University for Applied Sciences

Informatics Department

Applied Informatics

No More Waste

Documentation for the Architecture of an Mobile Application for Preventing Food Waste

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Working Period:	Summer Semester 2022
Due Date:	31.Juni 2022

Contents

Abbreviations

API Application Programming Interface.

DoS Denial of Service.

FAO Food and Agriculture Organization of the United Nations.

UN United Nations.

Glossary

Denial of Service (DoS) Intentional interruption or laming of network services.

Activity Diagram This kind of diagram shows the behavior of a system, it depicts in a graphical fashion the logic of a single use case Baresi (2009).

API Gateway Server used an single entry point into a system. It forwards requests to the used service. It is broadly used for authentication, auditing and logging services Richardson (2020).

App It refers to the mobile application to be developed.

Class Diagram This kind of diagram presents the structure of a system with its classes, attributes, methods and relationshipsIBM (2004).

Client Since we have two major stakeholders that will use the app, the word client will specify the one that places an order in the app.

Federated Login Authentication method in which users use existing accounts to gain access to another domains or systems without the need of creating new credentials. The authenticity of a user is attested by service and granted to another Robinson (2019).

Load Balancer Device used to distribute traffic/resource/request across different servers, so one of them are not overloaded nginx (2021).

Microservice Software architecture approach made of small independent services used to communicate with other resources like APIs. The advantage of using this architecture is its scalability and maintainability, since each service is responsible for a very small group of correlated tasks AWS (2017).

Mobile Payment Gateway Those services works as an intermediary between customer, merchant and bank/credit card company. Here a payment request is sent to the gateway and forwarded to the approval instances. The core functionality of those gateways is the cryptography within the communication stepsVilmate (2019).

Provider The second major stakeholders are those who offer their products. They can be restaurants, bakeries, pastries and similar.

Risk Assessment Report used to identify risk/weakness that may exist in a project. Schwarzer (2022).

Stakeholder Describes all kind of potential person or entity that may have interest using the app.

System Response The output of a system after an input HWE.DESIGN (2020). Robinson (2019).

Use Case Diagram This kind of diagram presents the main requirements and functionalitiesPa of a systems. It displays a simplified overview of core purpose of the application Waykar (2015).

User See stakeholder.

Wrapper Element used to encapsulate the complexity of one entity so it can be processed by another entity techopedia (2018).

1 Introduction and Goals

According to the Food and Agriculture Organization of the United Nations (FAO) in 2019, 931 millions tonne of food were wasted FAO (2013). This has environmental, but especially social consequences. In a world where approximately 9.9% of the AAH (2022) population suffers from hunger that waste percentage sounds paradoxal.

According to United Nations (UN) 5% of the global food loss and waste comes from restaurants UN (2022). The solution for this problem must be locally applied so its effects can be seen in a global structure. To do so we propose to develop a mobile application that connects restaurants, bakeries and or pastries to clients. The former would offer their remaining products, which are still consumable, prior to the closing time, to a small price and the latter would browser in the app to find which shops are offering products.

We as "Clean Up the World ®" are a rising StartUp whose main concerns is to find environmental solutions to daily problems. Our portfolio includes projects about management of waste and optimization of household water usage. This product we want to develop targets small communities, like small cities or regions within a big city, to reduce the amount of wasted consumable food.

With our project we want to achieve the following goals:

- Connect providers with clients, so the former can offer products that the latter can purchase
- Collect statistical data about waste reduction within the providers
- Promote reduction of food waste that still could be consumed
- Allow clients to have a different dining experience.
- Allow providers to promote their products and gather new clients.

To make the easy to read we will use the pronouns "'he"' and "his" every time we refer to a single person.

1.1 Design Purpose

The main purpose of this architecture is creating an exploratory prototype of an App. We aim to test it with potential stakeholders and regions to analyze their general acceptance and wishes Cervantes and Kazman (2016) and get a fast feedback.

This prototype will also make it feasible to identify unknown needs an wishes of the potential stakeholders, so we can eventually increase the scope of functionality. Exploring this domain will also provide us with information regarding the behavior of our target group when it comes to buying and serving food that would be wasted, but is still consumable.

1.2 Requirement Overview

The following functionalities describe the basic requirement for the App:

Id	Requirement	Description
F-1	Register as Client.	A Client can register to the app with its e-mail.
F-2	Login	After registration Client can login into the app.
F-3	Purchase option	A registered Client can purchase an available offer (see F7).
F-4	Filter/search options	A Client can perform filter and search actions for products.
F-5	Register as Provider	A Provider can register his store and add logos and pictures.
F-6	Create offer	A registered Provider can publishes what products they are offering with price and amount.
F-7	Upload offer	A registered Provider can add, edit or remove offers to his catalog.
F-8	Check orders	A registered Provider can check all existing orders targeting his/her shops.

ID	Motivation
F-1	The entry door of the App, where our Client get an overview of all available offers
F-2	In order to place purchases our client need to be registered. It will also provide statistical information about consumer behavior
F-3	Since we are dealing with a business relationship we have on one side a client willing to pay and for a product and on the other side a provider willing to offer a product/service
F-4	Like any other online-shop it is important that our Client can browse through the available possibilities
F-5	In order to make a product available a Provider needs to register his/her shop. This information will also be used for statistical analyzes about providers, products and consumer behavior
F-6 - F-7	A registered Provider can make an offer available according to his/her daily planning. For future development of this app, this will be helpful to identify tendencies regarding dates, periods and availabilities.
F-8	Also registered providers can get an overview about how often their products have been sold. This may open a different kind of business orientation.

The following Use Case Diagram displays an overview of the primary functionality of the app:

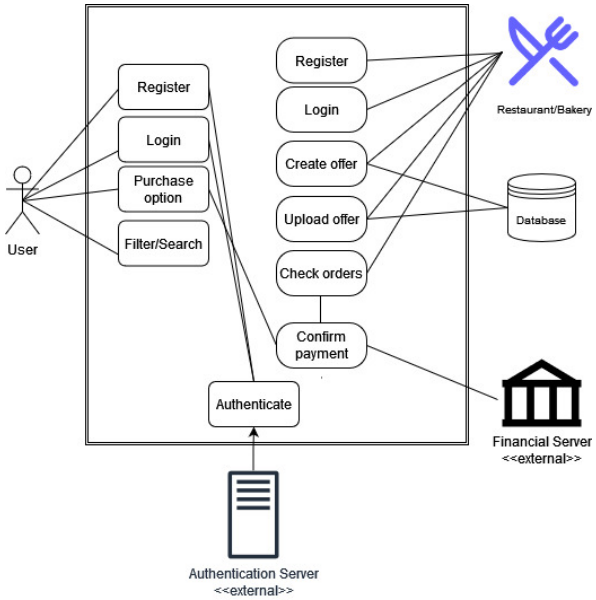


Figure 1: Preliminary functions

1.3 Qualitiy Goals

The key qualities of this app are described in the table below:

Quality	Priority	Motivation
Usability	1	Since we are working with a prototype it is important the usage is easy as possible, to attract more users and to gather information about consumer behaviour. clients and providers should have a simple interface where they can quickly interact without any burdens.
Interoperability	2	To reduce programming burdens and accelerate the delivery of a working product the registration and payment process will rely on third party providers. For that reason the developed features should work faultless in combination with the external Application Programming Interface (API)s (i.g Mobile Payment Gateway and Federated Login).
Performance	3	Many mobile and web-apps lose potential users because of the lack of performance. A System Response that takes too long (more than 1 second AppDynamics (2020)) may frustrate potential users and discourage them of using the application.
Security	4	To guarantee a secure and easy payment process we will handle the API of the Mobile Payment Gateway within the development process. The possibility of outsourcing this service would cause a big damage to the first priority.

1.4 Stakeholders

The main stakeholders of this app are described in the table below:

Stakeholder	Description	Motivation
Providers	Owner of a restaurant, bakery or pastry.	One of the protagonist of this app. They will interact with clients using the app. From his usage we will gather valuable information about consumer behaviour.
Clients	Person who wants to purchase last minute product from a provider.	The second protagonist of the app they will interact with the provider to search and to purchase product. The result of this interaction will provide us with statistical information to understand how food waste can be reduced.
Developers	Team in charge of creating the application using existing tactics and creating new solutions.	Responsable for guarantee that the main requirements of the app are fulfilled and fully functional. Since they will be dealing with the background of the product, it is important that they understand it very good so it can also be implemented in a final version.
Boarding Committee of "Clean Up the Word (R)"	Members of the management team who wants to delivery environmental solution do daily problems and at the same time develop a profitable product.	Group in charge of main decisions regarding what will be developed. Their decision are based on mark tendencies and on environmental issues.
Environment Activist	Part of the society who aims to find environmental solutions to daily problems.	They integrate local discussion groups, local public institutions, schools and universities. They are the one who brings their concerns to the boarding committee.

2 Architecture Constraints

In this project we must distinguish between Technical and Organizational Constraints. The former describes specific elements of the project, like programming language, released platform (e.g. operational systems) and technical decisions related to the functionalities. The latter deals with management elementsFranzen and Thoms (2020) (e.g time, budget and team). The following tables describes the technical and the organizational constraints of this project:

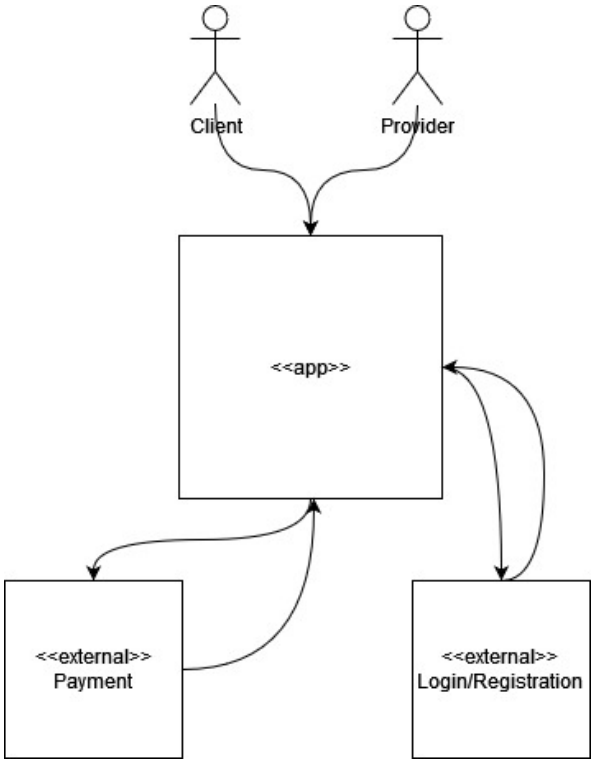
Technical		
Id	Constraint	Description
CT-T-1	Programming Language	A multilanguage (Java, Kotlin, iOS, Swift) approach increases the maintainability burden and consequently the costs (see CT-B-4). It can also interfere with compatibility with different kind of device.s
CT-T-2	Platform	Offering the application for different platforms (iOS and/or Android) increases costs for maintainability and requires a bigger team. Since the prototype should run during the first year mainly to gather information about consumer behavior the costs in this test phase can increase rapidly if we decide to develop for the most common platforms.
CT-T-3	Payment	One the one hand creating an own payment framework can gives full control of the application, but on the other hand it will required specialized team and increases costs and time (see CT-B-4).
CT-T-4	Payment gateway	Using existing Mobile Payment Gateway reduces development time, but demands fully Interoperability of the app with the existing gateways. It may also be a problem if the Client don't use this kind of payment method.
CT-T-5	Login	Using existing Federated Login decreases development time, but like CT-T-4 demands fully interoperability of the app with appliances. It may also be a problem if the Client don't trust this kind of login.

Organizational		
Id	Constraint	Reasoning
CT-O-1	Time to first prototype release	How much time is acceptable from starting the project until we have a functional prototype that can be used by our user?
CT-O-2	Development Team	The existing team can cover the main existing platforms, but their availability may be restricted to due work on other projects Specially for the maintainability of the app it can represents a problem.
CT-O-3	Analytical Team	During running phase of the prototype it will be necessary to have a team in charge of evaluating and interpreting the collected data, to find out if the goals are being achieved.
CT-O-4	Budget	Since this application falls in the category "'middle app" according to SPD LOAD (2019) the available budget of US$ 150.000 should cover the development of the main functionaliy and the data analisys (see CT-O-3)

3 Context and Scope

Since this system relies on the correct working of external elements it is important that their interaction is corrected displayed.

3.1 Business Context



Artefact	Description
Client	Searches for a last time offer from a restaurant, bakery or pastry.
Provider	Offers a still consumable product that was not sold during normal working time.
Payment	Deals with the payment processing using registered information from another payment platforms.
Login/Registration	Authenticated users using logins from other platforms.

3.2 Technical Context

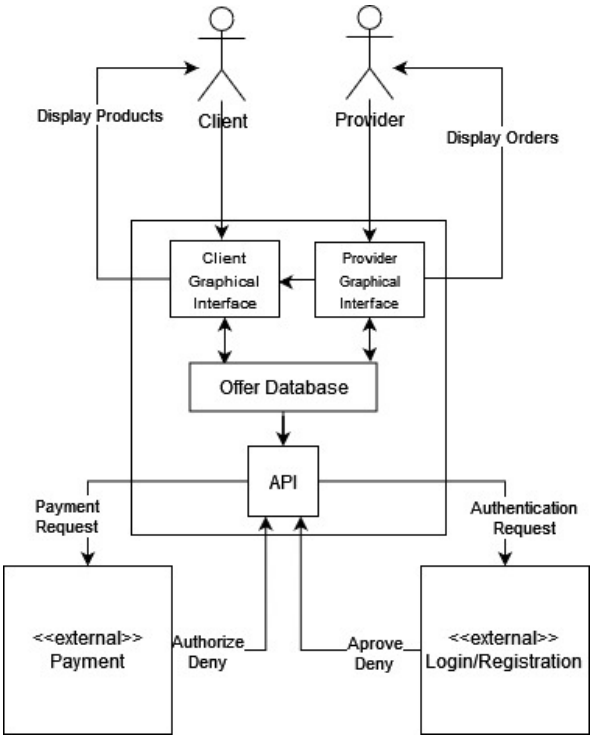


Figure 2: Technical Context

Artefact	Description
Graphical Interface	Client and Provider have an own interface to interact. Provider can access view their offer also with a Client's perspective.
Offer Database	Clients and providers can make requests to the database to inquire about its content.
API	For login and payment the authentication and authorization take places on the external service.

4 Building Block View

In this section we will describe the App using some elements of the 4+1 Architectural View Model. With this model we will represent the App using five different views, which should focus on specific elements of the project. Each view provide a different purpose Kruchten (1995). For this project we will provide the 3 following views of the 4+1 Architectural View Model:

- **Scenario view**: simple description for the end user
- **Behaviour view**: description of the existing processes
- **Structural view**: object-oriented decomposition

The scenario view was presented in the figure 1 of this project.

4.1 Behaviour view

The following Activity Diagram depicts the register and login procedure within the app.

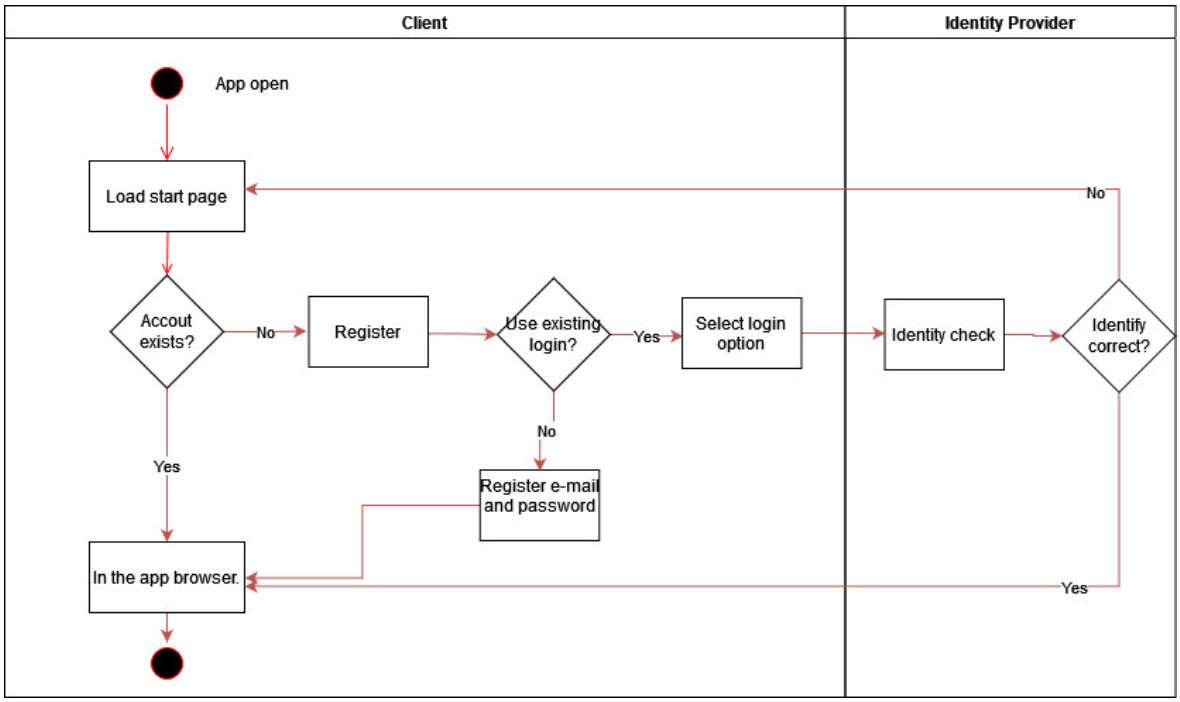


Figure 3: Login procedures

4.2 Structural view

To describe this view we choose a Class Diagram. With it we may provide a static description of elements of our app. This will be very relevant for the developing process of the App.

The first part of the this diagram describes the element within the Provider. It contains one or more addresses and it can offer one or more products. A provider will also fall into the category restaurant, bakery or pastry.

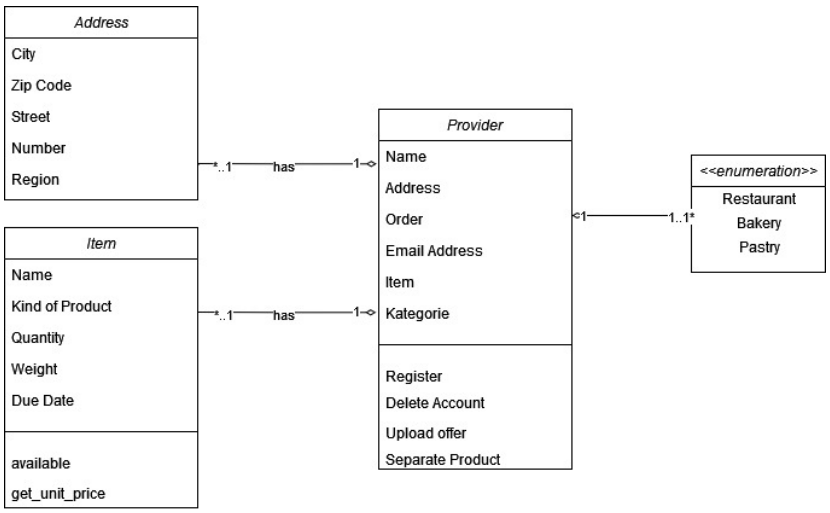


Figure 4: Provider overview

The class dedicated to the clients should be as simple as possible. It should provide basic interaction like registering, logging, deleting account, viewing product and placing order. The two last actions will stablish the communication with the providers.

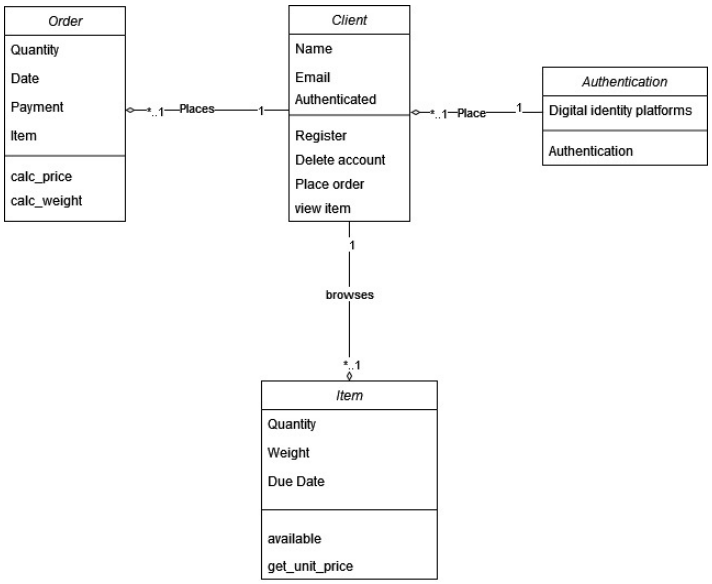


Figure 5: Client Overview

Finally we have an order placed by a Client and processed by a Provider. Here we will rely on a third party to stablish the payment procedures.

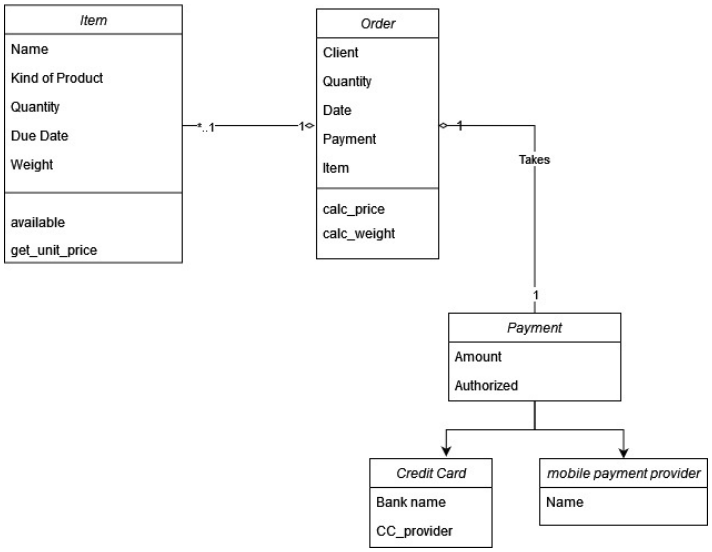


Figure 6: Order Overview

This final graphic show the whole classes in combination:

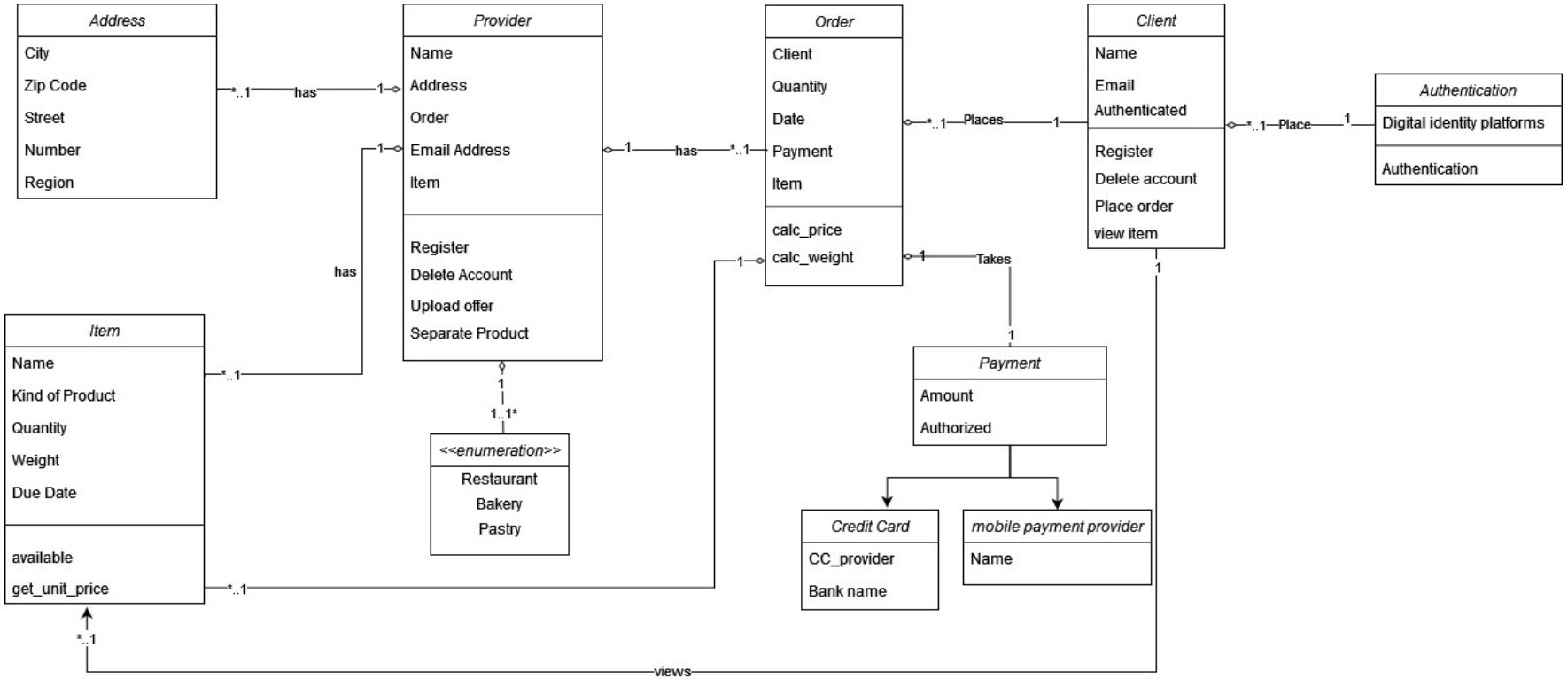


Figure 7: Classes Overview

5 Crosscutting Concept

In this chapter we will present the technical solutions that we will use to develop this project. For each quality attribute we will present the chosen tactics.

5.1 Solution for Usability

The core of our app is how easy it is to use. We want our user to navigate through it without being overwhelmed with information not related to the main objective: purchase a product or upload a product.

Tactict	Pattern	Motivation	QA
Support User Initiative	Observer	The interaction of the users is a main factor of our app. We want them to have fully control of their actions either by cancelling or by resuming an action.	QA-1
	Lazy Registration	Avoid having to memorize another password and username may increase the acceptance of the user. With this pattern we allow them also to browse in the app and seeing what is available without being registered Interaction Design (2017). This may give a glimpse of what they get if they join us.	
Support System Initiative	Observer	By each upload from the providers we want our clients to have it on his device, without having to "ask" for it.	

5.2 Solution for Interoperability

The communication with the 3rd party components should during the whole lifetime of the App reliable. Since we are dealing with two different services, Mobile Payment Gateway and Federated Login, we will describe the integration processes according to each specification.

From the third party applications we expect the following interaction:

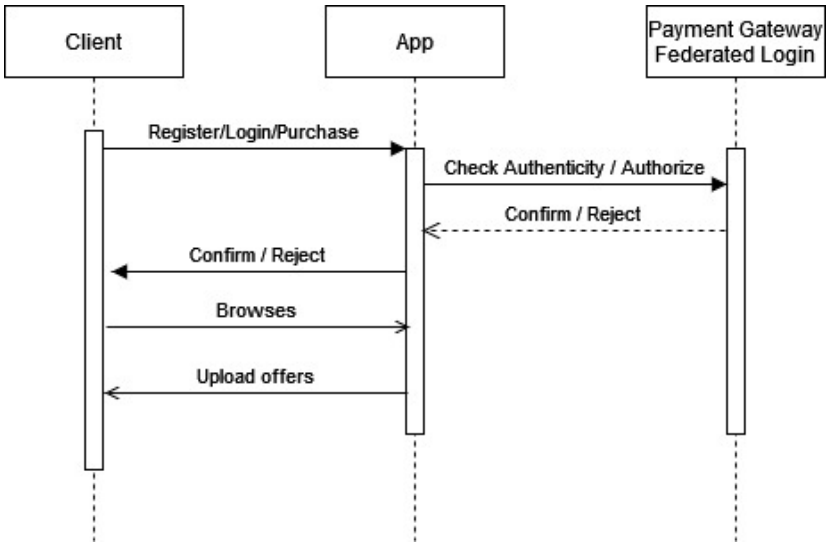


Figure 8: Sequence of actions with 3rd party applications

5.2.1 Payment Gateway

The usage of Mobile Payment Gateway offers three possibilities Zoho (2019):

- Redirection to payment processor's page
- Payment data and processing inside the application
- Payment data entered in the app, but processed with an API

The third option stays in direct contact with our top quality attribute, usability. Since we want to offer a easy shopping experience, the payment process should also be harmonic with other features.

Tactict	Pattern	Motivation	QA
Limit Dependencies	Wrapper	The API will be the intermediary for the payment process. For the clients all visible steps will occur in the app, without being sent to another page. On the background the API will receive the input and send it to the payment gateway. The verification takes place in gateway, which then communicate with the financial institute of the client and send the payment to the Provider Zoho (2019).	QA-2

5.2.2 Federated Authentication

Using of Federated Login reduces burden of saving user credentials locally. It also improves the Usability so users do not have to create and remember another username and password. The authentication process takes place on the third party operator, as seen in the picture 8.

Tactict	Pattern	Motivation	
Microservice	API Gateway	It increases security, so the microservice is not directly exposed to the external world. It reduces the complexity of the microservice, since the gateway will have to deal with data transfer rate, tokens and other activities. Dealing with failures would also be handled and logged by the microservice javarevisted (2021).	QA-2

5.3 Solution for Performance

We want our app to have a fast (no more than 1 second) response time. By clicking on an offer a Client should have it immediately displayed on his screen. Updated made by providers should also be promptly available for clients to browse.

Tactict	Pattern	Motivation	QA
Increase Resources	Load Balancer	This maybe implemented if, during the first test phase, we see that the usage of the app is so high that the existing components become overwhelmed. Specially during peak times we want our users to have a smoothly and fast interaction with the app. Providers and clients should perform their tasks, either browsing, purchasing or uploading offering without having to wait to get a response. With this decision all requests would be forwarded to the server that are available avoiding queuing of requests.	QA-3

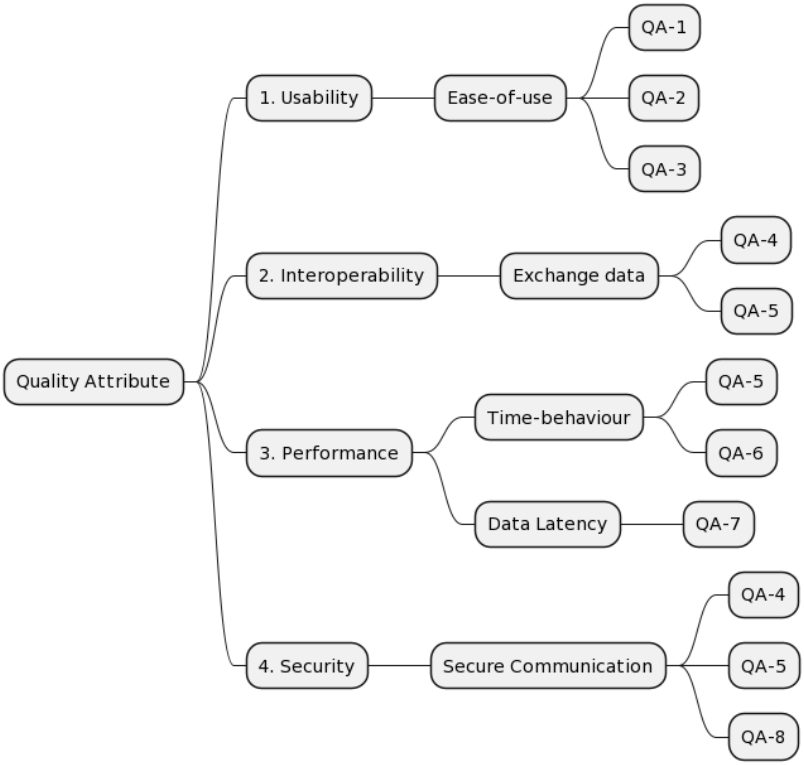
5.4 Solution for Security

There are two security concerns that need to be addressed to the users. The first one deals with the authentication and payment process. This will be managed by the third party providers. The second one involves the interaction of the providers with the app. Since this stakeholder can upload data and file to the app it is important that only approved data type is inserted. In the table below we will describe the tactics used for the these two concerns.

Tactict	Pattern	Motivation	QA
Support User Initiative	Observer	The interaction of the users is a main factor of our app. We want them to have fully control of their actions either by cancelling or by resuming an action.	QA-4
	Lazy Registration	Avoid having to memorize another password and username may increase the acceptance of the user. With this pattern we allow them also to browse in the app and seeing what is available without being registered Interaction Design (2017). This may give a glimpse of what they get if they join us.	
Support System Initiative	Observer	By each upload from the providers we want our clients to have it on his device, without having to "ask" for it.	

6 Quality Requirements

6.1 Quality Tree



6.2 Evaluation Scenarios

From the requirements, 1.2, we could develop the following uses cases and depict the main quality attributes of this project.

Use Case	Description
UC-1: Register as Client	The Client registers an e-mail address.
UC-2: Login	The Client logins in to the system.
UC-3: Places an order	The Client chooses a Provider.
UC-4: Register payment	The Client registers a payment method.
UC-5: Register as Provider	The Provider registers their facility and products.
UC-6: Update availability	The Provider uploads their product catalog.

With the following use cases we will be able to define the major quality attributes that are involved in the development of this application. They should be measurable and testable so we can verify if the system meets the needs our stakeholders Cervantes and Kazman (2016).

ID	Quality Attribute	Scenario	Associated Use Case
QA-1	Usability	A Provider is able to register his company, to specify the kind of products he offers and upload a logo or picture of his shop and products in a easy and fast (within 5 Minutes) fashion.	UC-5
QA-2	Usability	A Provider is able to update the offers at any time.	UC-6
QA-3	Usability	A Client is able to search and filter options.	UC-6
QA-4	Interoperability	A Client can register his e-mail using another account (Google, Microsoft, Facebook) in a Federated Login	UC-1
QA-5	Interoperability	A Client can pay the order using a Mobile Payment Gateway (e.g. Stripe, Square, PayPay, SecurePay)	UC-4
QA-5	Performance	A Client registers his/her e-mail address and can immediately browse in the app.	UC-1
QA-6	Performance	A Client opens the app and he can immediately search for products or providers.	UC-2
QA-7	Performance	A Client chooses a Provider and places his order. After the confirmation of payment, a push-message is displayed in the app confirming the purchase.	UC-3
QA-8	Security	The payment process should be secure and within the app. It should also give the Client the feeling of security. The Client inserts his payment information it is processed by the payment operator.	UC-4 & QA-5

The defined quality attributes are represented in the following scenarios:

Usability			
Scenario	**Value**		
Source	Provider	Registered Provider	Client
Stimulus	wants to register his shops	wants wants to make a last minute offer	wants to search/filter offers
Artifact	app	app	app
Environment	working time, during afternoon	peak period, between 4 and 7 pm on Friday	peak period, between 4 and 7 pm on Friday
Response	offer available in the app	immediate availability of the offer in the app	display of the filter/search output
Response Measure	How long did the registration and upload process take? How many and what kind of error messages did the Provider get?	How long did it take to upload an offer? How many and what kind of error messages did the Provider get?	What kind of inputs did the user has to place until he finds what he wants? Did he have to type anything or were filter/search options available? How long it takes until the client finds a product?

Interoperability		
Scenario	**Value**	
Source	Client	Client
Stimulus	wants register using a Federated Login	wants to pay using existing mobile payment account
Artifact	app and Federated Login provider	app and Mobile Payment Gateway
Environment	peak period (on the context of the Federated Login provider)	peak period (on the context of the gateway)
Response	authentication succeed or failed	confirmation / declined
Response Measure	How much data was transmitted and how much was queued? Focus on System overload Kasunic and Anderson (2004)	Total amount generated data in the app that are transferred and processed and rejected by the gateway? Focus o connectivity and system overload Kasunic and Anderson (2004)

Performance			
Scenario	**Value**		
Source	Client	Client	Client
Stimulus	wishes to create an account	wants to search for a Provider	places an order
Artifact	app	app	app
Environment	weekend between 3 and 7 PM	peak period, between 6 and 7 pm on a Friday	peak period, between 6 and 7 pm on a Friday
Response	immediate access to the app	immediate access to the offers	confirmation of payment / payment declined
Response Measure	time between confirmation and access	how quickly does the client's device get update of availabilities	How long did take until the client get the confirmation/declined of payment?

Security		
Scenario	**Value**	
Source	Client	Client
Stimulus	clicks on registration using an existing login	click on pay using an existing mobile payment account
Artifact	app, API Gateway and Federated Login provider	app, Microservice and Mobile Payment Gateway
Environment	peak period (on the context of the Federated Login provider)	peak period (on the context of the gateway)
Response	authentication succeed or failed	confirmation / declined
Response Measure	Required time and effort to intercept and/or block requests (create Denial of Service (DoS))	Extension to image damage of the app and of the company in case of attack

7 Risk and Technical Debt

To measure the risks of this project we will use the following 3x3 risk matrix, which will help us develop the Risk Assessment:

Figure 9: 3x3 Risk Matrix Template
Source: Smartsheet (2017)

The elements used to identify the risk are shown in the picture below:

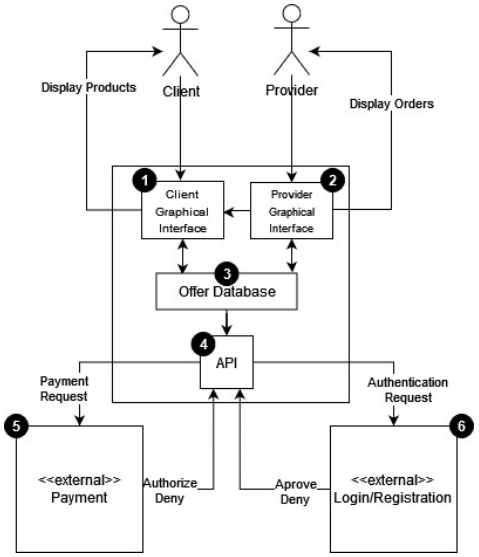


Figure 10: Modified from Figure 2

The following risk table was defined after several discussion with the team members:

Risk Criteria	Element ID					
	1	**2**	**3**	**4**	**5**	**6**
Unproven technology	1	1	1	1	1	1
Performance	2	2	1	1	1	1
Scalability	1	1	2	1	1	1
Availability	1	1	4	2	1	1
Data loss	1	1	3	1	1	1
Single points of failure	1	1	4	4	1	1
Security	1	2	3	2	2	2

7.1 Motivation

Risk Criteria	1 Client Graphical Interface	2 Provider Graphical Interface	3 Offer Database
Unproven technology	*not applicable*	*not applicable*	*not applicable*
Performance	Concerns regarding a such dynamic shop. Data displayed	Concerns regarding a such dynamic shop. Data update.	*not applicable*
Scalability	*not applicable*	*not applicable*	One database can be overwhelmed if the number of user is not limited for this prototype version.
Availability	*not applicable*	*not applicable*	In case of intense traffic the latency can be more than expected.
Data loss	*not applicable*	*not applicable*	Nowadays no company can survive in case of data loss. Technical damages can be mostly easy fixed, but moral damage stays forever.
Single points of failure	*not applicable*	*not applicable*	Only one component gives always this risk. Increasing the number of components increases also the total development costs
Security	*not applicable* the client's input is always processed by the API and by the third party providers	If no strong data filtering exists, providers can upload malicious files or execute unwished commands.	The filtering of the input should occur mostly on the server side, Source no external access can figure out, how it is implemented.

Risk Criteria	**4 API**	**5 External Payment Service**	**6 External Authentication Service**
Unproven technology	*not applicable*	*not applicable*	*not applicable*
Performance	*not applicable*	*not applicable*	*not applicable*
Scalability	*not applicable*	*not applicable*	*not applicable*
Availability	The access to the products become unstable.	*not applicable*	*not applicable*
Data loss	*not applicable*	*not applicable*	*not applicable*
Single points of failure	In case of failure login, registration and payment are compromised.	*not applicable*	*not applicable*
Security	Lack of practical experience within the team about this topic. we rely on the service provided by the third party companies	SLA Less than 99.5% but equal to or greater than 95.0% Paycore (2019)	SLA < 99.99% - >= 99.9% auth0 (2014)

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