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Software Engineering Capstone Project

Urban Waste Collection Aid 2.0

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1 Introduction

The Sustainable Development Goals (SDGs), adopted by United Nations Members in 2015, are a shared blueprint for peace and prosperity for people and the planet, now and into the future. These goals are an urgent call for action for all countries, with an emphasis on strategies that focus on improving health and education, reducing inequality, and spurring economic growth – all while tackling climate change and working to preserve our oceans and forests. Which, particular attention is given to SDG 11: sustainable cities and communities and SDG 6: clean water and sanitation for developing countries. With these goals in mind, we take a look at an urban context, where the solid waste management system yields low results while progressively increase in costs. As an example, currently, in Vietnam, the waste management system is still operated manually with assigned collectors. These collectors are usually assigned to a specific route or a specific area without any consideration for fuel economy or traffic. As a result, the system is proven to be costly and time-consuming. Therefore, our project will be revolving around improving the current waste collection and management system using techniques in the domain of Computer Science.

2 TASK#1

2.1 Problem Statement

In this section, we will represent the context of this project as well as the relevant stakeholders. We also explain their current needs and some problem facing. In the end, we state our opinion on the benefits that UWC 2.0 will deliver to each stakeholder.

2.1.1 Context of the project

In the context of this project, we were provided with a working waste managing system called Urban Waste Collection Aid - UWC: Janitors will take responsibility for gathering the garbage in a small neighbourhood and bring it manually to the major collecting points (MCPs). Collectors will have a specific route to come through the major collecting points and pick up the garbage. Calendar and routes given to teams of janitors and collectors will be coordinated by Back officers. There should be a strong communication line between the back officers and teams of janitors and collectors via messaging. In addition, the system already has a database, consisting of information from version 1.0 of UWC. We will be developing the 2.0 version of UWC, which is contracted to Organization X from Service Provider Y, to improve the efficiency of garbage collection and implement the Task Assignment Module provided in the assignment.

2.1.2 Relevant Stakeholders

- Back officers
- Janitors
- Collectors
- Organization X
- Service Provider Y

2.1.3 Current needs & problems

User story

Traditionally, a collecting team of at least two members, one janitor and one collector, will be assigned to a small area, where they take round trips around that area to collect waste house by house. Janitors want to gather around the neighbourhood quickly and then he will bring it to a specific place for his partner to collect. Collectors want to pick up one time and drive to other collecting points so that they can finish their job faster. Usually, the route is fixed and the truck stop house by house for one person to load up the truck. This system while simple introduces some problems regarding the efficiency and time consumption of the system. Without prior planning, the route might be hard to commute or closed for certain times, therefore, the collector has to waste time in traffic or have to take another route, which. As a result, we recommend a new position - back officers, this position will be able to access an overview of the whole system, including but not limited to collectors, janitors as well as other resources. Based on that information, the back officers should be able to schedule and assign tasks to teams of collectors and janitors effectively. In this project specifically, the back officers have to take into consideration some requirements about the fuel consumption and distance of travel of the vehicles to create and optimize the path taken by the collectors, with clear communication to the teams. In addition, these assignments and tasks will be stored in a database, together with other data from the staff, which can be accessed by a system administrator to be used for further analysis, an example would be to forecast the tasks based on historical analogies.

Needs & problems

Stakeholders	Needs	Problems
Back officers	A platform to assign tasks and communicate with teams of janitors and collectors, view information on available resources	No communications between teams. Cannot assign tasks to teams. Have no view of available resources
Janitors	Being able to receive assigned tasks	
Collectors	Being able to receive assigned routes	
Organization X	Build a suitable solution	Build UWC 2.0 with the specify requirements
Service Provider Y	An improved version of UWC	Improve the system and upgrade and import the old database from UWC 1.0

Table 1: Stakeholder's need and problem

2.1.4 Benefits

In our opinion, UWC 2.0 offers many benefits to the stakeholders. For instance, the back officers will be provided with a functional platform for administrative tasks, which promises better performance, quicker response time, and more direct communication via messages between teams. From the perspective of collectors and janitors, their tasks should be more straightforward and less time-consuming, improving productivity.
To service provider Y, the project introduces many solutions to both current and future issues. An example would be increasing the efficiency of the system by reducing the number of active vehicles and teams or yielding better results in fewer working hours. The data collected might also be instrumental in future developments.
All in all, UWC 2.0 is a suitable automation solution the current waste management system, pushing the industry to a digital future.

2.2 Functional Requirements

In this section, we will represent some functional requirements of the whole system in general and the specific requirements of the operation of back officers. For the ease of referring to particular requirements, we attached each requirement and its group with an identification. Therefore, we can further refer to the identification given to get the function group name or specific requirement description.

General Requirements

Requirement Identification (ID)	Requirement Description
F01	**Register**
F01_01	Users can register with an available valid username and password
F01_02	The system can catch and display any error messages in registering an account
F01_03	The system can save the account information (username, password, etc.) in the database
F02	**Login**
F02_01	Users can log in to the system by the registered account
F02_02	The system can catch and display any error messages in logging in
F03	**Display**
F03_01	The system can display the information of janitors and collectors
F03_02	The system can display the work calendar of janitor teams and collectors
F03_03	The system can display the details of vehicles such as weight, capacity, fuel consumption, etc
F03_04	The system can display the information of all MCPs such as location, capacity, etc

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Requirement Identification (ID)	Requirement Description
F03_05	The system can display the tracking information of each collector
F03_06	The system has language switching setting
F04	**Logout**
F04_01	Users can log out of the system
F05	**Communication**
F05_01	Back officers can communicate with janitors and collectors via messages
F05_02	Janitors and collectors can communicate via messages
F06	**Update information**
F06_01	Users can change/update personal information as well as password
F06_01	The ongoing status of each user should be updated to the system
F07	**Security**
F07_01	The system can verify the long-term inactive user
F07_02	Backup

Table 2: Functional requirements for the general operation of the whole system

Back Officiers Requirements

Requirement Identification (ID)	Requirement Description
F08	**Assignment**
F08_01	The system provides an interface for back officers to assign vehicles to janitors and collectors
F08_02	The system provides an interface for back officers to assign janitors and collectors to MCPs
F08_03	The system provides an interface for creating routes to MCPs

Table 3: Functional requirements for the operation of back officiers

2.3 Non-functional Requirements

In this section, we will represent the non-functional requirements of the system.

Non-functional requirements

Requirement Identification (ID)	**Requirement Description**
NF01	**Operation**
NF01_01	The system should be accessible from any device with a stable internet connection
NF01_02	The system has a user friendly interface
NF01_03	Information should be updated from MCPs every 15 minutes with the availability of at least 95% of their operating time
NF01_04	The system has an interchangeable language setting (Vietnamese - English)
NF01_05	Information of tasks on a daily and weekly basis must be displayed in one view

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Requirement Identification (ID)	Requirement Description
NF02	**Performance**
NF02_01	The system can be accessed at any time (24h/day 365 days/per year)
NF02_02	Assigned route is optimized in terms of fuel consumption and travel distance
NF02_03	Messages are sent with less than a 1-second delay
NF03	**Security**
NF03_01	The system can be accessed with the registered username and password
NF03_02	Meet basic cybersecurity standards (Authentication, Authorization, Data Protection)
NF03_03	Cooldown time when login failed more than 3 times
NF04	**External**
NF04_01	The system must comply with the law of the host government
NF04_02	The system must guarantee that information of a certain employee is private

Table 4: Non-functional requirements of the whole system categorized into several criterion

2.4 Use-case Diagram

In this section, we will represent the use-case study via use-case diagrams of the whole system and task assignment module. We also include the relation between the use cases.

Use-case diagram of a whole system

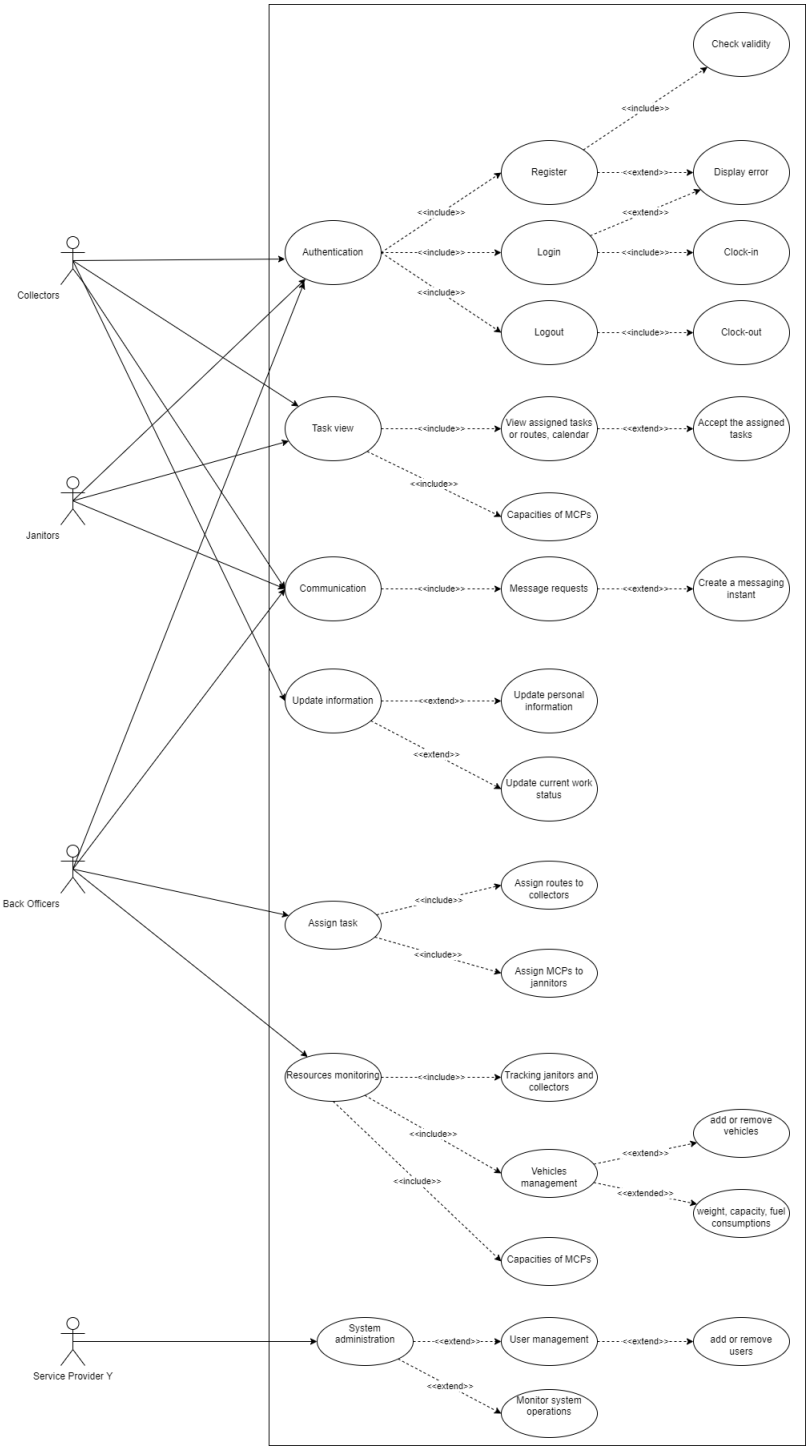

Figure 1: UWC 2.0

Use-case diagram of the task assign module

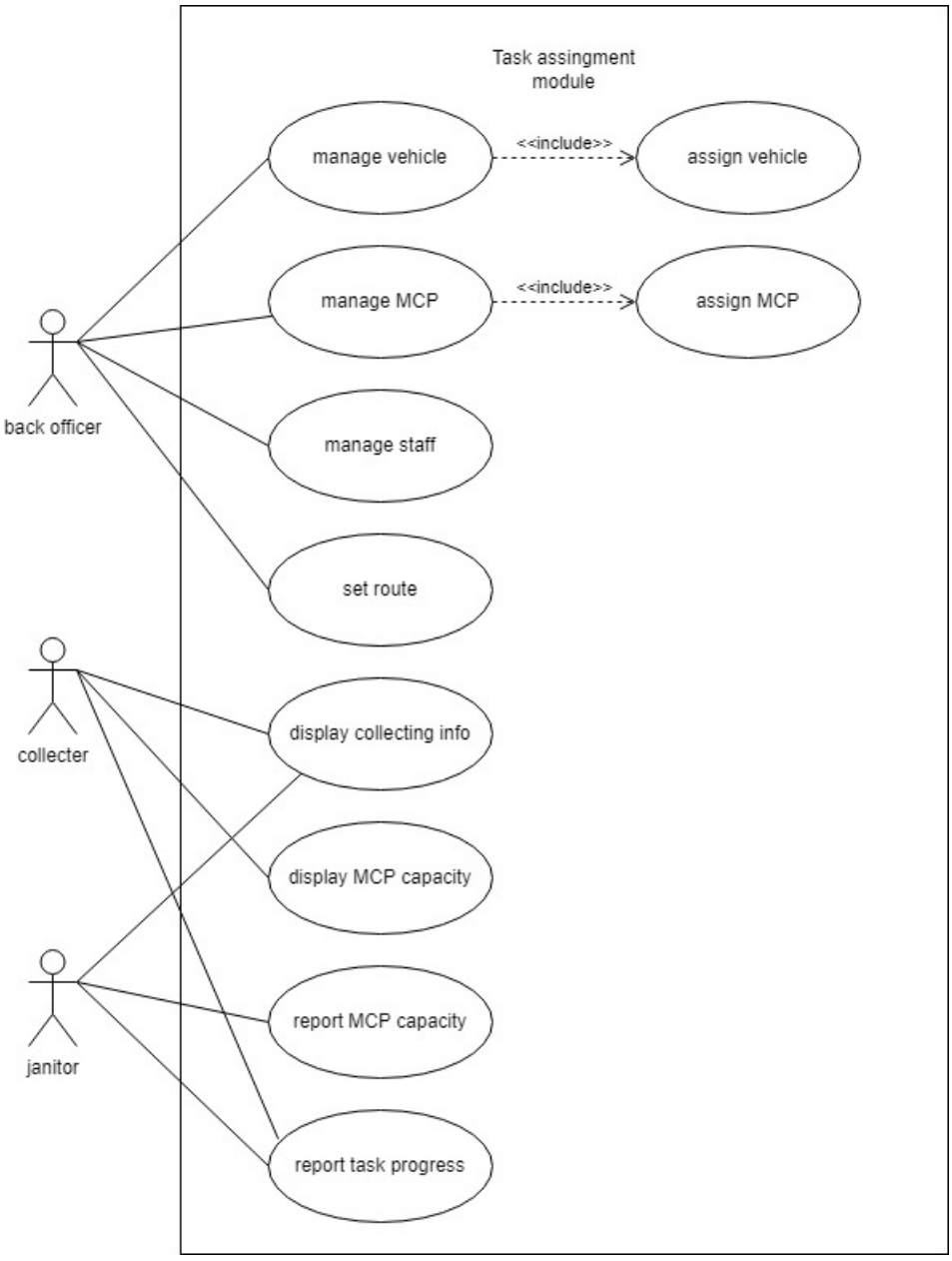

Figure 2: Task Assignment module

Use-case table

Use-case table - Task assign module

Use case ID	UC_01
Use case name	Manage vehicle
Description	View all information of the available vehicle, including capacity, weight, fuel consumption, etc.
Actors	Back officer, database
Trigger	Select the manage vehicle option
Pre-condition	Have access to internet, the database is available for update
Post-condition	Back officer has an overview of the vehicles
Step	1. Select the manage vehicle option
	2. Show all the available vehicles and their technical details
Exception	
Use case ID	UC_02
Use case name	Assign vehicle
Description	Assign appropriate vehicle for collector base on their collecting route
Actors	Back officer, database
Trigger	Select the vehicle assigning option
Pre-condition	Have access to internet, the database is available for update
Post-condition	Each collector get assigned to an appropriate vehicle
Step	1. Select the vehicle assigning option
	2. Check the available vehicles
	3. Assign a vehicle to a collector

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Exception	The assigned vehicle is not suitable for the collector route due to insufficient capacity, fuel consumption, etc, go back to the vehicle menu.
Use case ID	UC_03
Use case name	Manage MCP
Description	View all information of the MCPs, including their location and capacity
Actors	Back officer, database
Trigger	Select the manage MCP option
Pre-condition	Have access to internet, the database is available for update
Post-condition	Back officer has an overview of the MCPs
Step	1. Select the manage MCP option 2. Show the MCPs' details to the back officer
Exception	
Use case ID	UC_04
Use case name	Assign MCP
Description	Assign the janitors to the MCPs
Actors	Back officer, database
Trigger	Select the assign MCP options
Pre-condition	Have access to internet, the database is available for update
Post-condition	Each MCP is assigned to a janitor
Step	1. Select the assign MCP options 2. Choose the MCP location

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	3. Check for available janitors 4. Assign a janitor to the MCP
Exception	1. The chosen MCP is already assigned to a janitor, display an error message 2. Some MCPs are left out with no janitor assigned to, highlight these MCPs and display their locations to the user
Use case ID	UC_05
Use case name	Manage staff
Description	View all general information of the collectors and janitors, including their employee ID number, work schedule, etc
Actors	Back officer, database
Trigger	Select the manage staff option
Pre-condition	Have access to internet, the database is available for update
Post-condition	Back officer has an overview of the collectors and janitors
Step	1. Select the manage staff option 2. Show a list of staff with their general information to the back officer
Exception	
Use case ID	UC_06
Use case name	Set route
Description	To assign and change the route for collectors
Actors	Back officer, database
Trigger	Select the route setting option

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Pre-condition	Have access to internet and map, the database is available for update
Post-condition	A new collecting route is established and assigned to the collectors
Step	1. Select the route setting button 2. Look for collecting routes 3. Assign routes for the collectors
Exception	1. Multiple collector are assigned the same route, display an error message 2. The assigned route might not be available due to traffic or construction, display an error message
Use case ID	UC_07
Use case name	Display collecting info
Description	Display the information to the collectors and janitors, including the assigned route, vehicle, MCP location, collecting schedule, etc
Actors	Collector, janitor, database
Trigger	Select the information display option
Pre-condition	Have access to internet, the database is available for update
Post-condition	The information is delivered to the collectors and janitors
Step	1. Select the information display option 2. Check for the user registered ID number 3. Show the information to the user
Exception	
Use case ID	UC_08
Use case name	Display MCP capacity

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Description	Display the MCP capacity to the collectors
Actors	Collector, database
Trigger	Select the MCP capacity display option
Pre-condition	Have access to internet, the database is available for update
Post-condition	The MCP current capacity is display to the collector
Step	1. Select the MCP capacity display option 2. Choose the MCP location 3. Show the MCP capacity to the collector 4. If the MCP capacity reach a certain amount, collecting is required
Exception	If the MCP capacity does not meet the requirement, the collector can skip that MCP during collecting process
Use case ID	UC_09
Use case name	Report MCP capacity
Description	The janitor reports the MCP capacity to the system for collecting every 15 minutes
Actors	Janitor, database
Trigger	Select the MCP capacity report option
Pre-condition	Have access to internet, the database is available for update
Post-condition	The MCP capacity is reported into the database
Step	1. Select the MCP capacity reporting option 2. Choose the MCP location 3. The janitor report the MCP capacity
Exception	If the janitor does not send an MCP capacity report after 15 minutes, send a notification to the janitor

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Use case ID	UC_10
Use case name	Report task progress
Description	The collector and janitor check in/out their tasks
Actors	Collector, janitor, database
Trigger	Select the report task progress option
Pre-condition	Have access to internet, the database is available for update
Post-condition	The staffs update their working progress to the system
Step	1. Select the report task progress task option 2. Check in/out the assigned task
Exception	

Table 5: Use-case table explaining the diagram of the task assign module

3 TASK#2

3.1 Activity Diagram

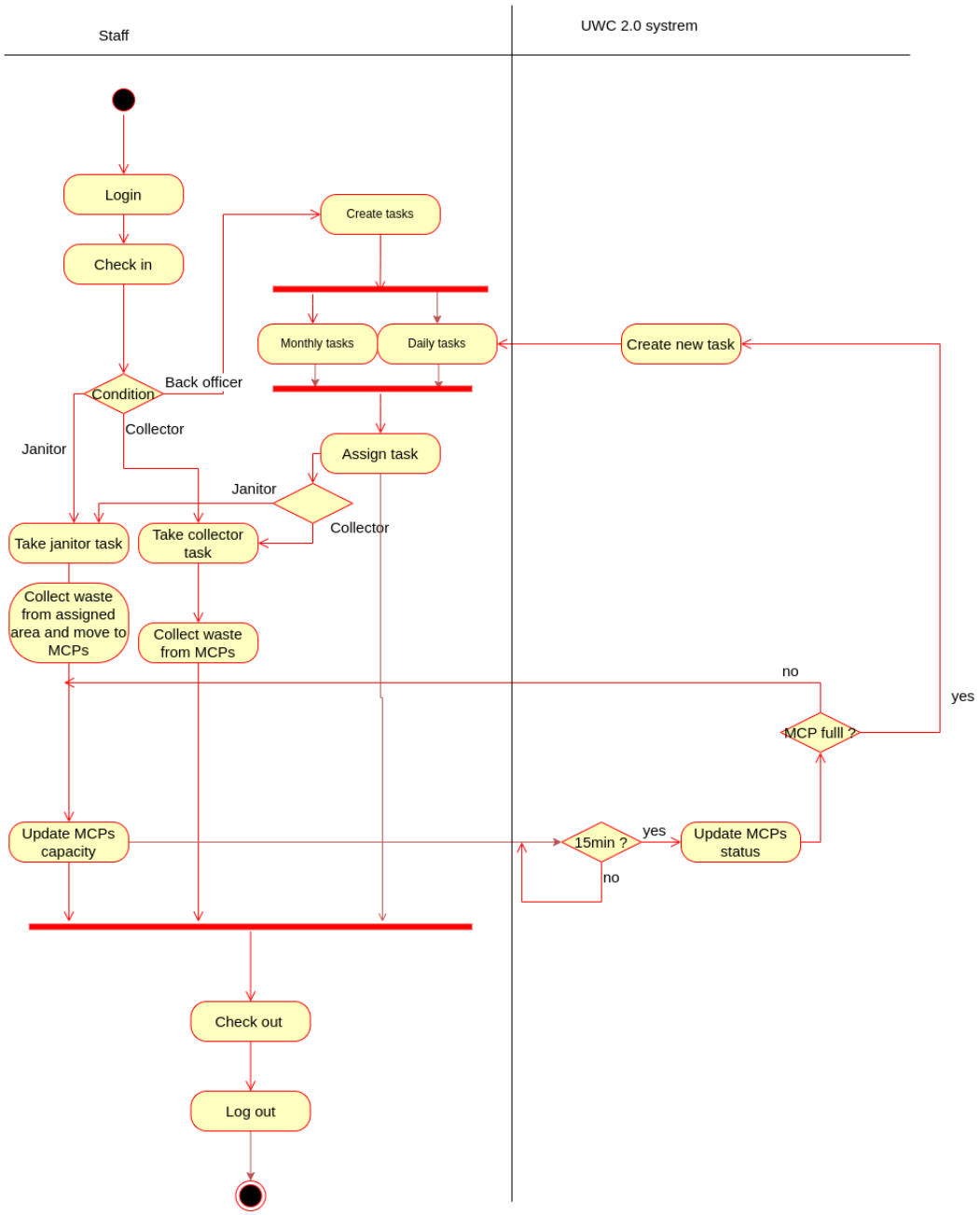

Figure 3: Activity Diagram

The activity Diagram describes how activities are coordinated to provide a service which can be at different levels of abstraction. It is simply an advanced version of a flow chart that models the flow from one activity to another. The activity diagram above captures the dynamic behavior of the business process between systems and the stakeholders in the Task Assignment module which are back-officers, collectors and janitors. This diagram helps you understand the role of each stakeholder in the business and visualize the system model easier.

3.2 Sequence Diagram

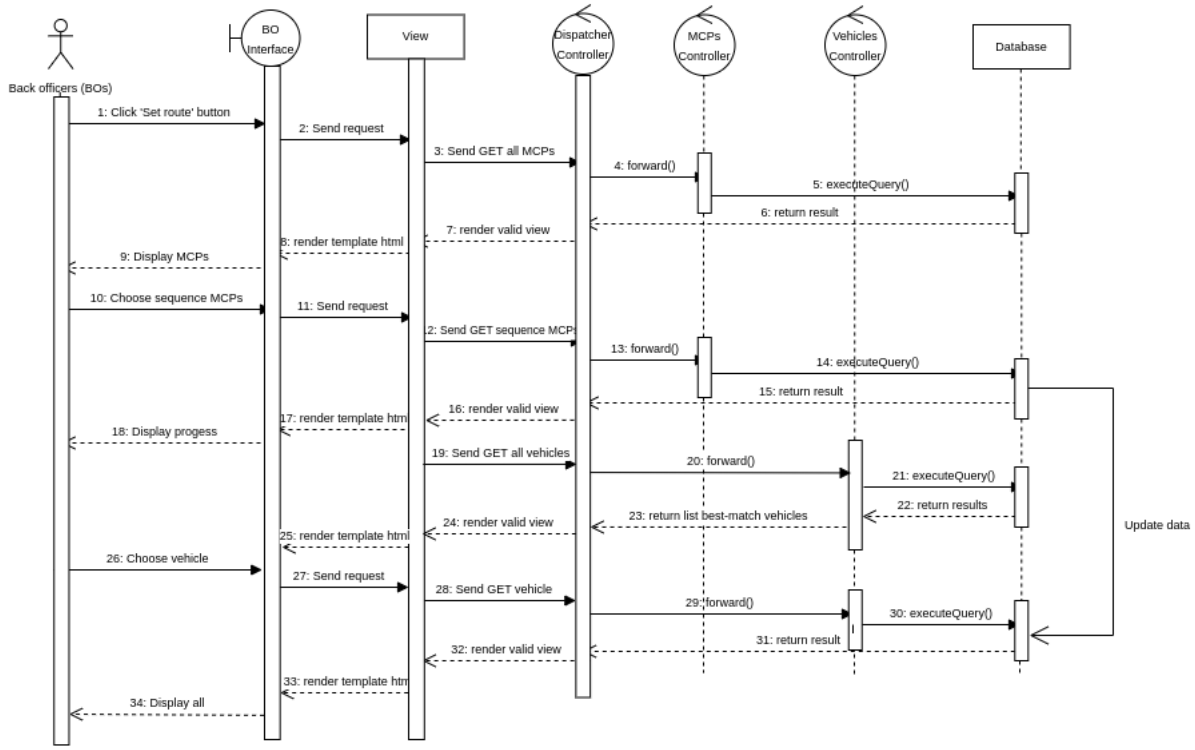

Figure 4: Sequence Diagram of Task Assignment Module

For the Route planning task, our team proposed the following solution: BO sends a request to the system to "Set route", and the system returns a list of available MCPs, BO then choose the available MCPs, and the system suggests the suitable vehicles based on the capacity and fuel consumption in regard to the chosen route, BO then selects the desirable vehicle, the system finally logs all the inputs of BO into the database. In our design, we are constructing an algorithm to calculate the suitable vehicles, taking into consideration the specifications of the vehicle and the features of the selected route. The system should be able to interact with the database to retrieve the wanted information and be able to perform the algorithm on said data to output the applicable selection of vehicles for the BO. In addition, we believed that the BO should be able to have flexibility in selecting the appropriate vehicle in case of any external factor, therefore, the BO will be given other options than the most viable.

3.3 Class Diagram

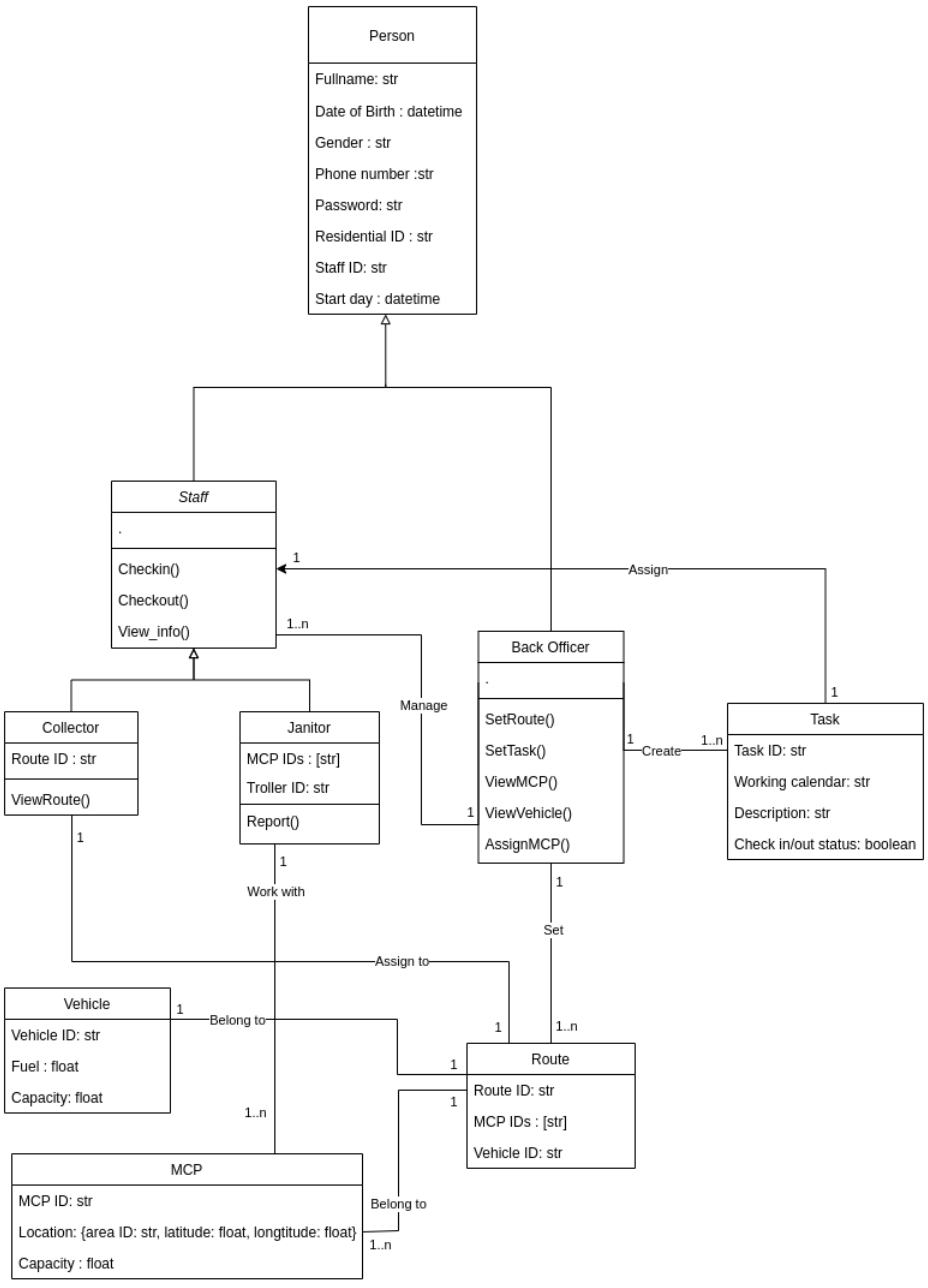

Figure 5: Class Diagram

The class diagram describes the system models and data schema; it helps us visualize the system construct, its stakeholders, the models' relationship and how these models interact with each other in the system during the business process. To structure this diagram, we start with the personal information of each stakeholder. From the person class containing all information we need for an employee, we divided into different classes distinguished by their activities using inherent relationships. The diagram ends with classes defining labour tools that correspond with their stakeholders.

4 TASK#3

4.1 Architectural approach of the system

MVC Diagram

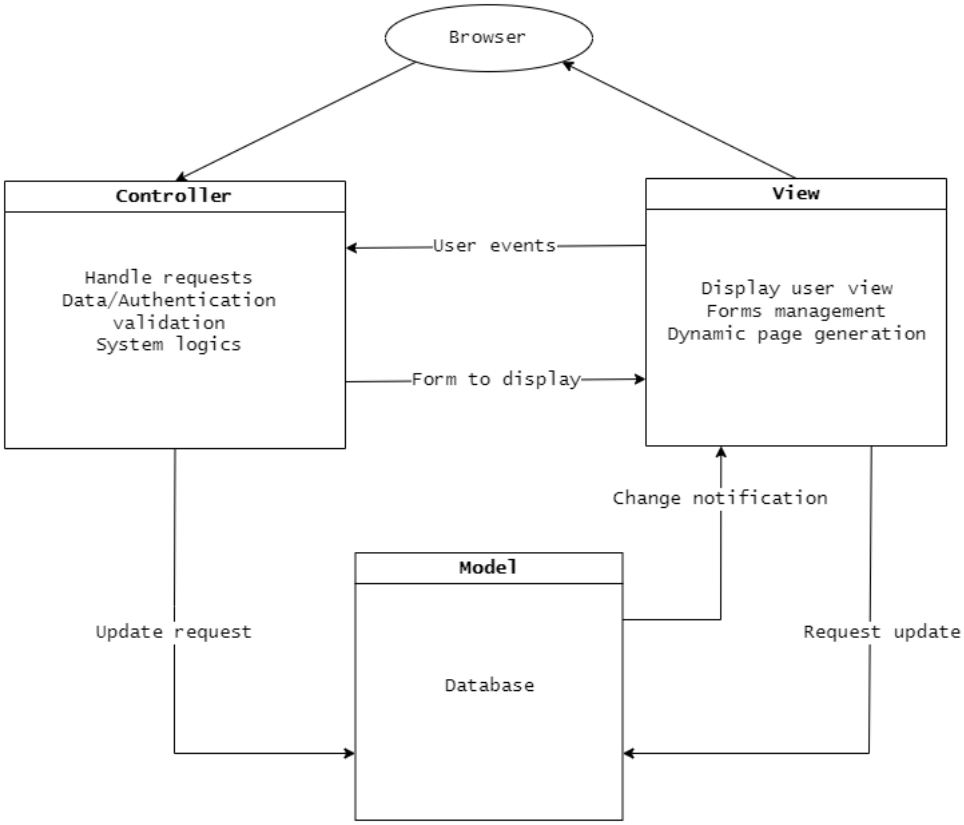

Figure 6: MVC Diagram

Description

Name	Description
Model	Contains APIs for application-specific logics. Provides access to database management system for modifications Send refresh and update requests to View module when changes in Model module is detected
View	Render user-specific views Render drop-down menu and sliders when needed Send user events to the Controller module Update user input Update UI when requested
Controller	Return the appropriate view Data validation Response to user events

Table 6: Specifying MVC diagram

4.2 Implementation Diagram

Package Diagram

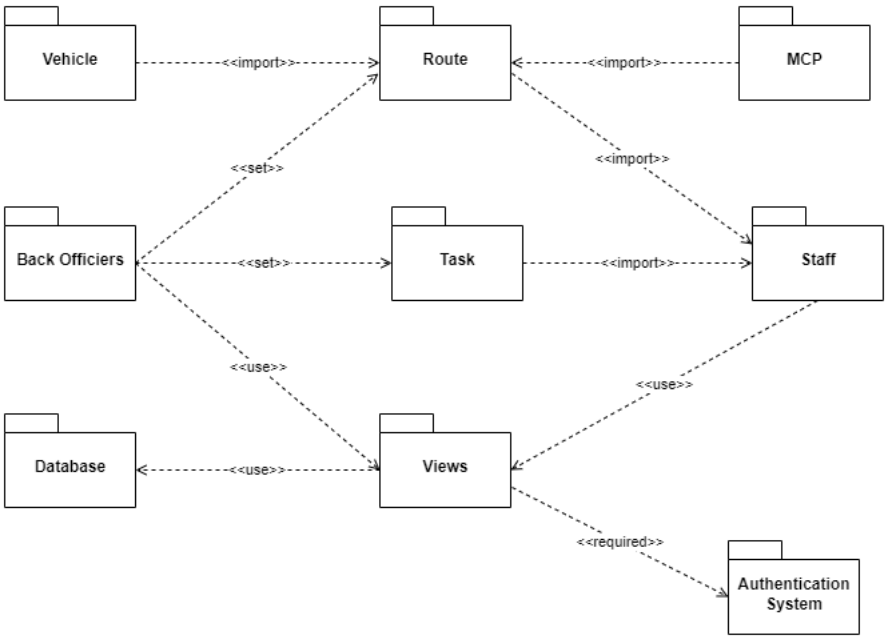

Figure 7: Package Diagram

We used a package diagram to simplify the complex class diagram, and organize the classes into packages. Therefore, we can visualize the whole system in a high-level abstraction.

Component Diagram

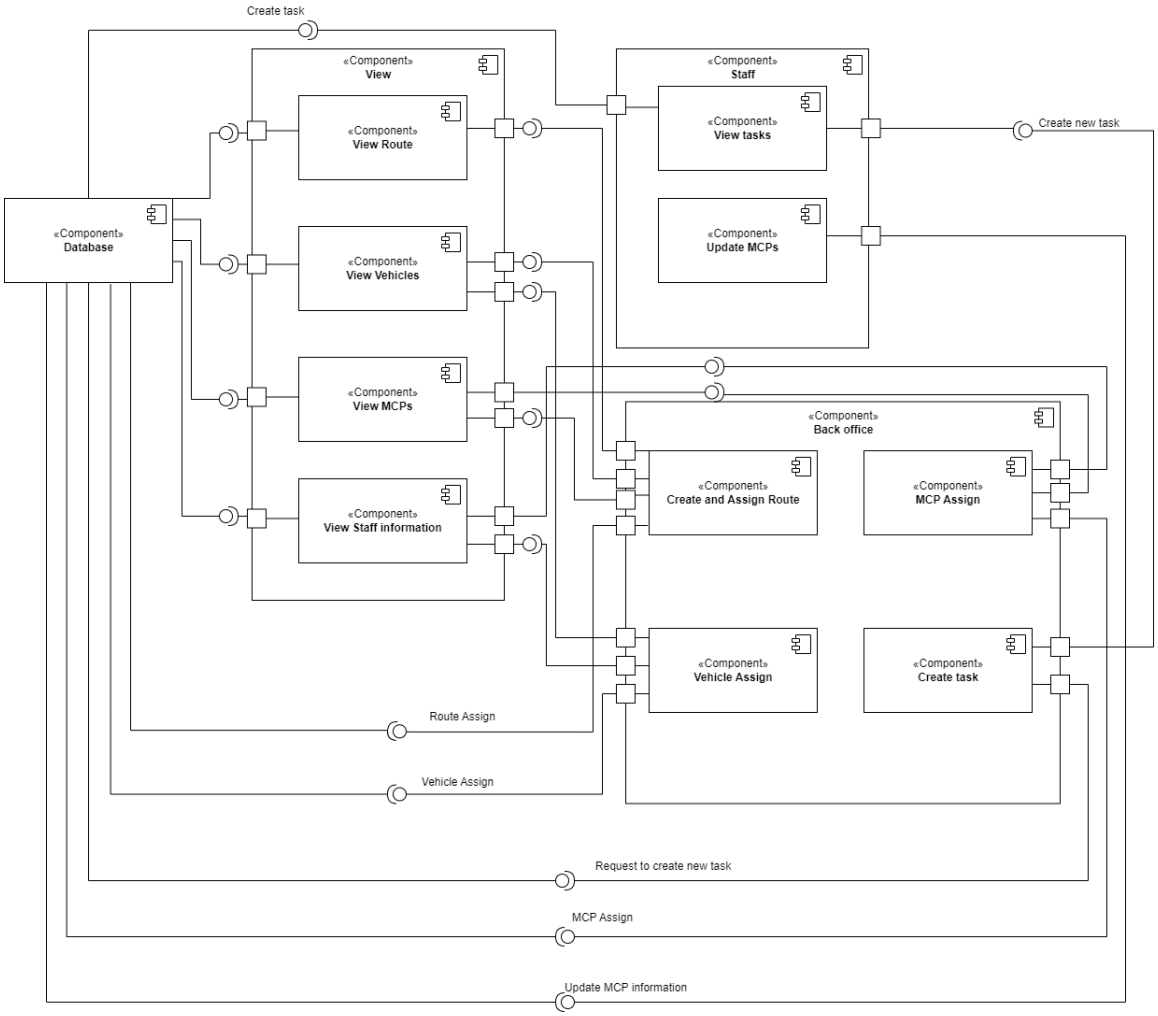

Figure 8: Component Diagram

In terms of component diagram, we describe 5 components including staff, back officer, view, database, and authentication. Actually, the authenticate process is compulsory before using services, thus, one can assume that interactions between actors (such as staffs or back officers) and services of the system have involved successful authentication. We represent each component in the following sections.

4.3 Modules

In our design, we propose the following breakdown structure includes three main modules:

Task Assignment

In this modules, the back officers create and assign tasks for collectors and janitors, provided all necessary allocated resources such as MCPs, specification of vehicles, etc.

- Input:
  - MCPs
  - Vehicles
  - Collectors
  - Janitors
- Output:
  - Tasks (assigned to
  - Routes (assigned to

Authentication

In this module, the system handles authentication requests, including but not limited to log in, log out, registration, etc.

- Input:
  - Staff ID
  - Password
  - Personal information
- Output:
  - Access token
  - Account's information

Display

In this module, the system renders the appropriate view for each users, handles requests from client devices.

- Output:
  - Route
  - Task's dashboard
  - Account's information

5 Revision versions

To be determined...

–END–