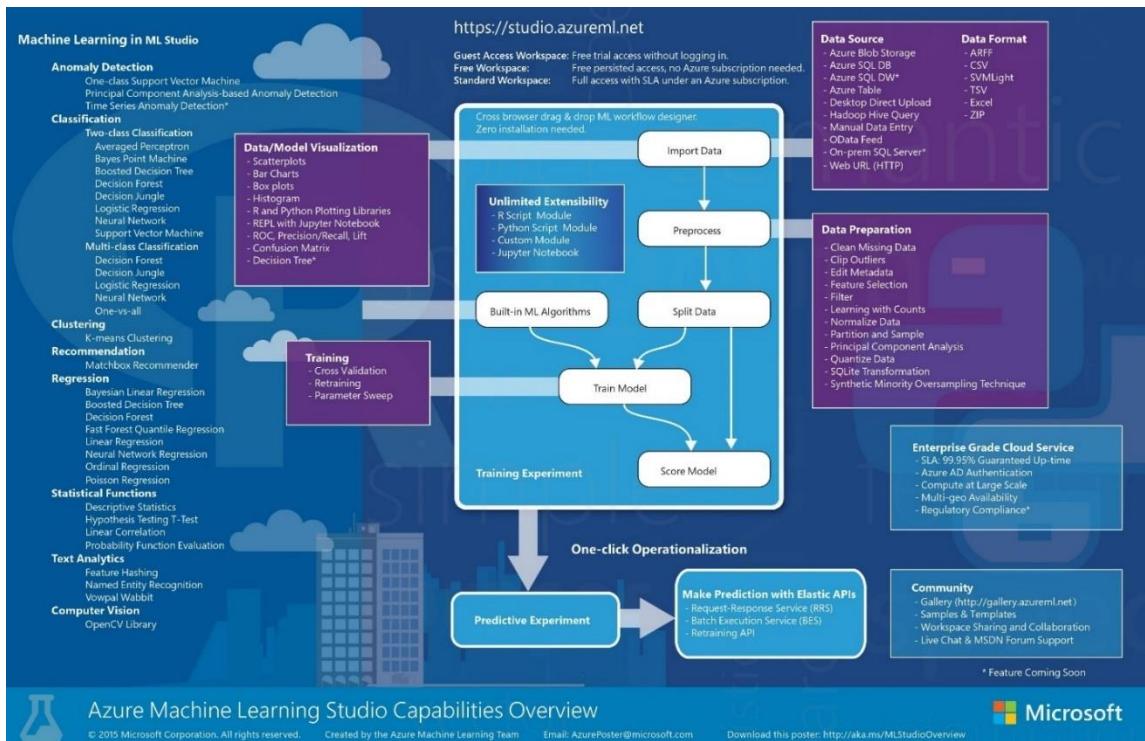


Diagram 1: Capabilities Overview of Azure Machine Learning Studio. Taken from: <https://docs.microsoft.com/en-us/azure/machine-learning/studio/deploy-a-machine-learning-web-service>

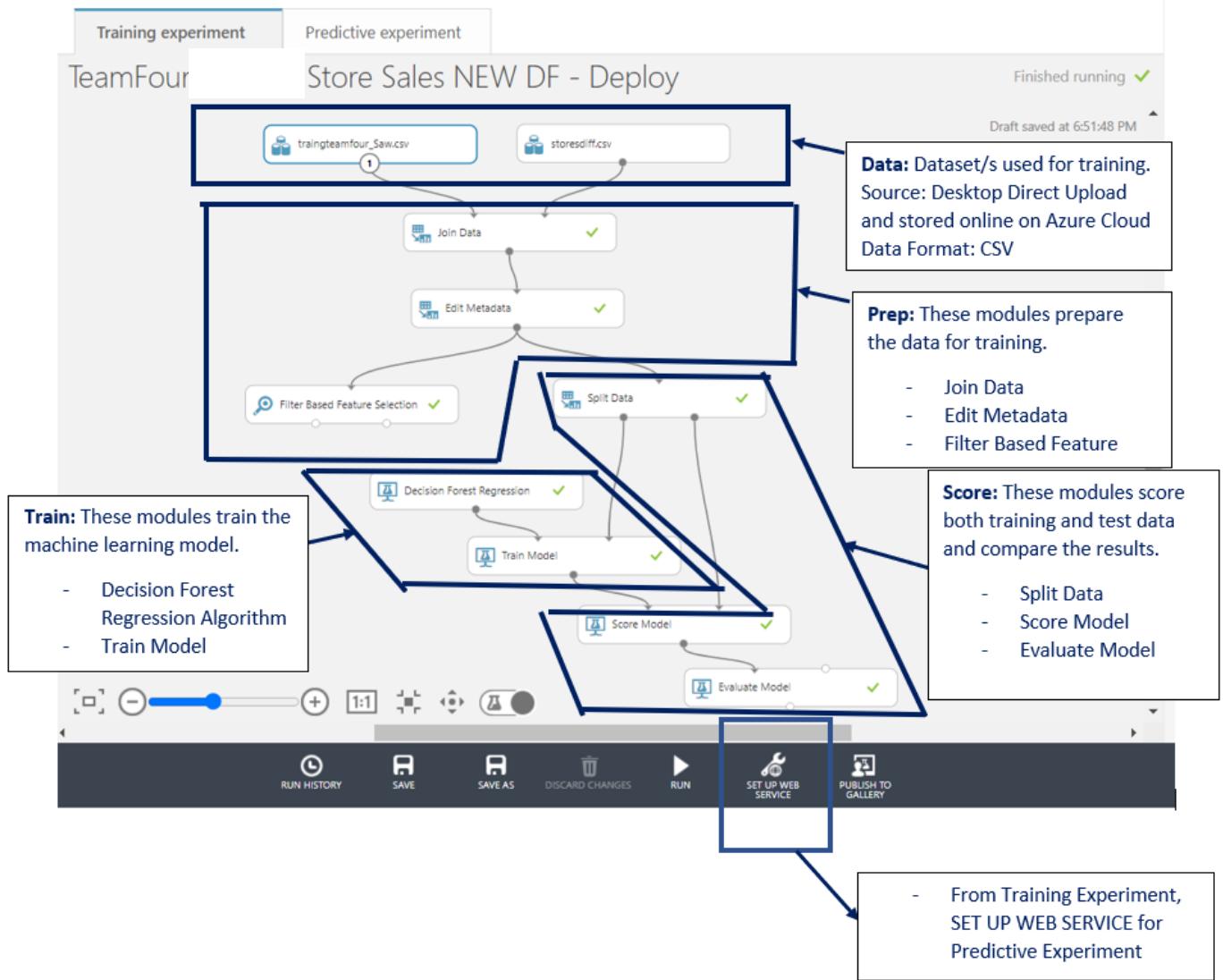


Figure 3: The flow of the Training Experiment modules that perform different functions

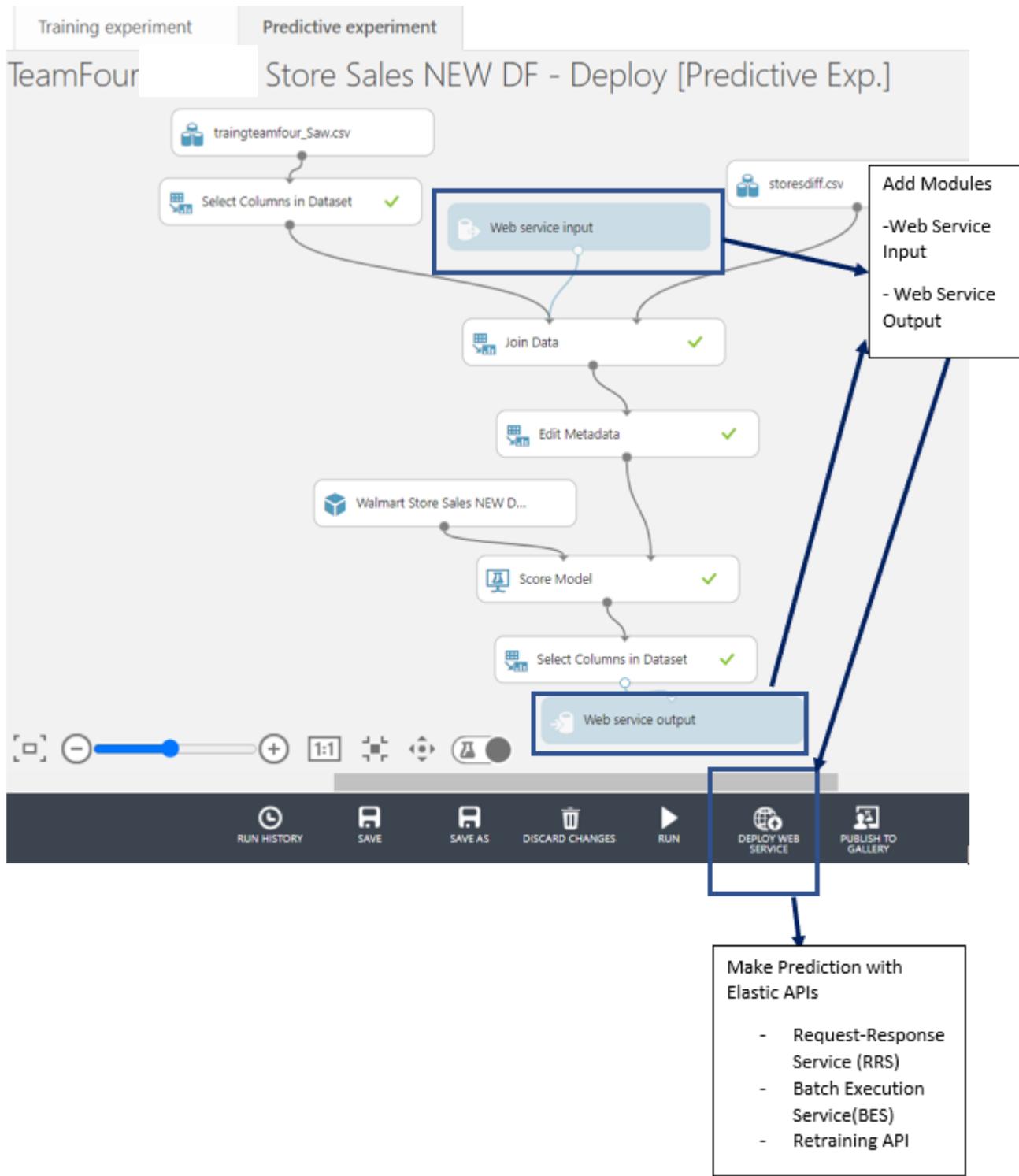


Figure 4: The flow of the Predictive Experiment modules that perform different functions and deploy web service

Test Web Service

After creating a web service. From here, you can easily access both the Test page and Consume page as shown in **Figure 5**. In Logic University ASP.NET project, Request-Response web service was consumed with C# and apiKey is unique in **Figure 6** and **7**.

DASHBOARD CONFIGURATION

General New Web Services Experience [Preview](#)

Published experiment:

- [View snapshot](#)
- [View latest](#)

Description:

No description provided for this web service.

API key:
G+THPwarr2qvfXLEZ3CAgRoUbnTISb/PooHueQQXo2VBmxdoYbVHDlQHuBmgLYH0yclOvbH5hqjmZ08mLUBHg==

Default Endpoint

API HELP PAGE	TEST	APPS	LAST UPDATED
REQUEST/RESPONSE	Test Test preview	Excel 2013 or later Excel 2010 or earlier workbook	8/13/2020 5:06:32 PM
BATCH EXECUTION	Test preview	Excel 2013 or later workbook	8/13/2020 5:06:32 PM

Figure 5 : Web Service , apiKey

```

Request-Response Batch

C# Python Python 3+ R

// This code requires the Nuget package Microsoft.AspNet.WebApi.Client to be installed.
// Instructions for doing this in Visual Studio:
// Tools -> Nuget Package Manager -> Package Manager Console
// Install-Package Microsoft.AspNet.WebApi.Client

using System;
using System.Collections.Generic;
using System.IO;
using System.Net.Http;
using System.Net.Http.Formatting;
using System.Net.Http.Headers;
using System.Text;
using System.Threading.Tasks;

namespace CallRequestResponseService
{
    class Program
    {
        static void Main(string[] args)
        {
            InvokeRequestResponseService().Wait();
        }

        static async Task InvokeRequestResponseService()
        {
            using (var client = new HttpClient())
            {
                var scoreRequest = new
                {
                    Inputs = new Dictionary<string, List<Dictionary<string, string>>> () {
                        {
                            "input1",
                            new List<Dictionary<string, string>>(){new Dictionary<string, string>(){
                                {
                                    "Store", "1"
                                },
                                {
                                    "Dept", "1"
                                },
                                {
                                    "Date", "5/2/2010"
                                },
                                {
                                    "IsHoliday", "false"
                                },
                            }
                        }
                    }
                };
            }
        }
    }
}

```

Figure 6 : Consume Web Service Part 1

```
        },
        GlobalParameters = new Dictionary<string, string>() {
    }
};

const string apiKey = "abc123"; // Replace this with the API key for the web service
client.DefaultRequestHeaders.Authorization = new AuthenticationHeaderValue( "Bearer", apiKey);
client.BaseAddress = new Uri("https://ussouthcentral.services.azureml.net/workspaces/9c7eacb777ca45079d3a311454a48511/services/c
284dfa711c8462488effaa2d008d1f/execute?api-version=2.0&format=swagger");

// WARNING: The 'await' statement below can result in a deadlock
// if you are calling this code from the UI thread of an ASP.NET application.
// One way to address this would be to call ConfigureAwait(false)
// so that the execution does not attempt to resume on the original context.
// For instance, replace code such as:
//     result = await DoSomeTask()
// with the following:
//     result = await DoSomeTask().ConfigureAwait(false)

HttpResponseMessage response = await client.PostAsJsonAsync("", scoreRequest);

if (response.IsSuccessStatusCode)
{
    string result = await response.Content.ReadAsStringAsync();
    Console.WriteLine("Result: {0}", result);
}
else
{
    Console.WriteLine(string.Format("The request failed with status code: {0}", response.StatusCode));

    // Print the headers - they include the request ID and the timestamp,
    // which are useful for debugging the failure
    Console.WriteLine(response.Headers.ToString());

    string responseContent = await response.Content.ReadAsStringAsync();
    Console.WriteLine(responseContent);
}

}
```

Figure 7 : Consume Web Service Part 2 , apiKey

Consume Azure Machine Learning in ASP.NET CORE MVC

With Azure Machine Learning Web Services, an external application (ASP.NET) can communicate with the Machine Learning scoring model in real time with API call. The API call will return the prediction results from the model to the external ASP.NET application.

Azure Machine Learning has two types of services:

Request-Response Service(RRS) and Batch Execution Service(BES). RRS will be used in the ASP.NET Project while BES will be used and tested for the model's accuracy via Excel.

Request-Response Service (RRS)

RRS is a low latency, highly scalable service that provides an interface to the stateless models created and deployed from the Machine Learning Studio. To generate the result, in ASP.NET, a .cshtml razor page is created for the UI and to get the user inputs to pass the parameters from the inputs into the Store Controller.

Cleaner Coding and calling Azure Machine Learning API- QtyPredictionServices.cs

To facilitate cleaner and readable codes, in **Figure 8**, a Services folder is created and the codes from **Figure 6** and **7** are added into QtyPredictionServices.cs in **Figure 9** so the Store controller or any other controllers/functions can call QtyPredictionServices and reduce duplicate codes. In QtyPredictionServices.cs , to make the API service call, we pass the unique API key in **Figure 10**, that was created when the web service was deployed.

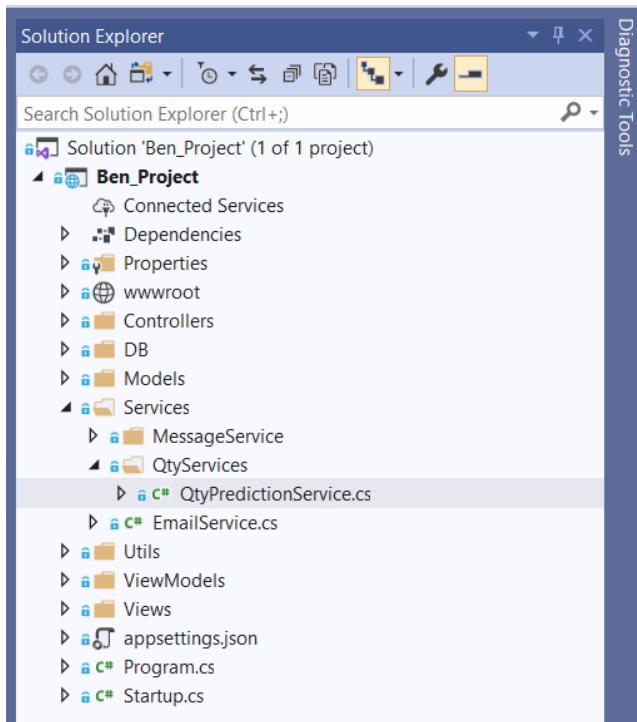


Figure 8: Services, QtyServices

```

1  using System;
2  using System.Collections.Generic;
3  using System.IO;
4  using System.Net.Http;
5  ...
6  using System.Net.Http.Headers;
7  using System.Text;
8  using System.Threading.Tasks;
9  using Newtonsoft.Json;
10 using System.Text;
11 ...
13
14 // This code requires the Nuget package Microsoft.AspNet.WebApi.Client to be installed.
15 // Instructions for doing this in Visual Studio:
16 // Tools -> Nuget Package Manager -> Package Manager Console
17 // Install-Package Microsoft.AspNet.WebApi.Client
18
19 namespace Ben_Project.Services.QtyServices
20 {
21     ...
22     public class QtyPredictionService
23     {
24         ...
25         public async Task<string> QtyPredict(string item_category, string item_ID, string date, string IsHoliday)
26         {
27             using (var client = new HttpClient())
28             {
29                 var scoreRequest = new
30                 {
31                     Inputs = new Dictionary<string, List<Dictionary<string, string>>() {
32                         {
33                             "input1",
34                             new List<Dictionary<string, string>>() { new Dictionary<string, string>() {
35                                 {
36                                     "Store", item_category
37                                 },
38                                 {
39                                     "Dept", item_ID
40                                 },
41                                 {
42                                     "Date", date
43                                 },
44                                 {
45                                     "IsHoliday", IsHoliday
46                                 }
47                             }
48                         },
49                         GlobalParameters = new Dictionary<string, string>()
50                         {
51                             ...
52                         }
53                     }
54                 };
55
56                 const string apiKey = "G+THPwarr2qvfXLEZ3CAGRoUbnTISb/PooHueQOxo2Vmxdx0ybVHD1QHuBmgLYH0ycIOvbH5hqmZ08mLUBHg=="; // Replace this with the API key for the web service
57                 client.DefaultRequestHeaders.Authorization = new AuthenticationHeaderValue("Bearer", apiKey);
58                 client.BaseAddress = new Uri("https://ussouthcentral.services.azureml.net/workspaces/9c7earcb777ca45079d3a311454a48511/services/c284dfa711c8462488effaea2d008d1f/execute?api-version=2");
59
60                 // WARNING: The 'await' statement below can result in a deadlock
61                 // if you are calling this code from the UI thread of an ASP.NET application.
62                 // One way to address this would be to call ConfigureAwait(false)
63                 // so that the execution does not attempt to resume on the original context.
64                 // For instance, replace code such as:
65                 //     result = await DoSomeTask()
66                 // with the following:
67                 //     result = await DoSomeTask().ConfigureAwait(false)
68
69                 //HttpResponseMessage response = await client.PostAsJsonAsync("", scoreRequest);
70
71                 HttpResponseMessage response = await client.PostAsync("", new StringContent(JsonConvert.SerializeObject(scoreRequest), Encoding.UTF8, "application/json"))
72                 .ConfigureAwait(false);
73
74                 if (response.IsSuccessStatusCode)
75                 {
76                     string result = await response.Content.ReadAsStringAsync();
77                     return result;
78                 }
79                 else
80                 {
81                     return string.Format("The request failed with status code: {0}", response.StatusCode);
82                 }
83             }
84         }
85     }
86 }

```

Figure 9: Part 1_QtyPredictionService.cs with QtyPredict and Parameters (string item_category, string item_ID, string data, string isHoliday)

```

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88

```

Figure 10: Part 2_QtyPredictionService.cs with apiKey

Cleaner Coding and calling Azure Machine Learning API- Razor View (.cshtml)

On Azure Machine Learning, the Testing User Interface as shown in Figure 11. As reference to **Figure 11**, we create a similar User Interface with Razor View in ASP.NET in **Figure 12**. **Figure 12** contains a form that when PredictionBtn is submitted, the data - item_category, item_ID, date, isHoliday goes to the logic, IActionResult Prediction(string item_category, string item_ID, string date, string IsHoliday) in the Store Controller of **Figure 13**.

The logic will process, and check whether there is enough stock or need to order. Each input also contains validation to ensure no null empty fields, inputs requiring string can only accept string and inputs requiring int can only accept int value.

The screenshot shows the Azure Machine Learning Testing User Interface. At the top, there is a navigation bar with links: Quickstart, Dashboard, Batch Request Log, Configure, Consume, **Test** (which is underlined), and Swagger API. Below the navigation bar, the word "default" is displayed. On the right, there is a green button labeled "View in Studio (classic)".

The main area is titled "Request-Response" and "Batch". It features two sections: "input1" and "output1".

input1:

- Store:
- Dept:
- Date:
- IsHoliday:

output1:

- Scored Label Mean: 200.78052962179

At the bottom left, there is a green button labeled "Test Request-Response". At the bottom right, there is a Microsoft logo and links to FAQ, Privacy and Cookies, Terms of Use, and © Microsoft.

Figure 11: Azure Machine Learning Testing User Interface

```

<p style="color:red">@TempData["Error"]</p>

<h2>@TempData["Message"]</h2>
<h2>@TempData["result"]</h2>

<form asp-controller="Store" asp-action="Prediction" method="post">
  <table align="center">
    <tr>
      <td>Item Category:</td>
      <td>
        <input id="item_category" name="item_category" value="@ViewData["item_category"]" />
      </td>
    </tr>
    <tr>
      <td>Item ID:</td>
      <td><input id="item_ID" name="item_ID" value="@ViewData["item_ID"]" /></td>
    </tr>
    <tr>
      <td>Date:</td>
      <td>
        <input id="date" name="date" type="date" value="@ViewData["date"]" />
      </td>
    </tr>
    <tr>
      <td>IsHoliday?( write true or false only):</td>
      <td>
        <input id="IsHoliday" name="IsHoliday" type="radio" value="true" />
        "true" &nbsp;&nbsp;
        <input id="IsHoliday" name="IsHoliday" type="radio" value="false" />
        "false"
      </td>
    </tr>
    <tr>
      <td colspan="2" align="right">
        <input id="PredictBtn" type="submit" value="Prediction" />
      </td>
    </tr>
  </table>
</form>

```

Figure 12: Create Razor Form View

The screenshot shows a Visual Studio interface with multiple tabs open. The active tab is 'StoreController.cs' under the 'Ben_Project.Controllers' namespace. The code implements a 'Prediction' action method. It first checks for null values and attempts to parse them into integers. If successful, it retrieves a stock item by ID and checks its current quantity and safety stock level. It then calls a 'QtyPredict' service to get a prediction result. The result is then processed by replacing specific characters ('Results', 'output1', etc.) and rounded to a double. Finally, it compares the calculated quantity with the current stock level to determine if an order should be placed or if there's enough stock, displaying the outcome in TempData['result'].

```
StoreController.cs*  X  StoreController.cs  QtyPredictionService.cs
it
Ben_Project.Controllers.StoreController

return View();
}

0 references | shermanelim, 6 days ago | 1 author, 4 changes
public IActionResult Prediction(string item_category, string item_ID, string date, string IsHoliday)
{
    int number;
    var result5 = int.TryParse(item_category, out number);
    var result6 = int.TryParse(item_ID, out number);

    if (item_category == null || item_ID == null || date == null || IsHoliday == null)
    {
        TempData["Error"] = "Enter the empty fields";
        return RedirectToAction("Index");
    }
    else if (result5 == false || result6 == false)
    {
        TempData["Error"] = "Enter only int fields";
        return RedirectToAction("Index");
    }

    int itemid = Int32.Parse(item_ID);
    Stock stock = _dbContext.Stocks.SingleOrDefault(x => x.Stationery.Id == itemid);
    int safetyStock = stock.Stationery.ReorderLevel;
    int currentStock = stock.Qty;
    var result = new QtyPredictionService().QtyPredict(item_category, item_ID, date, IsHoliday).Result;

    var result2 = result.Replace("Results", "")
        .Replace("output1", "")
        .Replace("Scored Label Mean", "")
        .Replace("{", "")
        .Replace("}", "")
        .Replace(":", "")
        .Replace("[", "")
        .Replace("]", "")
        .Replace("'", 'o')
        .Replace("o", "");

    TempData["Message"] = result2;

    double final = Math.Round(Double.Parse(result2));
    if (((final + safetyStock) > currentStock))
    {
        TempData["result"] = "You should order : " + ((final + safetyStock) - currentStock);
    }
    else if ((final + safetyStock) < currentStock)
    {
        TempData["result"] = "You have enough stock";
    }

    return RedirectToAction("Index");
}

```

Figure 13: Logic in Store Controller

UI to use Demand Forecasting

Figure 14 shows the user interface created from the MVC codes and the inputs need. **Figure 15** shows the user interface for the demand forecasting results. **Figure 16** and **17** shows the user input validation.

The screenshot shows a web browser window titled "Store Index Page - Ben_Project". The URL is "localhost:56352/Store". The page header includes "Ben_Project" and navigation links for "Home", "Dept", "Store", and "Privacy". On the right, there are "Hello, ! Login" and "Logout" links. The main content area is titled "Store Index Page". It contains four input fields: "Item Category" (with value "1"), "Item ID" (with value "2"), "Date" (with value "25/08/2020"), and a radio button group for "IsHoliday?" with "true" selected. A "Prediction" button is located below these fields.

Item Category:	1
Item ID:	2
Date:	25/08/2020
IsHoliday?(write true or false only):	<input checked="" type="radio"/> "true" <input type="radio"/> "false"

Prediction

Figure 14: User Interface: Demand Forecasting Inputs

The screenshot shows a web browser window titled "Store Index Page - Ben_Project". The URL is "localhost:56352/Store". The page header includes "Ben_Project" and navigation links for "Home", "Dept", "Store", and "Privacy". On the right, there are "Hello, ! Login" and "Logout" links. The main content area is titled "Store Index Page". It displays the forecasted value "201.304535808076" and the recommended order quantity "You should order : 151". Below this, there are four input fields: "Item Category" (empty), "Item ID" (empty), "Date" (empty), and a radio button group for "IsHoliday?" with "false" selected. A "Prediction" button is located below these fields.

201.304535808076

You should order : 151

Item Category:	
Item ID:	
Date:	dd/mm/yyyy
IsHoliday?(write true or false only):	<input type="radio"/> "true" <input checked="" type="radio"/> "false"

Prediction

Figure 15: User Interface : Demand Forecasting Results

The screenshot shows a web browser window with the URL localhost:56352/Store. The page title is "Store Index Page". The navigation bar includes links for Ben_Project, Home, Dept, Store, Privacy, Hello, ! Login, and Logout. A red error message "Enter the empty fields" is displayed above a form. The form contains fields for Item Category (two stacked input boxes), Item ID (one input box), Date (date input box with placeholder "dd/mm/yyyy"), and IsHoliday? (radio buttons for "true" and "false"). A "Prediction" button is at the bottom right.

Figure 16: User Interface : Demand Forecasting Validation-1

This screenshot is identical to Figure 16, but the error message "Enter only int fields" is displayed instead of "Enter the empty fields". The rest of the interface and validation logic remain the same.

Figure 17: User Interface : Demand Forecasting Validation-2

Purchase Order (PO) Form with Demand Forecasting

The demand forecasting is integrated to the Purchase Order Form and displays as under the Column "Predicted Quantity" so the store clerk knows the Quantity to order from supplier as shown in **Figure 18**.

The screenshot shows a web browser window with the URL localhost:56352/PO/CreateNext. The page title is "Create Supplier". The navigation bar includes links for Trend Analysis, Requisition, Disbursement, Stocks, Adjustment, P.O., Supplier, Department, and Logout. A logo for Logic University is on the left. The main content area has a table for creating a supplier with columns for Item Name, Unit Price, Predicted Quantity, and Quantity. Two rows are present: one for "Hole Puncher 2" with values 20, 150, and 0; and another for "Highlighter Blue" with values 10, 200, and 0. A "Submit" button is at the bottom left.

Item Name	Unit Price	Predicted Quantity	Quantity
Hole Puncher 2	20	150	0
Highlighter Blue	10	200	0

Figure 18: PO Form with Demand Forecasting

Batch Execution Service(BES) and Testing Accuracy of Model in Excel -Part 1

An asynchronous service that scores a batch for data records. A BES can be executed with Excel. The Excel .xslb is downloaded from Azure Machine Learning. When opening this Excel file, Azure Machine Learning will load (**Figure 19**) to do Batch prediction for many rows. In **Figure 20**, we open another csv file, the csv file that was used to train the model and we copy the columns Store, Dept, Date, Weekly_Sales, Holiday until row 600 to the .xslb Machine Learning Excel in **Figure 19**.

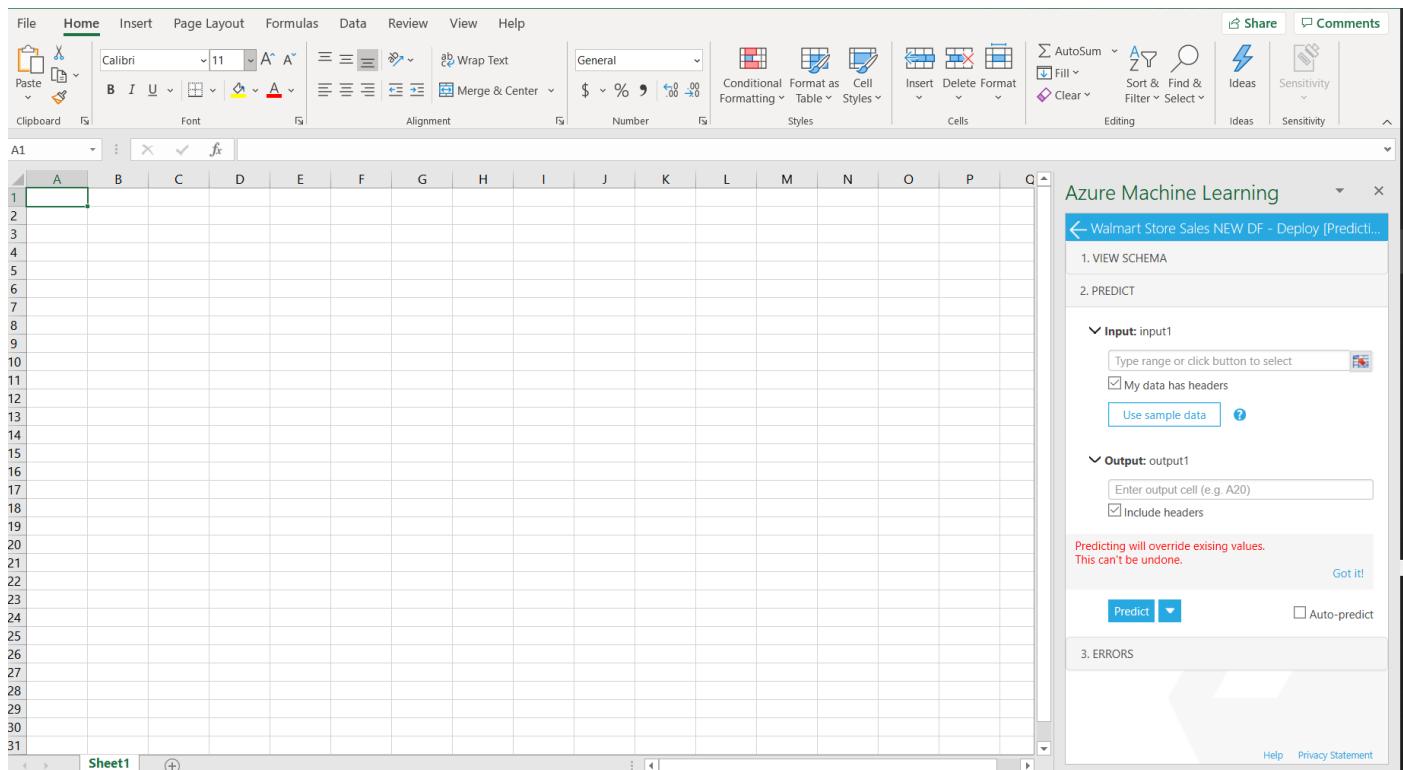


Figure 19: Batch Execution Service with Azure Machine Learning in Excel

	Store	Dept	Date	Weekly_Sales	IsHoliday
2	1	1	5/2/2010	60	FALSE
3	1	1	12/2/2010	285	TRUE
4	1	1	19/2/2010	285	FALSE
5	1	1	26/2/2010	80	FALSE
6	1	1	5/3/2010	115	FALSE
7	1	1	12/3/2010	85	FALSE
8	1	1	19/3/2010	175	FALSE
9	1	1	26/3/2010	325	FALSE
0	1	1	2/4/2010	170	FALSE
1	1	1	9/4/2010	70	FALSE
2	1	1	16/4/2010	245	FALSE
3	1	1	23/4/2010	385	FALSE
4	1	1	30/4/2010	375	FALSE
5	1	1	7/5/2010	40	FALSE
6	1	1	14/5/2010	135	FALSE
7	1	1	21/5/2010	260	FALSE
8	1	1	28/5/2010	250	FALSE
9	1	1	4/6/2010	100	FALSE
10	1	1	11/6/2010	15	FALSE
11	1	1	18/6/2010	175	FALSE
12	1	1	25/6/2010	45	FALSE
13	1	1	2/7/2010	195	FALSE
14	1	1	9/7/2010	280	FALSE
15	1	1	16/7/2010	355	FALSE
16	1	1	23/7/2010	145	FALSE
17	1	1	30/7/2010	330	FALSE
18	1	1	6/8/2010	250	FALSE
19	1	1	13/8/2010	325	FALSE
20	1	1	20/8/2010	310	FALSE

Figure 20: CSV Dataset used to train model

Batch Execution Service(BES) and Testing Accuracy of Model in Excel -Part 2

After pasting the no of rows from the csv sheet that was used to train the model to the .xslb Excel with BES Azure Machine Learning, we only want the inputs from Column A-D (Store, Dept, Date, IsHoliday).

Weekly_Sales from the csv training dataset will not be included in the Prediction as we want the Machine Learning to predict the Weekly_Sales then cross check with the csv training dataset Weekly Sales to obtain the accuracy of the prediction. Weekly_Sales refers to the Ordered Quantity from Departments. The output for the Prediction of Weekly_Sales will be in Column E. We then press the blue button “Predict”.

Figure 21 as shown.

The screenshot shows a Microsoft Excel spreadsheet titled "Sheet1" with data from row 1 to 31. The columns are labeled A through J. Columns A, B, and C contain numerical values (Store, Dept, Date). Column D contains boolean values (IsHoliday). Column E is labeled "Weekly_Sales". The data includes various dates from May to August 2010 and corresponding sales figures like 60, 285, 325, etc., along with some FALSE values in the IsHoliday column.

To the right of the spreadsheet is the "Azure Machine Learning" interface. It shows a "Predictive Experiment" window with the following details:

- Input:** Set to "Sheet1!A1:D600" with the "My data has headers" checkbox checked. There is a "Use sample data" button.
- Output:** Set to "Sheet1!E1" with the "Include headers" checkbox checked.
- Predict:** A large blue "Predict" button.
- Errors:** A section indicating "Predicting will override existing values. This can't be undone." with a "Got it!" link.
- Auto-predict:** A checkbox at the bottom right.

Figure 21: Columns to Predict Azure Machine Learning in Excel

Batch Execution Service(BES) and Testing Accuracy of Model in Excel -Part 3

Azure Machine Learning will generate the Scored Label Mean. Scored Label Mean is the Predicted Weekly_Sales by the Machine Learning. This is shown in **Figure 22**.

Next, we sum up the entire Scored Label Mean from Row 2 to 600 in cell F2. We also sum up the entire Weekly_Sales from Row 2 to 600 in F3. We get the Prediction Accuracy of the model by dividing the sum of the entire Weekly_Sales with the sum of the entire Scored Label Mean, in cell F4 (=F2/F3) and the accuracy results is 96% meaning the prediction accuracy is quite good. This is shown in **Figure 23**.

	A	B	C	D	E	F	G
1	Store	Dept	Date	IsHoliday	Scored Label Mean		Weekly_Sales
2		1	1	5/2/2010	FALSE	199.8458714	60
3		1	1	12/2/2010	TRUE	199.8458714	285
4		1	1	19/2/2010	FALSE	199.8458714	285

Figure 22: Scored Label Mean

	A	B	C	D	E	F	G	H	I
1	Store	Dept	Date	IsHoliday	Scored Label Mean	Prediction Accuracy		Weekly_Sales	
2		1	1	5/2/2010	FALSE	199.8458714	120175.1218	60	
3		1	1	12/2/2010	TRUE	199.8458714	124585	285	
4		1	1	19/2/2010	FALSE	199.8458714	0.964603458	285	

Figure 23: Azure Machine Learning Model Accuracy

Improvements

AutoML- Automated Machine Learning

Automated Machine Learning can automatically select and train Machine Learning models.

Microsoft's AutoML can build a set of Machine Learning models automatically, intelligently select models for training and recommend the best ones based on the Machine Learning problem and data type. Normally, models are manually produced and compared against dozens of models. With AutoML, it can select the right algorithm and help tune hyperparameters(Sue, 2016). AutoML currently supports classification, forecasting and regression problems. This is useful for the forecasting used in Logic University. With AutoML, it saves time, effort while producing excellent results.

AutoML Integration with Azure Machine Learning

AutoML can be used with Azure Machine Learning to optimize model scoring. An automated ML training experiment is designed and run by first identifying the ML problem, specifying the source, and formatting of the labelled training dataset. The compute target for model training and automated ML parameters are then configured (Sue, 2016).

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