RÉPUBLIQUE DU CAMEROUN
Paix-Travail-Patrie
****
UNIVERSITE DE YAOUNDE 1
****
FACULTE DES SCIENCES
****
DEPARTEMENT D'INFORMATIQUE
****
NIVEAU 4

REPUBLIC OF CAMEROON
Peace-Work-Fatherland
****
THE UNIVERSITY OF YAOUNDE 1
****
FACUTY OF SCIENCE
****
COMPUTER SCIENCE DEPARTMENT
****
LEVEL 4

PRATICAL WORK INF4178

TOPIC : DELIVERY SYSTEM

Members team

Name	Matricule
TEGUIMENE YENDJI FUREL	22W2453
METILI DONATIEN	17A2387
LOTSI AICHA	20V2098
KENGNI MANUELLA	20V2255
NDUWARUGIRA BRUNO	20U2598

Instructor : Dr KIMBI XAVERIA

Academic year 2023-2024

Table des matières

1. Topic

Our topic was the design of a package delivery system.

2. Research Problem

Nowadays, many people have packages to move from their neighborhood to another but do not find the time to travel to this other neighborhood, which poses a problem if the package in question is an important thing. If we could have the possibility of having this package delivered that could be a good thing but until then we would have to be prompt and drop it off on time which requires the person delivering the package to choose the shortest route in order to arrive at the destination. quickly to the destination. How can we resolve this?

3. General objective

a. Specific objectives

The specific objective of this project is to set up a delivery system available to each delivery person which will allow them to choose the best route to travel from a collection point A to a collection point B when they will want to deliver a collected package to collection point A.

4. System requirements

a. Functional requirements

Functional requirements refer to the functionality that the system must provide to satisfy the needs of each end user. In our case, we have :

The delivery application will allow you to:

- ✓ Select a package awaiting delivery ;
- ✓ Remove a package from a collection point (by scanning or providing the packet code);
- ✓ Drop off a package at a collection point ;
- ✓ Seacrh a collect point ;
- ✓ See the route between point A and point B on the map ;
- ✓ See its stats in packages picked up, dropped off and available

The POC application will allow you to:

- ✓ Save packet ;
- ✓ Track a packet ;
- ✓ Search a collection point ;
- ✓ Scan a packet

The customer application will allow you to:

- ✓ Track a packet ;

b. Non-functional requirements

Non-functional needs are essential and allow the improvement of the quality of our system. They act as constraints on the solution, but taking them into consideration avoided several inconsistencies in the system. The latter must meet the following requirements :

- **The Authentification :** The system must allow any user before accessing it to provide a telephone number and a password. This operation ensures system security and limits the number of users so that important data is only visible to authenticated users ;
- **Fiability :** Our system must be reliable, meaning that the user must have confidence in the quality of their data to process it better ;
- **Authorization :** The system must be able to display to a user only the functionalities intended for them. This will help secure everyone's data.

5. Application of Scrum
    a. Presentation of scrum team

- **SCRUM MASTER :** TEGUIMENE YENDJI FUREL ;
- PRODUCT OWNER: LOTSE Aïcha ;
- SCRUM DEVELOPMENT TEAM : METILI Donatien, NDUWARUGIRA Bruno, KENGNI Manuella.

b. Description of how you applied scrum to your specific project

i. Explanation of how Sprints were carried out

The sprints were performed as follows:

- Duration of Sprints: 2 weeks ;
- Sprint Planning: Definition of Product Backlog elements to include, effort estimation, team commitment to a realistic objective ;
- Execution of Sprints: Scrum meeting twice a week, collaboration between members and self-organization of the team ;
- Sprint Review: Presentation of the developed features to stakeholders, collection of comments ;
- Sprint retrospective: Identification of points for improvement and implementation of concrete actions.

ii. Team organization and roles

Team organization and roles:

- **Product Owner:** Responsible for defining and prioritizing the Product Backlog ;
- **Scrum Master:** Facilitator of Scrum events and protector of the team ;
- **Scrum Development Team:** Multidisciplinary, self-organized team responsible for implementing features

iii. Daily scrum Agenda

- Round table discussion on everyone's achievements, plans and obstacles ;
- Review of the Sprint Backlog and identification of problems ;
- Planning the day and coordinating interdependencies ;
- Conclusion and definition of next actions.

iv. Scrum conflict Resolution

- Rapid identification of conflicts during daily Scrums ;
- Conflict resolution as a team, with the help of the Scrum Master if necessary ;
- Establishment of a mediation process in the event of persistent disagreements.

v. Scrum workflow management

- Using Jira to track the Sprint Backlog ;
- Visualization of workflow using Trello boards ;
- Respect of Lean principles (pulled flow, reduction of waste, continuous improvement).

vi. Product Backlog

The product backlog allows you to visualize all customer needs

User Story ID	User Story	Acceptance Criteria	Priority	Initial Estimate	Adjustment Factor	Final Estimate
1	As a customer, I want to register a package at the collection point so that it is ready for delivery.	The poc manager can register a package by entering the necessary information and get confirmation.	High	3	1	3

2	As a customer, I want to collect a package from a collection point to collect my order.	The customer can collect a package by providing proof of identity or a collection code.	High	3	1	3
3	As a delivery person, I want to drop off a package at a collection point so that the customer or other delivery can collect it.	The delivery person can drop off a package by scanning the QRCode and obtain a drop-off confirmation.	High	3	1	3
4	As a customer, I want to collect a package from a collection point to collect my order.	The customer can collect a package by providing proof of identity or a collection code.	High	3	1	3
5	As a delivery person, I want to display the route on the map to know the path to follow.	The route is displayed on a map with clear navigation instructions.	Medium	5	1,2	6
6	As a delivery person or poc, I want to search for a collection point to find the one closest to me.	The user can search and find a nearby collection point.	Medium	3	1	3
7	As a delivery person, I want to scan the QRCode of a package to record its delivery.	The delivery person can scan the QRCode and get confirmation of the recorded delivery.	High	3	1	3
8	As a client, I want to search a package via its code to check its status.	The client can enter a packet code and see its current status.	Medium	3	1	3

vii. Sprint Backlog

Represents the planning of the implementation of the different functionalities

Release	Sprint	User Stories ID	Date	Meetings
Version 1.0	Sprint 1	1, 2, 3	from July 1 to 14	Wednesdays July 3 and July 10, Saturdays July 6 and July 13
Version 1.0	Sprint 2	4, 5, 6	from July 15	Wednesdays July 17 and July 24,

			to 28	Saturdays July 20 and July 27

6. Methodology

a. Architecture of your system

i. Architectural Diagram

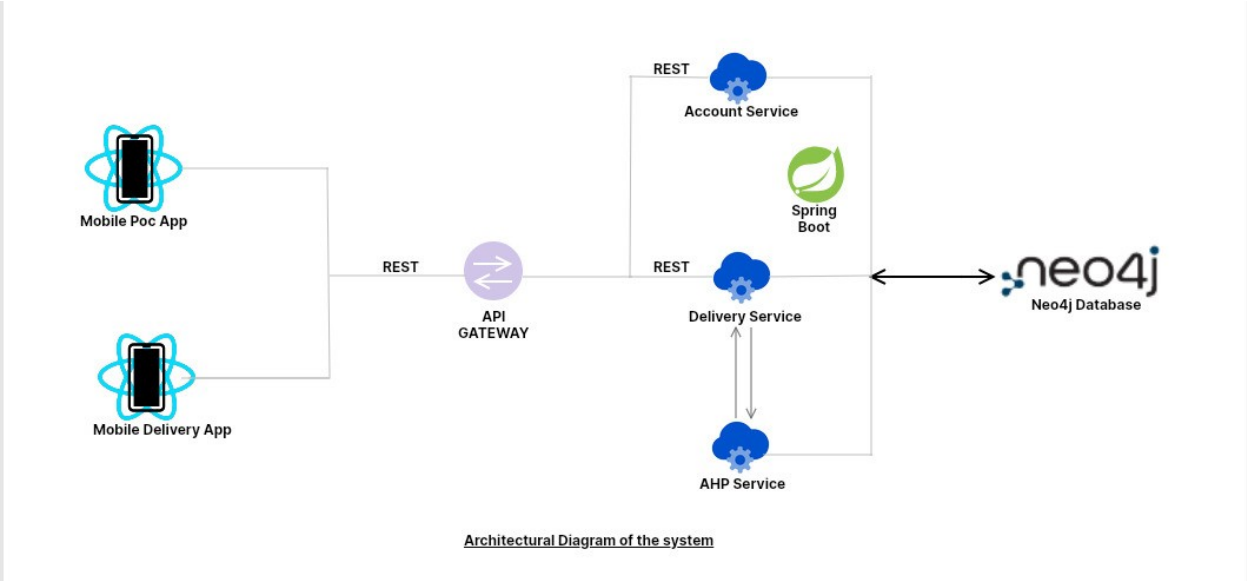


Figure 1 : Architectural diagram of the system

ii. Description of Architecture

The description of our architecture:

- **AHP Service :** This service will allow us to make our choice of route consistent by calculating the weights which will be used to strengthen the algorithm for searching for the shortest route between point A and point B. Once the weights are found, it will send the results to the delivery service for use ;
- **Delivery Service :** This service manages everything related to package deliveries including deposit, registration, withdrawal, tracking by a user ;
- **Account Service :** This service manages everything related to users. The creation of delivery, customer and collection point accounts as well as their management ;
- **Neo4j database:** This serves as a database for our system based on the principle of colored oriented graph to allow good navigation consistency.
- **User system:** Users interact with the architecture through a mobile application. We have 3 types of users, delivery people, collection points and customers.

iii. Architectural Drivers

b. Model of your system

i. Model UML

1. Use case diagram

In order to give an overall vision of the functional behavior of our system, we represent the use case diagram below :

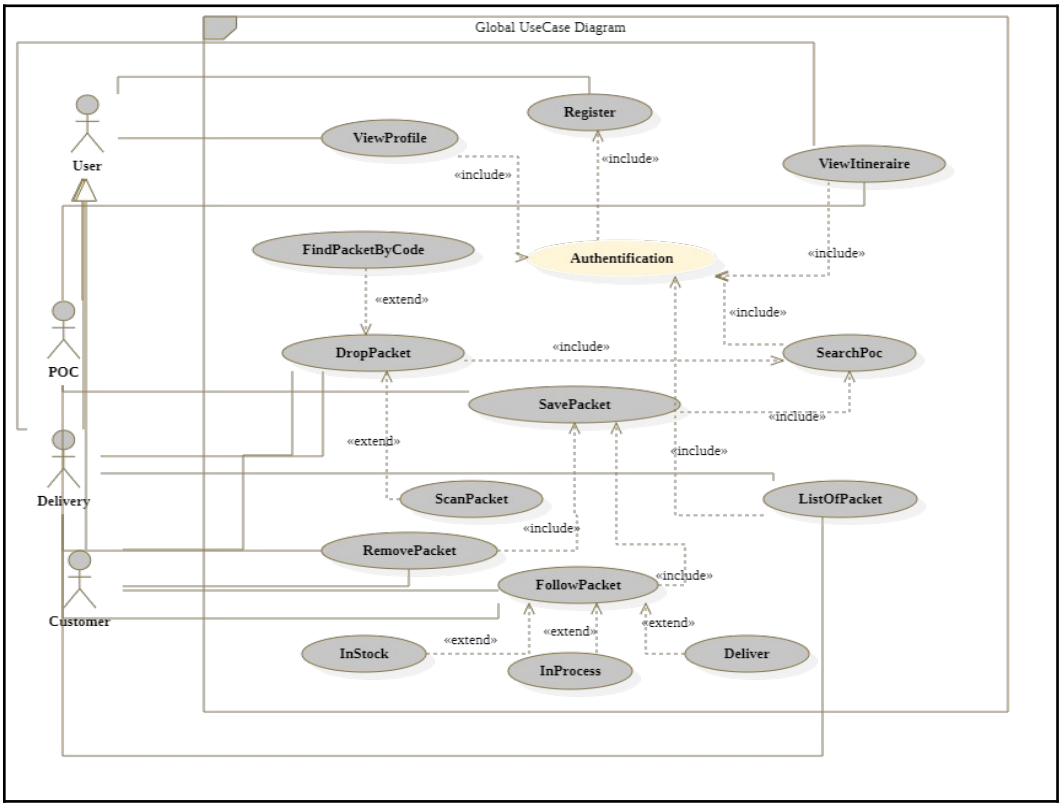


Figure 2 : Global use case diagram

2. Class diagram

This UML class diagram represents the structure of objects and information used by our system both internally and in communication with users.

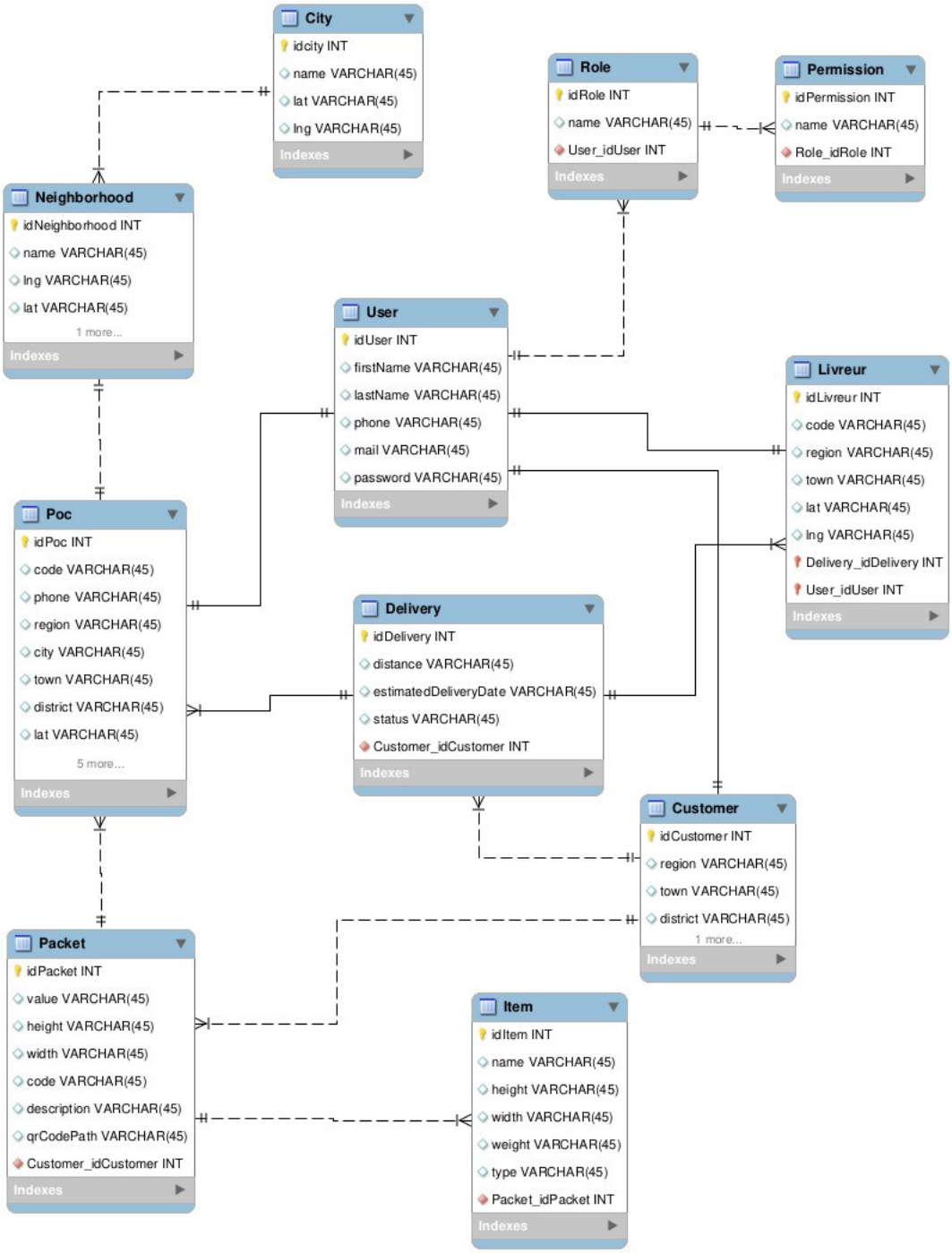
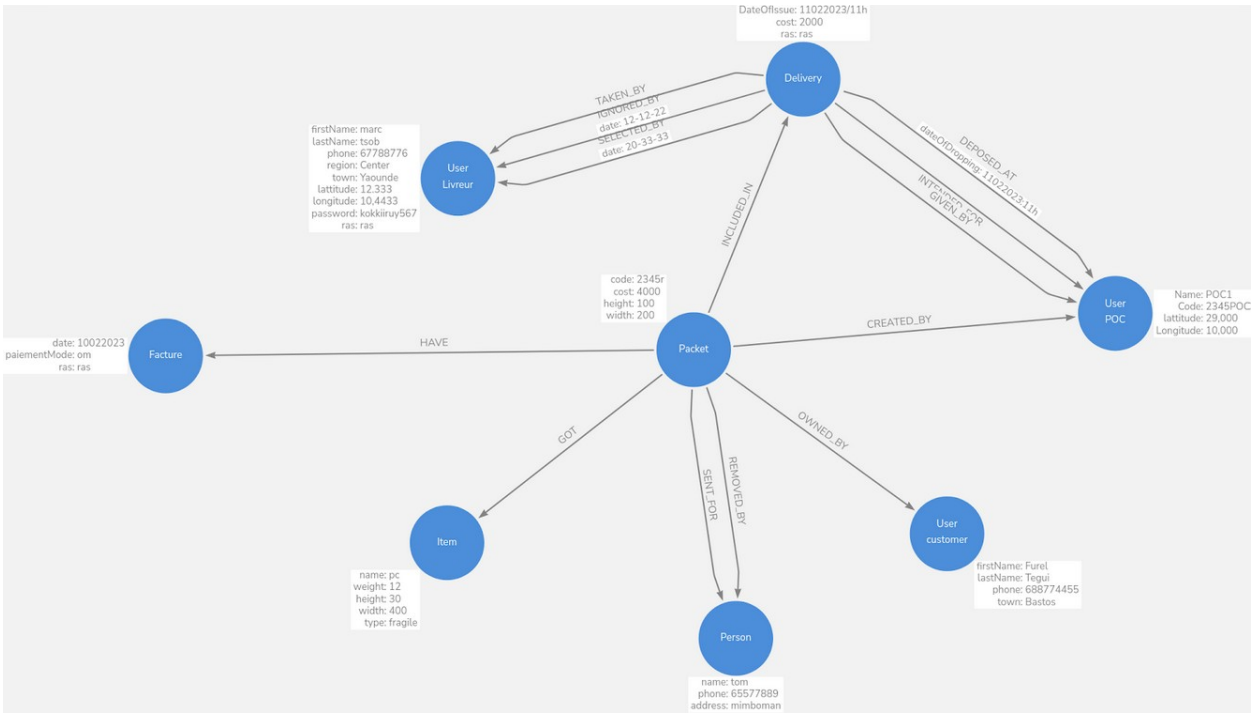


Figure 3 : Class diagram



This diagram represents the graphical modeling of the system.

3. Activity diagrams

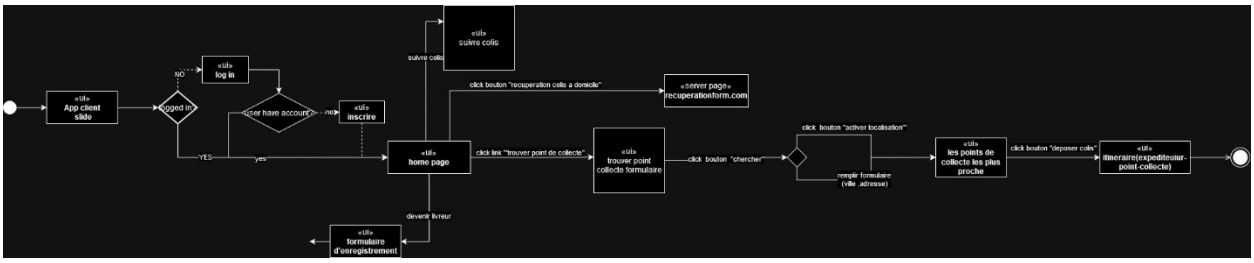


Figure 4 : Activity diagram for a client workflow

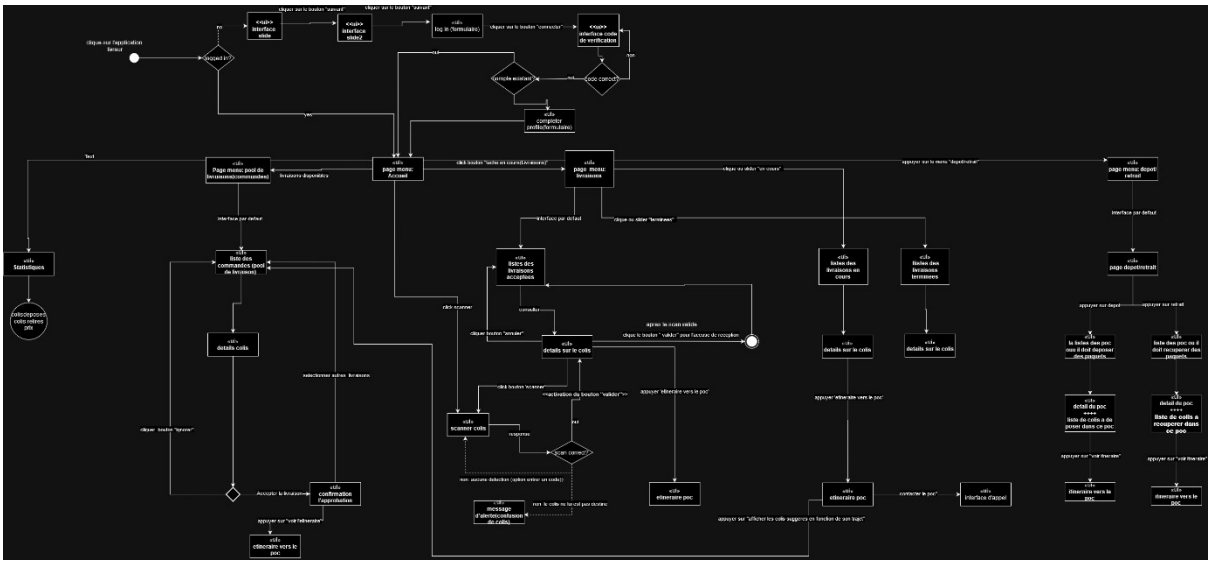


Figure 5: POC workflow

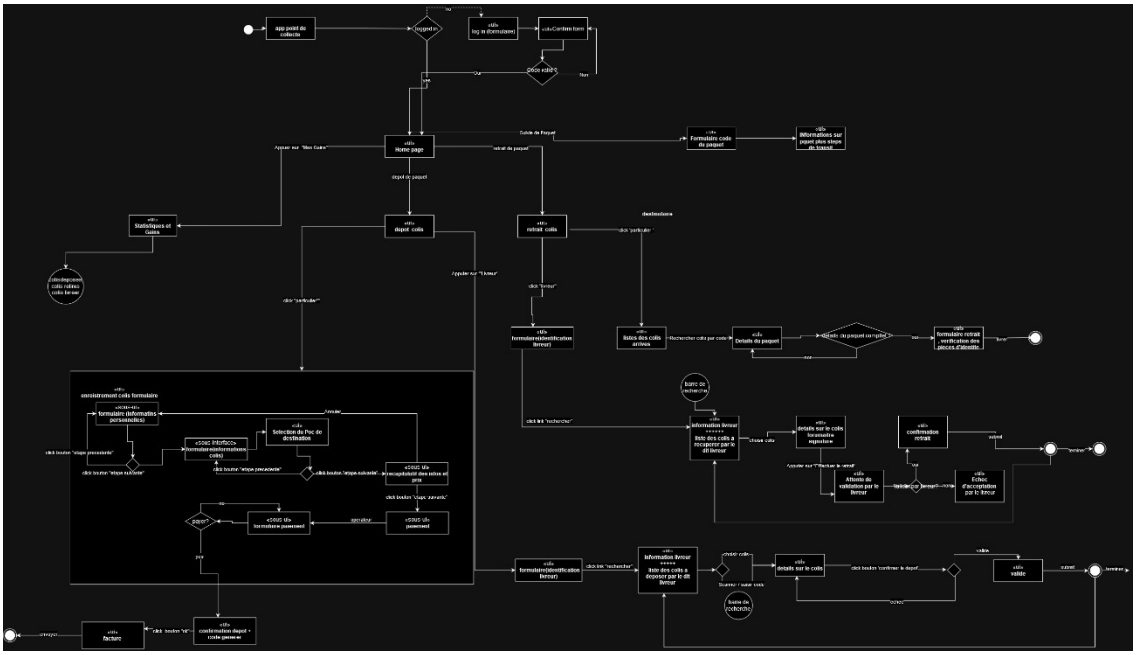


Figure 6: Delivery workflow

4. Sequence diagram

A sequence diagram presents the interactions between the different actors in the system. In general, use sequence carries a specific type of action whose description should be reinforced.

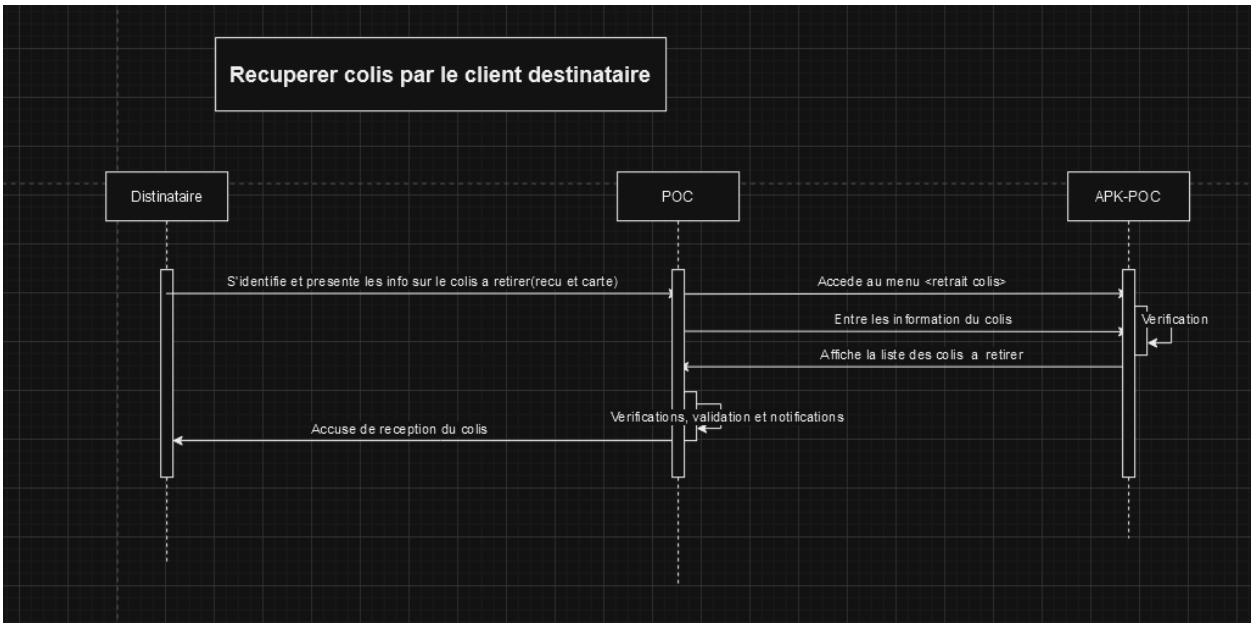


Figure 7: Sequence diagram to take packet

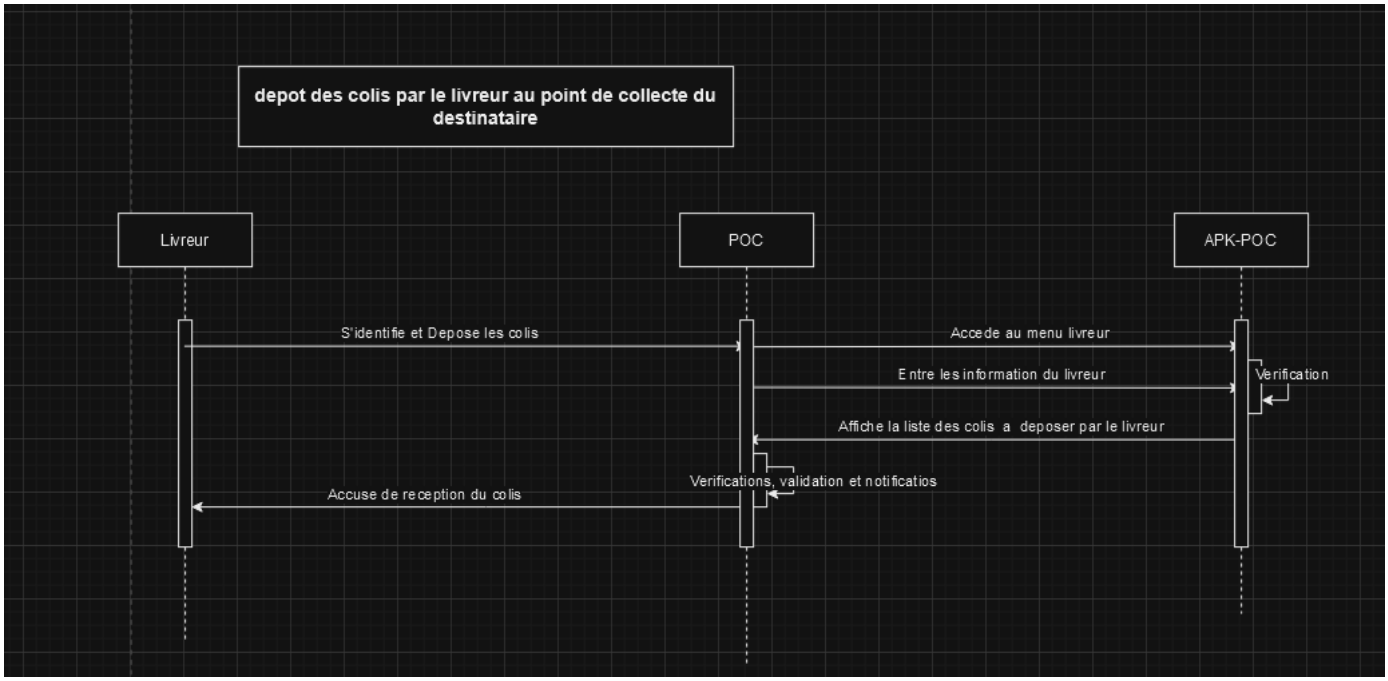


Figure 8: Sequence diagram to remove packet

ii. Mathematical Model

ii.1) Identification du problème

ii.2) Définition des notations et des variables

- **Notations (Ensembles et Paramètres)**

- ✓ **P :** Représentant l'ensemble des paquets ;
- ✓ **I :** Représentant l'ensemble des points de collectes (POC) ;
- ✓ **L :** Représentant l'ensembles des livreurs ;
- ✓ $\mathbf{c_{ilj}}$ **:** Distances qu'il faut au livreur ***l*** pour transporter le paquet du POC ***i*** au POC ***j*** ;
- ✓ $\mathbf{t_{ilj}}$: Temps qu'il faut au livreur ***l*** pour transporter le paquet du POC ***i*** au POC ***j*** ;
- ✓ $\mathbf{r_l}$: Score de fiabilité du livreur ***l*** ;
- ✓ $\mathbf{d_p}$: Poids du paquet ***p*** à transporter ;
- ✓ $\mathbf{q_{ilj}}$: Capacité maximale de paquets que le livreur ***l*** peut transporter du POC ***i*** au POC ***j*** ;
- ✓ $\mathbf{T_l}$: Temps maximale que détient le livreur ***l*** pour sa livraison ;

➢ **Variables**

$\mathbf{x_{iljp}} =$ { 1 si le paquet ***p*** est transporté du POC ***i*** au POC ***j*** par le livreur ; 0 si non }

i.3) Contraintes

➢ **Contraintes Dures**

- **Contrainte de demande :** Chaque paquet doit être transporté exactement une fois d'un POC ***i*** vers un POC ***j.***

$$\sum_{j \in I} \sum_{j \in I} \sum_{l \in L} x_{iljp} = 1 \ \forall p \in P$$

- **Contrainte de capacité :** Le nombre total de paquets transportés par un livreur ne doit pas dépasser sa capacité**.**

$$\sum_{p \in P} x_{iljp} * d_p < q_{ilj} \ \forall i,j \in I, \forall l \in L$$

- **Contrainte de temps :** Le temps total de transport pour chaque livreur doit respecter les contraintes horaires

$$\sum_{p \in P} \sum_{i \in I} \sum_{l \in L} t_{ilj} * x_{iljp} \leq T_l \ \forall l \in L$$

➢ **Contraintes Souples***

- **Contrainte de temps de livraison :** Les paquets doivent être livrés dans un certains délais mais les retards peuvent êtres tolérés avec des pénalités

i.4) Fonction objective

La fonction objective va combiner les critères (qui serons utilisé dans notre AHP) pondérés de distance, temps et fiabilité pour minimiser la distance totale de transport. Les poids w_d, w_t et w_r seront déterminés via le processus AHP développé dans la prochaine section de ce rapport.

$$F(p,i,j,l) = Min \sum_{p \in P} \sum_{i \in I} \square \sum_{j \in I} \square \sum_{l \in L} \square \ (w_d * c_{ilj} + w_t * t_{ilj\,i} + w_r * r_l + x_{iljp})$$

iii. Algorithms

To solve our best route problem we used the djikstra algorithm defined as follows

```
function Dijkstra(Graph, source) :
    for each vertex v in Graph.Vertices:
        dist[v] ← INFINITY
        prev[v] ← UNDEFINED
        add v to Q
    dist[source] ← 0

    while Q is not empty:
        u ← vertex in Q with minimum dist[u]
        remove u from Q

        for each neighbor v of u still in Q:
        alt ← dist[u] + Graph.Edges(u, v)
        if alt < dist[v]:
            dist[v] ← alt
            prev[v] ← u

    return dist[], prev[]
```

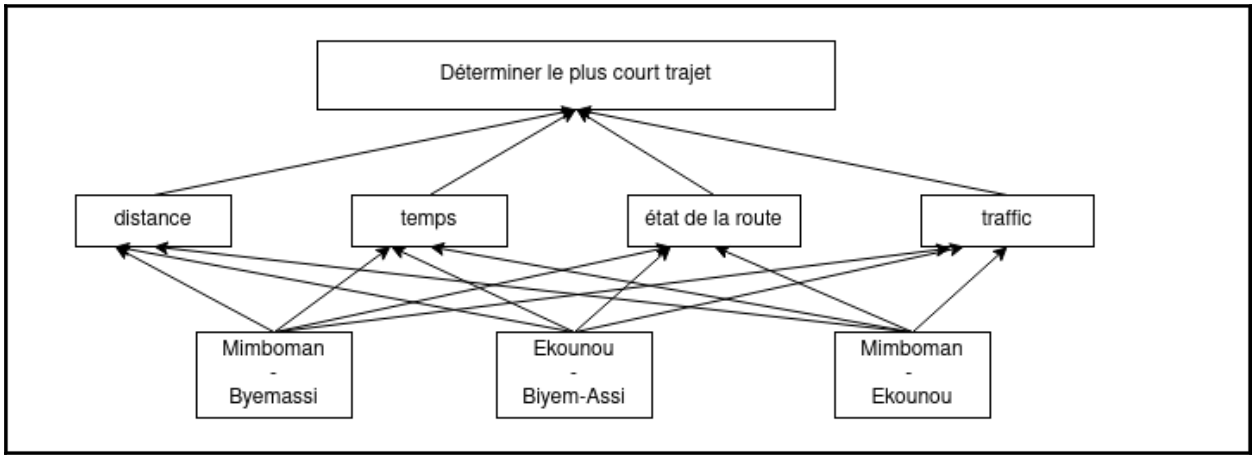
c. Analytical Hierarchical process (AHP) algorithm applied to your project

The AHP process allows you to solve a decision problem. It will help us here to strengthen our choice on the shortest route.

- CRITERIA:
  -distance
  -time
  -state of the road
  -traffic

- ALTERNATIFS:
  - mimboman- biyem-assi
  - ekounou-biyem-assi
  - mimboman-ekounou

. **Develop a hierarchical model of the decision problem**



Establish a scale of preference relative to the criteria

1 Equal importance

3 Moderate importance

5 Strong importance

7 Very important

9 Extreme importance

2,4,6,8 intermediate values

1/3,1/5,1/7,1/9 Inverse values

Ddist:Distance between endpoints of collect A to end point of collect b to the final destination.

Tliv : Delivery Time.

Erout : State of the road.

Trtraf : Road trafic.

Establish a pairwise comparison matrix

This matrix gives the relative importance of each criterion in relation to the objective.

We continue to ask questions on the preference scale until we fill out the entire matrix.

	Ddist	Tliv	Erout	Trtraf
Ddist	1	3	5	7
Tliv	0.3333	1	2	2
Erout	0.2	0.5	1	3
Trtraf	1.6761	5	8.3333	13

iv. Pairwise matrix normalization

Normalization is done by dividing each cell by the sum of the corresponding column, i.e. cell PxP .

	Ddist	Tliv	Erout	Trtraf
Ddist	0.5966231132	0.6	0.6000024	0.5384615385
Tliv	0.1988544836	0.2	2	0.1538461538
Erout	0.1193246226	0.1	0.12000048	0.23076923308
Trtraf	0.0851977805	0.1	0.03999615998	0.07692307692
SUM	1	1	1	1

v. Calculate criteria weighting

The weighting of the criteria is calculated by averaging the row values.

we calculate this by taking the sum on each line divided by 4

	Ddist	Tliv	Erout	Trtraf	WEIGHTED CRITERIA
Ddist	0.59662311	0.6	0.6000024	0.538461538	0.58377176
Tliv	0.19885448	0.2	0.24000096	0.15384615	0.198175399
Erout	0.1193246	0.1	0.12000048	0.23076923	0.142523583
Trtraf	0.0851977	0.1	0,039996	0.07692307	0.075529254
	1	1	1	1	

Vi. Consistency check

Multiply each cell value of the non-normalized matrix pairwise with the weight of the criterion.

	Ddist	Tliv	Erout	Trtraf	WEIGHTED CRITERIA
Ddist	0.583777176	0.594526198	0.71261791	0.5287047806	0.5837717629
Tliv	0.194571	0.198175	0.28504	0.15105850	0.198175399
Erout	0.116754	0.0990876	0.142523	0.22658	0.142523583
Trtraf	0.083362	0.0990876	0.047503	0.0755292	0.075529254
SUM	0.978459	0.990876	1.18769177	0.9818803	

Calculate the weighted sum of the criteria To do this, we add all the values in a row.

	Ddist	Tliv	Erout	Trtraf	WEIGHTED CRITERIA
Ddist	0.583777176	0.594526198	0.71261791	0.5287047806	2.419620
Tliv	0.194571128	0.198175399	0.2850471	0.15105850	0.82885220
Erout	0.116754352	0.0990876	0.1425235	0.2265877	0.584953
Trtraf	0.0833626077	0.0990876	0.047503	0.07552925	0.30548267
SUM	o.9784598518	0.990876	1.1876917	0.98188030	

b. Calculation of Li and Lmax

Li= (weighted sum of criteria) / weighted criteria

	Ddist	Tliv	Erout	Trtraf	WEIGHTED SUM CRITERIA
Ddist	0.583777176	0.594526198	0.71261791	0.5287047806	0.5837717629
Tliv	0.19885448	0.2	0.24000096	0.15384615	0.198175399
Erout	0.119324622	0.1	0.12000048	0.23076923	0.142523583
Trtraf	0.08519778	0.1	0.03999615	0.07692307	0.075529254
SUM	o.978	1	1	1	

Lmax = Avarage (Li)

Lmax =4.119010243

vs. Calculate the consistency index (CI)

CI = (Lmax -n) /(n-1) where n=number of criteria. For this case, n=4

CI = 0.03967008092

d. Calculate the consistency rate (CR)

Where RI is the randomly generated index, which is a randomly calculated index for a number of criteria. RI for 4 criteria is 0.9

CR = CI/RI. With RI=0.9 because we have four criterias

CR = 0.04407786769

We are consistent with our decision because CR < 0.1. We can conclude to synthesis

vii. Summary of results

Let's consider our 3 road with road i = short distance with i =[1,2,3]

	Ddist	Tliv	Erout	Trtraf
Ddist	30	1	1	1
Tliv	100	1	1	1
Trtraf	70	1	1	1

Evaluate the overall weight of each alternative based on the weight of its criteria.

	Ddist	Tliv	Erout	Trtraf	TOTAL WEIGHTED
Mimboman-biyem-assi	17.51315289	0.1981753994	0.1425235834	0.07552925437	17.929381127
Ekounou-biyem-assi	58.37717629	0.1981753994	0.1425235834	0.0755292543	58.793404527
Mimboman-ekounou	40.8640234	0.1981753994	0	0.0755292543	41.13772805

MIMBOMAN-BIYEM-ASSI **is the best option because it has an underall item weight**